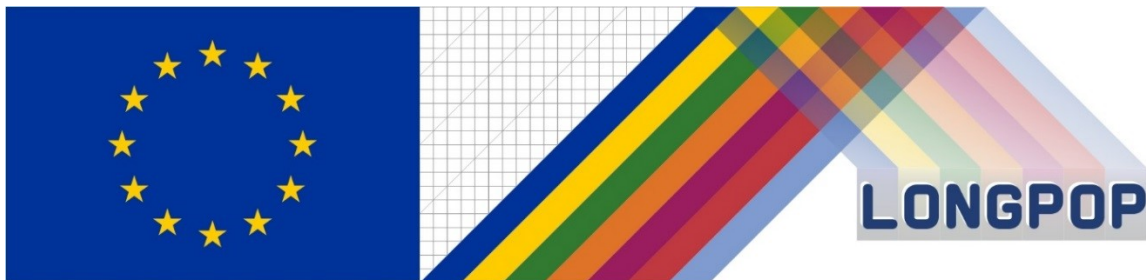THE UNIVERSITY *of* EDINBURGH
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# Neighbourhood conditions and mental health: time and space over the life course

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# Contents

# Abbreviations

APC - Age, Period and Cohort

BCS70 - 1970 British Cohort Study

CMDs - Common mental disorders

CVD - Cardiovascular disease

ELSA - English Longitudinal Study of Ageing

GBD - Global Burden of Diseases

HPA - Hypothalamic–pituitary–adrenal axis

ICD 10 - International Classification of Diseases, 10th Revision

LSOA - Lower Super Output Area

NHS - National Health Service

OR - Odds Ratio

PIS - Prescription Information System

SES - Socioeconomic Status

SHARE - Survey of Health, Ageing and Retirement in Europe

SIMD - Scottish Index of Multiple Deprivation

SLS - Scottish Longitudinal Study

SMR04 - Scottish Morbidity Database, Mental Health Inpatient and Day Case dataset

UK - United Kingdom

US - United States of America

WEMWBS - Warwick-Edinburgh Mental Wellbeing Scale

YLDs - Years lived with disability

# List of Figures

# List of Tables

# 1. Introduction

Mental health problems are a significant public health concern due to their high burden for individuals and societies, caused by disability and economic costs. According to the Global Burden of Diseases (GBD) estimates, in 2010 worldwide 22.9% of years lived with disability (YLDs) were due to for mental health and substance use disorders, making them one of the leading causes of disability among all health conditions.[1] In Western economies, the proportion is even higher. In the United Kingdom (UK), they are responsible for 28% of lost years caused by disability.[2] Mental health problems constitute a major economic challenge, causing not only direct costs such as outpatient care and medication, but also indirect costs due to reduced ability to work or early retirement. The total cost of all brain disorders was estimated at 800 billion EUR in Europe (2010), more than the cost of all cardiovascular diseases, cancer, and diabetes together.[3] In the UK, costs of mental health problems are likely to amount to between £70-100 billion each year.[2] Although psychiatric disorders often occur together, they comprise a very heterogeneous group with different symptoms, aetiology and treatment.

## Depression[i] and anxiety

A substantial part of the mental health burden is due to common mental disorders (CMDs). CMDs are marked by emotional distress, problems in daily function and significant impairments in quality of life, and comprise different types of depressive and anxiety disorders.[4] Depressive illnesses and anxiety disorders often share similar aetiology[5,6] and are highly comorbid; about 60% of individuals with depression report lifetime history of anxiety disorders.[7] In a nationally representative survey, 16.2% of English adults met the diagnostic criteria of at least one CMD in the week prior to interview.[4]

Depression is characterised by negative changes in mood, interests, and pleasure, and by a range of associated emotional, cognitive, vegetative and behavioural problems, which cause significant distress for individuals.[5,8] Anxiety is a mental state anticipating (potential) threats accompanied by behavioural and physiological responses. In a pathological form, sensations become inappropriate and anxiety can severely interfere with normal life.[9] In every year 8.7% of the UK population experiences mood disorders, while 18.2% suffer anxiety disorders.[10]

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[i] Although the diagnostic category mood or affective disorders (ICD 10: F30-39) includes also bipolar disorders (ICD 10: F30-31), when writing about depression, the author means almost exclusively unipolar depression (ICD 10: F32-39).

Epidemiological studies show consistently higher rates of depression in women than in men (2:1),[8,11] and elevated rates of almost all CMDs are observed among women.[4]

Common mental disorders are often linked to physical impairments, such as diabetes, stroke and cardiovascular events: they significantly increase the risk of developing severe health conditions and are more prevalent in clinical groups.[8] A review has shown that depression and anxiety are independently associated with elevated risk of cardiovascular disease (CVD): CVD patients with CMDs have worse health outcomes and higher mortality in cardiovascular events than those without.[12] Clinically relevant cognitive deficits have been identified in patients with major depression, affecting visual learning, memory and executive functions.[13] Furthermore, CMDs increase the risk of suicide ideation and suicide attempts; according to a meta-review, individuals with depression have 20 times higher risk, with anxiety disorders 3 times higher risk, than the general population of dying in suicide.[14]

## Individual determinants: the biopsychosocial model

The biopsychosocial model of health emphasises a multifactorial aetiology in the development of CMDs, where stressors (e.g. life events, physical diseases) interact with individual vulnerability, influenced by biological, psychological and social factors (Figure 1).[15]
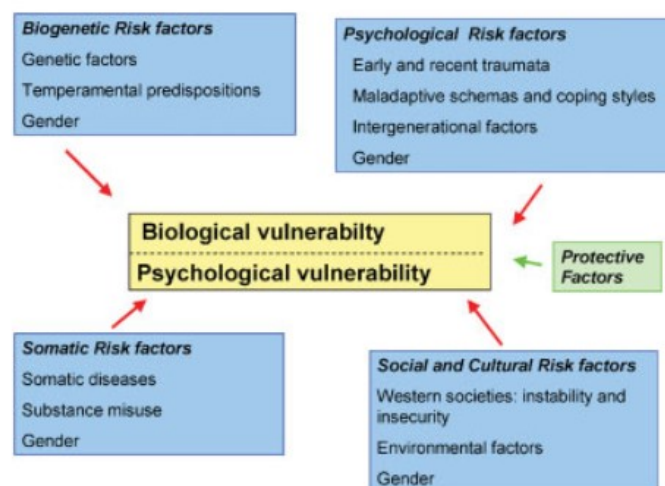


*Figure 1: Biopsychosocial model of vulnerability of depression with major risk and protective factors (p. 315)[15]*

Research on *biogenetic determinants* of CMDs has demonstrated clustering of major depression within families: genome-wide association and linkage studies estimate the heritability of major depression as approximately 35%,[8] with evidence for sex-specific genetic differences causing higher heritability in women than in men.[7] Despite the emerging genomic

research on several mental disorders, the genetic background of anxiety disorders has been still neglected by robust genetic analysis.[16] *Psychological factors*, such as early socialisation, childhood maltreatment, relationship to parent and peers, cognition or coping with stressful life events can shape the occurrence and onset of depression and anxiety.[17-19] One of the most eminent psychological theories about the development and maintenance of depression is Beck's cognitive model.[20] The central construct of his theory is the cognitive triad (negative view about world, self and future), a distorted, extreme and negative way of perception and thinking, which is responsible for the emotional, behavioural and physiological symptoms of depression. Earlier schemas, such as childhood experience, shape the dysfunctional attitudes, which - by activation of an external stressor - guide the processing of incoming information and lead to cognitive distortions, characterised by the cognitive triad.[21]

*Social and socioeconomic factors* such as income, education, social status or social support are significant determinants of health with an even stronger relationship to mental health problems.[22] Health inequalities follow a social gradient, where the disadvantaged and poor suffer more frequently from mental health conditions.[23] A meta-analysis on social determinants of depression found 1.8 times higher odds ratios (OR) of depression in individuals with lower socioeconomic status than in the highest group.[24] Higher rates of anxiety disorders have been also found in groups with lower socioeconomic position.[25] Although gender differences in CMDs are often ascribed to genetic background, they can be also associated with social roles of men and women in the society. As women are overrepresented in lower, and underrepresented in higher, occupational grades, comparing those working in the same job can largely decrease gender differences in psychological distress (depressive and anxiety symptoms together).[26] Moreover, a meta-analysis has recently confirmed that social support is an important protective factor against depression. Individuals in every life stage show lower prevalence when they perceive more (emotional, instrumental or informational) support from their family members, friends and from their social networks.[27]

## Contextual factors: the role of neighbourhood

Within social science and medicine, the study of the effects of social and environmental *context* on health goes back over a hundred years, to Durkheim's work on suicide.[28] Since then findings suggests that the surroundings where we are born, live and work have a significant effect on health. However, in comparison to individual level factors, neighbourhood influences are still poorly understood and studies often show conflicting results, strengthening critical voices

against the independent effect of neighbourhood over individual or household variables.[28,29] In spite of this criticism, a continuously increasing number of research publications (especially in the US, Canada and Australia) and a growing interest from the public sector signals the major public health concern of neighbourhood conditions.

In comparison with studies focusing on physical health or health behaviour, much less attention has been paid to investigating the relationship of neighbourhood and mental health. However, systematic reviews show elevated risks of CMD problems in socially or physically disadvantaged neighbourhoods; there are major gaps in our knowledge.[30-38] Existing literature is particularly lacking in high quality studies with rigorous methodological and statistical design. Using longitudinal datasets, research would be better able to tackle methodological concerns occurring from the causal inference between neighbourhood and mental health and to examine short- and long-term consequences of adverse or health promoting neighbourhoods.[28,37,39] Furthermore, a better understanding of the neighbourhood level determinants of mental health and identifying vulnerable groups in this context would provide an evidence-based background for developing and addressing community health programmes or preventions and engage policy makers in creating good urban planning policies.[40]

After this introduction, I will focus more closely on the relationship between neighbourhood level determinants of depression and anxiety, and present current approaches of epidemiologic research. Introducing the life course theory, the concept of resilience and vulnerability, I am aiming to highlight research gaps arising from the lack of longitudinal research in the geographic distribution of mental health problems. By concentrating on the (1) relationships between neighbourhood conditions and psychological distress across the entire life course, (2) analysing vulnerable groups and (3) life course determinants of vulnerability and resilience to depression in adverse neighbourhoods, this piece of work aims to add relevant contributions to the existing literature. Furthermore, tailoring the appropriate methodology and sources of information to each research question (e.g. ageing birth cohorts, panel studies and administrative datasets), the proposed PhD project hopes to overcome methodological barriers of previous research. Finally, in order to assess temporal and methodological feasibility of the work, I will identify key resources and training requirements as well as give a detailed time plan for the project.

# 2. Literature review

## 2.1 Neighbourhood and mental health

*Neighbourhood conditions*

Research on the neighbourhood-level determinants of mental health uses different distinctions to describe places where individuals are born, live and age, their residential environment. Although these works often use different categorizations, they always stress the effects of physical and social conditions. In his systematic review on neighbourhood and adult depression, Kim[36] broadly categorized the neighbourhood into *material/physical* and *psychosocial/social* environments, which interact with individual level variables (Figure 2).
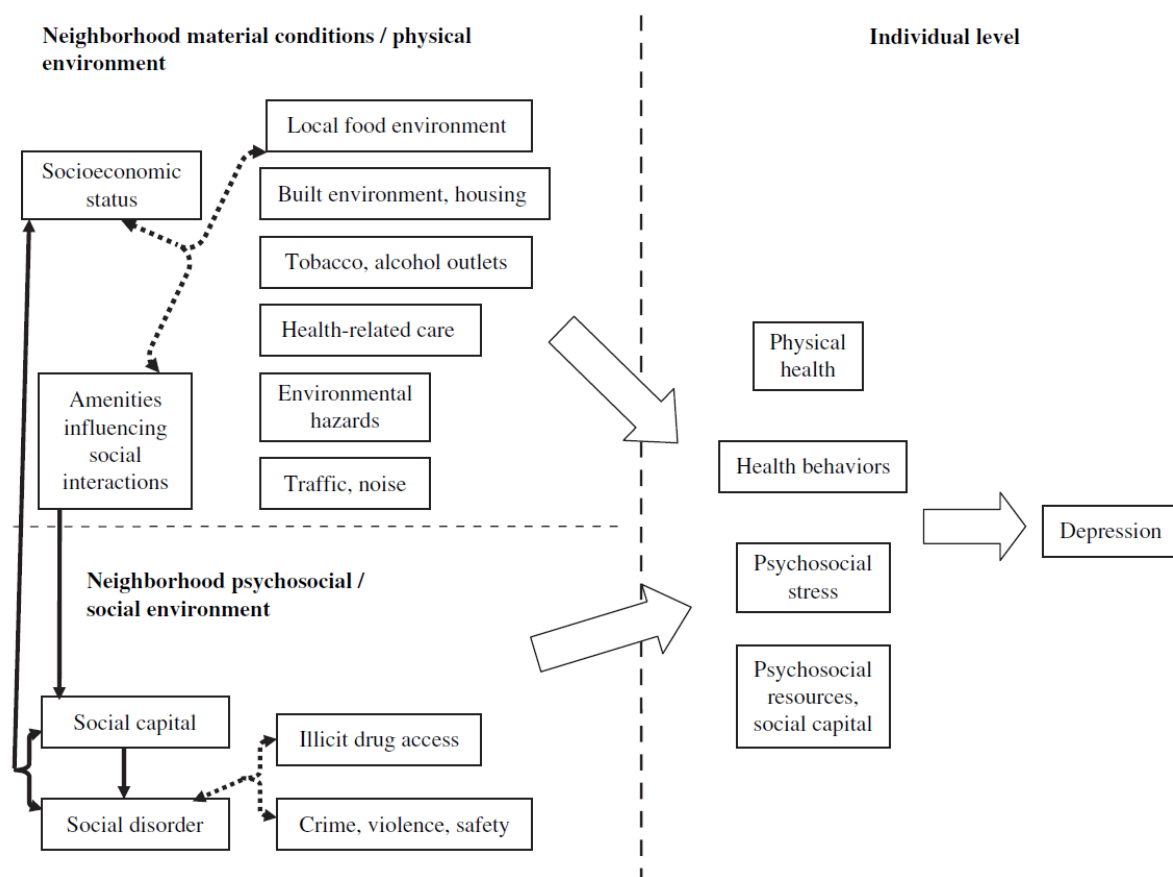


*Figure 2: Social and physical neighbourhood condition and depression by Kim, 2008[36]*

(1) The first group includes determinants such as neighbourhood socioeconomic conditions, the natural and built environment and environmental hazards, which might affect health behaviour (e.g. substance use, physical activity), physical health, and ultimately mental health. (2) The social dimension of the neighbourhood environment mainly includes social capital and

social disorder. The former can be defined as features of social organisation, which includes social trust, reciprocity and civic participation and might be connected with better health behaviours and stress buffering psychosocial resources. By contrast, social disorder is the disintegration of processes and structures, which are normally responsible for preserving safety and order in the community. Signs of disorder such as drugs, crime and lack of social control might lead to psychosocial stress and influence mental health.[36] Although the classic differentiation between physical and social characteristics of neighbourhood might need to be slightly reconsidered due to overlapping characteristics (e.g. vandalism), it provides still a useful framework when describing neighbourhoods.

Another differentiation by Galster[41] gives a broader understanding of neighbourhood effects and besides social and environmental, introduces also geographical and institutional mechanisms. *Geographical effects* refers to larger scale economic and political determinants, which influence the local neighbourhood. Particular areas might have restricted access to job opportunities or public services, based on macro level factors. *Institutional mechanisms* refers to actions of external institutes or persons, which influence neighbourhoods' lives by controlling resources. Area-based stigmatisation by institutions can reduce job and other local opportunities and influence the self-esteem of local residents. Institutional resources, such as charities, schools, clinics and other public or private services as well as local market characteristics (e.g. fresh food market, illegal drug markets) may also influence neighbourhood health.[41] Moreover, Allen et al.[23] emphasise *humanitarian settings* (besides natural and built environments and healthcare infrastructures), as an important determinant of mental health on the community level. This refers to man-made or natural events, such as conflicts, war and natural disasters, which affects individuals and communities.

*From neighbourhood to mental health: the question of causality*

Although causal inference is an important concern in epidemiology – not just because of theoretical considerations but also in the implementation of interventions or creation of evidence based policies – it often remains unexplained in empirical findings. Adverse neighbourhoods can influence mental health outcomes *(causation hypothesis)*, but also individuals with mental health conditions might show downwards social and geographical mobility, by moving to less attractive neighbourhoods *(drift or selection hypothesis)*. In their reviews, Muntaner[42] and Lorant[24] emphasise that, although there is more evidence for social causation effects between individual or contextual socioeconomic status and mental health; moving downwards to less favourable neighbourhoods among individuals with mental

10

disorders can be also a valid explanation, especially for severe mental health conditions, such as psychotic disorders. Causation and selection are not mutually exclusive hypotheses and they can interact over the life course and even across generations,[24] making it hard to distinguish between them using cross-sectional or short term longitudinal analyses.

For the explanation of causal effects between neighbourhood and mental health, Elliott[43] draws upon the *stress process model* from Pearlin, which is based on sources of stress, mediators of stress and manifestations of stress.[44] Although the original model concentrates more on individual level factors, it provides a useful framework for interpreting contextual effects. According to this theory-driven model, neighbourhood might influence health through direct effects, and through conditions which influence vulnerability or individual resources.[43] On the contrary, a more data-driven framework from Blair et al.[45] differentiated between five main underlying pathways between neighbourhood and depression: neighbourhood-based stress, protective and supportive social networks, resilience to stress, aesthetic and form of neighbourhood and sense of control and agency. Although both models have advantages and disadvantages, in the following I would like reframe and integrate them, in order to provide a more comprehensive explanation of neighbourhood effects.

(1) *Direct effects* from neighbourhood to mental health might operate by causing either higher stress level in residents or buffering effects of stressful environments. The stress model assumes that higher stress influences the cortisol level and the functioning of the hypothalamic-pituitary-adrenal (HPA) axis, which in turn plays an important role in the aetiology of major depressive disorders and cardiovascular problems.[46,47] Residents living in neighbourhoods with high environmental stressors, such as road traffic, railway and aircraft noises,[48] show elevated risk for depression due to heightened biological stress reactions or sleeping problems. Similarly, higher air pollution may cause inflammation in the organism and oxidative stress, which contribute to the risk of depression.[49,50] Moreover, living in high crime neighbourhoods increases the likelihood of becoming a victim of violence, which might lead to mental health problems.[43,45] On the other hand, evidence suggests stress buffering effects of green space, by reducing the exposure to stressful environmental and social conditions and by restoring adaptive resources,[51] which mechanism operates through the HPA axis and the daily cortisol level.[47]

(2) Neighbourhood stressors can influence the *vulnerability to stress* in resident individuals.[43] Living in social disadvantaged areas with high unemployment rates and job scarcity might be

particularly adverse for those currently looking for a job. Whether there is an interaction effect (local social inequalities model) or effects are additive (collective resources model), is controversial in the literature. A study analysing the Whitehall II study of British servants did not find any interaction effect between individual and neighbourhood level SES but an additive mechanism.[52] Taking into consideration urban and rural differences, a cross-sectional study suggested an interaction effect between rural context and employment, where rural dwellers in employment have better mental health, than residents in urban neighbourhoods.[53] In addition, neighbourhood might be important for vulnerable groups. Neighbourhood poverty and high crime rate are associated with a higher risk of depression in the elderly;[54,55] in particular, living alone and being exposed to adverse perceived neighbourhood has a strong effect on health outcomes.[56]

(3) Neighbourhood *resources or lack of resources* influence stress and mental health outcomes. Social network, social cohesion and social capital in the direct neighbourhood are important protective factors for mental health, even after adjustment for individual level variables.[38,57-59] A mixed-methods approach based on three ageing UK cohorts, found robust and moderate positive association between neighbourhood cohesion and mental wellbeing, which might operate through facilitating participation in local social groups.[58] Although factors which influence vulnerability (2) and which strengthen resources (3) are separated in this classification, they can closely interact. Furthermore, when considering social deprivation and social cohesion in the same model, findings show that social cohesion attenuates the negative effect of deprivation on mental health, which might be important for interventions and policy making in disadvantaged areas.[59]

(4) The effect between neighbourhood and mental health can be *mediated through underlying factors*. One of the most commonly cited mediators is physical activity and neighbourhood walkability. Physical exercises have a mild to large antidepressant effect so that they can reduce the risk of developing depression.[60] Green qualities facilitate and promote physical exercises, walking, cycling and other recreational sport activities are common in urban parks and gardens, which in turn influence mental health.[51,61,62] Although walkability in the least deprived neighbourhoods is positively associated with mental health, the relationship in the most adverse neighbourhoods is the opposite, which might be caused by environmental stressors, such as traffic, noise or abandoned buildings.[63] Other mediating pathways between neighbourhood and mental health might include sense control, social norms and agency.[43,45]

Perceived and objective neighbourhood effects are strongly interrelated and they can influence mental health by direct and indirect ways, such as affecting individual vulnerability and personal resources or operating through other mediating factors. Empirically distinguishing between these effects is particularly challenging. In the following, I give a short summary of this complex relationship through the example of neighbourhood crime, which will be one of the main predictors in the project proposed later.

Reported neighbourhood crime is a significant risk factor for mental health and wellbeing, and its complex relationship can be direct and indirect (Figure 3).[64] Becoming a victim or witnessing violent acts might proceed several common mental health conditions like post-traumatic stress disorder, major depression or anxiety disorders, in particular for women.[65] On the other hand, increased local neighbourhood crime is also negatively associated with mental health, with more distinct effects for vulnerable groups, such as women and elderly.[64,66] A longitudinal examination with a three years follow-up found significant association between rising crime in the neighbourhood and increasing distress. Risk estimates were particularly high for women, especially for malicious damage (OR=2.4, 95% CI 1.88-3.05).[67]

One of the possible mediator variables is *fear of crime*, a subjective perception about neighbourhood safety, which is often associated with mental health outcomes.[68,69] In an extensive review, Lorenc at al.[64] outline evidence for several pathways with regards to the influence of fear of crime on mental health. (1) Fear of crime can have a direct impact on mental health by inducing chronic psychological distress. Individuals with higher fear were 1.9 times more likely to have depression and 1.8 times more likely to have anxiety symptoms.[68] (2) Fear of crime might lead to avoidance behaviour and restrained mobility in the neighbourhood, and thus influence mental health by limiting physical activities and social interactions in public places.[64] (3) There is also evidence for a bi-directional relationship between fear of crime and mental health. A prospective cohort study showed that poorer physical and mental health increases fear of crime in individuals, which maintains the emotional reaction to crime.[69]

Not only the direction of the relationship between the fear of crime and mental health appears to be conflicting, but also the connection between crime (objective measure) and fear of crime (subjective measure) is more complex than expected. Criminologists have been interested for a long time in the unreliable relationship between the actual rate of crime and fear of crime.[70]
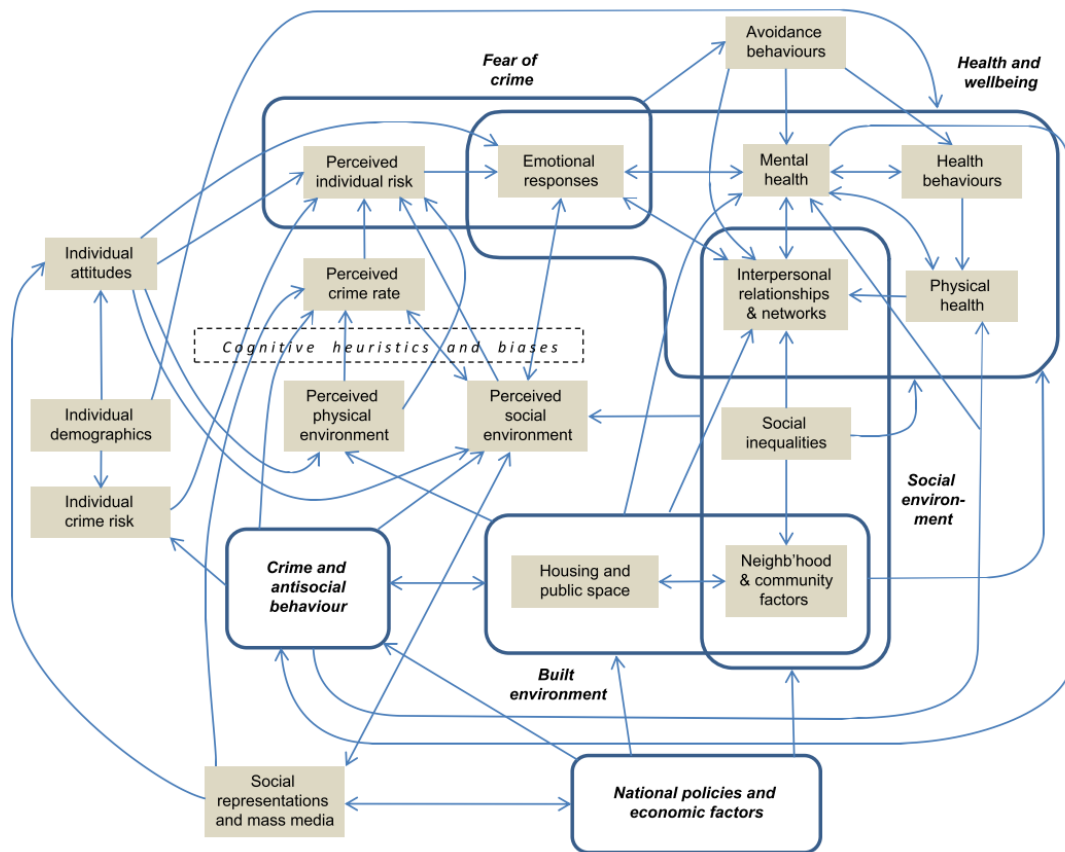
*Figure 3: Theoretical model of crime, fear of crime and mental health by Lorenc et al, 2012[64]*

Although this paradox might be partly explained by the underreporting of criminal events, cognitive biases (habituation, heuristics) and interpersonal relationships (information transfer in the local neighbourhood) also have to be taken into account.[64,68] Given the weak association, one can conclude that a drop in neighbourhood crime rates does not necessarily influence the subjective feeling about crime and thus the mental health status of the population.[68]

Future research on crime and mental health should therefore examine the effect of neighbourhood crime rates across the entire lifespan. Exposure to crime in vulnerable life stages or critical periods might influence fear of crime more directly, which in turn, affects subsequent mental health. A significant early life risk factor of psychiatric disorders is low birth rate and preterm. Research has shown that living in a neighbourhood with a higher crime rate is a chronic stressor during pregnancy and it is associated with a lower birth rate, even after adjustment for area level deprivation.[71]

## 2.2 Ageing and the life course approach

*Mental health and neighbourhood in ageing societies*

Epidemiologic research on common mental disorders has shown that the prevalence rates of CMDs vary across the life span, driven by age-related factors.[72] Although, the median age of onset in major depression is 25 years (with a peak between adolescence and adulthood)[8] depressive disorders are one of the most prevalent disabilities among older adults, affecting over 13% of the older population.[73,74] This rate continues to rise in late old age, where 40% of people over the ages of 85 exhibit depression.[74] Different patterns of risks and specific late life experiences are associated with the onset and course of CMDs. Retirement, lower income, loss of status, death of spouse or close friends, age discrimination, living alone or in residential care settings, limited mobility and lower social support can all contribute to higher vulnerability among older adults.[11,56,74] Chronic physical and neurodegenerative disorders, like diabetes, angina or dementia occur more often in later life and are important risk factors for first onset, persistence and reoccurrence of depressive symptomes.[74] Demographic changes, low birth rates and ageing emphasise the importance of late life depression and psychological distress.

With increasing morbidity and limited mobility, older adults become more dependent on their local amenities and neighbourhood resources. As they are less able to relocate from disadvantaged neighbourhoods, contextual factors of CMDs become particularly important. Accordingly, systematic reviews suggested that older adults might be more vulnerable to adverse neighbourhoods than younger ones.[33,75] Neighbourhood social and environmental characteristics such as neighbourhood poverty, lack of green space, less access to public transportation and crime have been consistently associated with late life depression.[54,55,76] In a random sample from New York, a range of adverse neighbourhood conditions on census-tract level predicted higher risk for late life depression.[55] Another study from the same city suggested that the adverse effects of neighbourhood deprivation can be partly mediated by area level homicide rate and, therefore, violence prevention might attenuate the negative effects of neighbourhood poverty on mental health.[54] Furthermore, lack of public transportation and lower neighbourhood social capital predicted elevated risk of depression in older residents in Berlin, suggesting that they rely more on the social support from their direct neighbourhoods.[76]

*Resilience and healthy ageing*

Although adverse neighbourhoods might have long-term effects on health, not all elderly living in those neighbourhoods develop depression. Older age is not necessarily characterised by the

decline of physical and mental health or loss of social connections. Positive or healthy ageing is increasingly become a focus of geriatric research, particularly in the context of living with physical morbidities and restricted mobility. The Italian island of *Sardinia* is known in research for the exceptional longevity of its elderly population and their resistance to age related diseases. Comparing elderly people's mental health status in Sardinia with these in Lombardy, significantly lower rates of depressive symptoms were found, especially in rural areas.[77] Old Sardinians receive strong social and emotional support from their neighbourhood, remain physically active in their older age and are more respected by the younger generation. Moreover, they are less likely to consider occurring depressive symptoms as an expression of mental illness and therefore rely more on the support provided by family members and friends.[78] Although living alone or loneliness is a significant risk factor for mental health problems among older individuals, perceived social neighbourhood or social network integration can largely mitigate this relationship, especially among women.[56,79]

Consequently, older adults are not only more vulnerable to adverse neighbourhood conditions, but they can also better benefit from health promoting social and physical characteristics of their immediate surroundings,[80] by building up resilience against late life chronic or acute stressors and attenuating the negative effect of loneliness.[56] The term *psychological resilience* in ageing populations describes the ability to positively adapt and response to adversities as well as achieve, retain and manage physical and mental health after illness or stressful events.[81,82] According to the *stress inoculation hypothesis*, even previous exposure to stressful events can contribute positively to later resilience, as long the stressor was tolerable and not toxic.[81] Exposure to moderate or positive childhood stressors, that are not overwhelming and usually can be overcome (e.g. daily hassles, not having enough money for hobbies), might buffer the effect of subsequent stressors, attenuate depressive response and contribute to positive coping and later resilience.[81,83]

### Life course approach: vulnerability and neighbourhood

Human lives do not only take place in the *"here and now"*, but also have a strong temporal aspect. The dynamic interaction of historical and contemporary time with context and processes influence our actual state or condition, which is an always-changing result of interdependent pathways through our entire life course. Studying changes in time and developments over individual's life and beyond is becoming a prominent theory in social, behavioural and medical sciences.[84-86] In epidemiological research, the *life course approach* can be understood as the study of long-term biological, behavioural and psychosocial pathways linking physical and

social exposures to health conditions and disease risks. These processes can operate across the individual's entire lifespan, from foetal period through childhood and adolescence until late adulthood, but also across generations.[85,87] Long-term pathways might operate in additive or interactive ways; life course epidemiology distinguishes between two main theoretical models: (1) The *critical and sensitive periods* hypothesis postulates that there are time windows during our life, when exposure to particular stressors may result in specific disorder or increase the risk of certain health conditions. (2) The *accumulation model* assumes that adverse exposures or health damaging behaviours accumulate (in a correlated or not correlated way) over the life course and gradually increase the risk of illnesses.[85] Accordingly, focusing only on particular life stages or adjusting for age (or gender) might miss relevant findings related to life stages.[88]

Applying the interdisciplinary framework of life-course approach, evidence was found for early life determinants of later depression, which correspond to the psychological model of depression.[20] Studies from western countries suggest, that family social environment,[89] parental education,[90] childhood illnesses,[91] childhood maltreatment,[18,19] but also the quality of parenting[91] have prolonged effects on mental health. Similar to individual factors, associations between contextual factors and health might vary across the life course, while adverse or health-promoting neighbourhoods may have prolonged effects on mental health. However, in comparison to individual factors, the investigation of life course effects of area on health is even more challenging. Research not only has to deal with attrition (temporal drop out due to immigration, death or refusal) or other sources of biases commonly associated with longitudinal analyses, but also gain consistent neighbourhood level information on equivalent geographical level over time.[92]

In recent years, there have been promising theoretical attempts to incorporate the life course perspective in research, focusing on historical and contemporary contextual or neighbourhood determinants of health.[88,92-96] However, only a few of them have conducted convincing empirical analysis. Living in disadvantaged neighbourhoods in earlier life has long-lasting effects on mortality and on health status. A study from the UK, linking a census-based administrative sample (coverage England and Wales) with historical data on neighbourhood deprivation from the 1930s, found higher relative risk for illnesses and death in later life among those living in areas with high unemployment in their childhood. Neighbourhood conditions remained independent risk factors even after adjustment for individual variables.[94] Another study from the US followed its participants over 38 years and found that adverse neighbourhood conditions at age 20-30 explained one-quarter of the variation in mid-to-late

life self-assessed general health.[96] An 26-year prospective study from Sweden suggested that neighbourhood unemployment (regardless of individual unemployment) has a significant impact on functional somatic symptoms at the age of 42.[97] Moreover, physical capability in older age can be influenced by earlier neighbourhood level conditions.[92] Analysing the relationship between life course of place and mental health is even more lacking in scientific evidence. A robust examination of neighbourhood change and depression during adolescence and adulthood pointed out that neighbourhood effects on mental health are dependent on age and gender, and life course events can significantly influence this relationship. As a result, after controlling for current life course changes (marriage, degree etc.) the previous neighbourhood effects were majorly attenuated, but a decreasing risk for depression remained significant for women moving to better well-off neighbourhoods during this important life course transition.[29] Another study investigating the associations between green space availability and mental health in the UK, emphasises that while men have better mental health outcomes in mid-adulthood when living near to green spaces, women benefit more from a moderate access to greenery.[98]

Examining the temporary dynamic of exposures, vulnerability and periods of illnesses, research requires longitudinal studies with advanced statistical analysis. However, the use of longitudinal design does not necessarily make research life course. Because direct pathways are often weak and are only able to explain a small part of the total variance, it is important to investigate interacting moderating and mediating pathways across the entire lifespan and use explanatory models,[85] in order to provide a plausible causation of long-term health risks. According to the literature, possible underlying pathways between childhood risk factors and adult depression might include adult SES,[90] emotional reactivity[89] and locus of control in adolescence.[99] In addition, our understanding of vulnerability and resilience has to be reframed in the sense of the life course framework and completed with a temporal dimension and a dynamic interaction between resources and stress. Vulnerability can be defined as *"a weakening process and as a lack of resources in one or more life domains that, in specific contexts, exposes individuals or groups to (1) negative consequences related to sources of stress, (2) an inability to cope effectively with stressors, and (3) an inability to recover from stressors or to take advantage of opportunities by a given deadline"* (p 8).[100] Similarly, resilience is also an ongoing process, where influences from early life until advanced age are accumulating across the lifespan, and building up resources of resilience, leading to better physical and mental health.[81,82]

## 2.3 Methodological concern

Considering the relationship of mental health and neighbourhood over the life course, research face several methodological concerns.

1. Not only do neighbourhood features influence mental health, but also individuals can migrate to particular neighbourhoods. Therefore, **longitudinal research** is needed to overcome potential risks arising from different causal inferences and to test long-term effects of neighbourhood condition on psychological distress.

2. Longitudinal and life course analysis distinguish between **age, period and cohort effects (APC)**, three distinct ways in which health can change over time. Age effect means the individual ageing process through the life span; cohort effects describe changes between cohort groups and period effects are the consequences of time-specific influences (e.g. natural disaster) affecting all cohorts.[101] As different temporal changes might cause various health outcomes and require different public health interventions, it is important to understand these changes and clearly distinguish between them.[101]

3. The studies previously referred to often used various **size of geographical areas**, which might significantly influence findings. As the contribution of neighbourhood area effects to the total variance of CMDs is notoriously low, smaller scale geography might ensure higher homogeneity within areas.[102] This, in turn, would lead to better understanding of neighbourhood level effects. The consistent use of small area data during longitudinal studies is crucial.

4. Spatial data often rely on self-reported information. Only objective measures of neighbourhood can overcome same source bias (both exposure and outcome is self-reported), which is important as individuals with mental health problems[30] and with low SES[103] tend to describe their neighbourhood as more disadvantaged. On the other hand, setting arbitrary neighbourhood borders and describing them along objective categories created by the researcher might be far from residents own perception about the place where they live. Therefore, researchers have to be cautious about the different **sources of neighbourhood characteristics** (subjective and objective measurement) and interpret them accordingly.

5. Spatial-temporal analysis can increasingly benefit from the use of data science. **Big Data** has enormous potential in mental health research and diseases prevention by integrating and linking different sources of data on individual level, such as administrative databases, cohort studies or spatial information.[104-106] It can also deal

with the often observed low response rate and high loss to follow up by disadvantaged and more vulnerable study participants,[106] one of the greatest challenges of epidemiological research. Big Data or administrative data is not collected for research purposes; therefore, careful consideration of variables, accurate data cleaning and management is crucial for successful research projects.

# 3. Research aims

After summarizing the literature on neighbourhood level determinants of mental health, and reframing it in a life course approach, four research gaps can be highlighted, which will yield separate - but closely connected - research projects. They all emphasise the importance of a life course approach by analysing mental health in place and time and build on each other's findings:

(1) There is a need to *critically evaluate the strengths of evidence* on the relationship between neighbourhood social and physical conditions and psychological distress, by including all social and physical neighbourhood conditions, and setting findings in a life course framework.

(2) The second project aims to examine systematically *vulnerable groups* to depression in exposure to adverse neighbourhood conditions. Are there specific vulnerable groups which show elevated risks for depression and anxiety, when living in disadvantaged neighbourhoods? What are the main sociodemographic characteristics of these groups?

(3) The third project will focus on age effects, by examining the relationship of neighbourhood and mental health over the *individual's life course*. Does adverse neighbourhood have a long-term effect on mental health? Does this effect accumulate over a longer period or are there life stages in which exposure is more strongly associated with later mental health outcomes?

(4) Even in particularly vulnerable groups, such as older adults, there are individuals who remain resilient to depression. This last project focuses on the *life course determinants of resilience and vulnerability* in adverse neighbourhoods. What are the long-term social, financial, educational and health characteristics of resilient and vulnerable individuals?

# 4. Projects

In the following pages I will give a short introduction to each project and introduce the samples/datasets, as well as possible variables I intend to use for the investigation of my research aims. Progress and major challenges will be highlighted.

## 4.1 Systematic review

The first project aims to summarize the literature on neighbourhood conditions and mental health, including population studies with longitudinal and experimental design and provide a substantial background for the empirical research projects. Although there are several narrative[45,64] and systematic[33,36,37,75,107-109] reviews in the field, only one used meta-analytic approach concentrating on longitudinal studies assessing neighbourhood socioeconomic conditions.[37] The last systematic review including all possible neighbourhood conditions (social and physical) was conducted a decade ago and there is no review at all on environmental stressors (air pollution, traffic noise etc.) and mental health. More importantly, none of the reviews took into consideration the life course framework when interpreting the results, or compared perceived and objective neighbourhood. Therefore, this systematic review aims to incorporate the following points: (1) analysing the relationship between neighbourhood and mental health; (2) building a model of all neighbourhood determinants of psychological distress over the life course; (3) highlighting vulnerable groups and underlying pathways. (4) Furthermore, relevant sample and study characteristics (e.g. objective vs subjective measurement of neighbourhoods) will be taken into consideration, in order to interpret different risk estimates.

**Methods**

To ensure high methodological and reporting standards, the review will be conducted following the Meta-analysis Of Observational Studies in Epidemiology (MOOSE) guidelines[110] and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).[111] Moreover, a detailed protocol has been already published at the PROSPERO website for systematic review registrations (CRD42017055661).

*Exposure*: The systematic review focuses on all physical and social conditions to which people in resident neighbourhoods might be exposed. (1) Under *physical conditions* I include not only neighbourhood socioeconomic status and deprivation, but also built and natural environment (e.g. green space, buildings), and other relevant environmental exposures in the residential area

(air pollution, traffic noise). (2) Essential qualities of *neighbourhood social environment* are social cohesion/social fragmentation, social capital and also social disorder and crime. Objective and subjective measurements of neighbourhood will be included.

*Outcome:* The main outcome of the review is psychological distress, anxiety and depressive symptoms. Different sources of information will be included such as service use data, diagnosis by clinical interviews, standardized questionnaires for depressive and anxiety symptoms, and psychological distress.

*Study design:* The review will include studies with longitudinal and experimental design; cross-sectional studies will be excluded.

*Search strategy:* A systematic and multistage search strategy will be applied to find relevant publications, including searches in electronic databases (CAB Abstracts, Embase, MEDLINE, and PsycINFO per OVID; ASSIA, IBSS, Social Services Abstracts and Sociological Abstracts per ProQuest; Scopus; Web of Science), hand searches of relevant journals and grey literature, and sighting reference lists. A preliminary, non-systematic search in March 2017 yielded 63 studies, with a majority assessing depressive symptoms and psychological distress.

*Assessment of bias and quality of evidence:* As the quality of a review depends on the quality of studies included, a study level and outcome level assessment of bias is essential. Quality appraisal of all included studies will be done with the Quality Assessment Tool for Quantitative Studies, designed by the Effective Public Health Practice Project.[ii] Funnel plots of the risk estimates against standard errors and Egger's regression tests will be calculated to detect publication bias.

*Data synthesis:* Narrative data synthesis will be conducted to structure and interpret findings. When the number of comparable studies allows, we will statistically pool risk estimates of neighbourhood-level determinants by using random effects meta-analyses. Study and sample characteristics will be assessed by subgroup analysis and by meta-regression.

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[ii] http://www.ephpp.ca/tools.html

## 4.2 Vulnerability to depression in high crime neighbourhoods

Previous findings suggest that there are certain social, age and gender groups, which might be more vulnerable to developing depression and anxiety, when exposed to adverse neighbourhood conditions.[33,45,75] However, empirical studies often concentrate their analysis only on groups – such as women,[112] elderly[54] or African American adults[113] – which they already assume to be more vulnerable. On the other hand, representative studies from the general population usually do not have sufficient number of cases, which would allow multiple sample stratification, with reasonable effect size. Therefore, to find an eligibly large sample from the general population is a basic requirement for this project.

The theoretical focus will be on small geographic level reported crime, where life course examinations are particularly lacking (see page 14). The geographic coverage is Scotland, with increasing health and social inequalities, high deprivation and crime rates.[114] In 2004/2005, there were 134 homicide cases reported by the police, 40 of them in Glasgow City – one of the highest rates among UK cities.[115] In the past 10 years a significant drop in crime was observed (33%),[116] although the relative position of neighbourhoods has remained similar: neighbourhoods with high crime rates 10 years ago are still high crime neighbourhoods.[117] From this background, there are two main research questions arising: (1) which groups are more vulnerable to depression in high crime neighbourhoods; (2) and does the drop of absolute number of reported crimes or the relative neighbourhood position (or both) affect mental health?

**Methods**

*Sample:* Research will make use of the Scottish Longitudinal study (SLS), which is a census-based nationally representative sample, covering 5.3% of the Scottish population and linking records with other sources of administrative data (see Figure 4 for geographical coverage).[114] The research project will draw on individuals present in the SLS in the 2001 and 2011 Census, with an approximate sample size of 190,000 individuals.[iii] To analyse cohort effects, the sample will be stratified by gender and classified into 4 or 5 age cohorts, at the time of first data collection (2001).

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[iii] As childhood depression has different aetiology, symptoms and treatment needs than adult depression, it might be important to consider the exclusion of children under the age of 18.

*Exposure:* Small area data on recorded crime will be included from the 2006, 2009 and 2012 releases of the Scottish Index of Multiple Deprivation (SIMD). The Crime Domain in SIMD consists of several categories of recorded crimes or offences, grouped into five indicators (crimes of violence, drug offences, common assault, crimes of dishonesty and vandalism) and aggregated into one single crime domain. On *data zone level* (500 - 1000 household residents), crude crime counts, rank of neighbourhoods and rate of total SIMD crime per 10,000 individuals have been published and made publicly available. Moreover, in 2006 and 2009, the Scottish Neighbourhood Statistics released non-aggregated data on *intermediate geography level* (2500 - 6000 household residents). Table 1 shows available data on reported crime in Scotland.

*Table 1: Available data on recorded crime from the SIMD 2006, 2009 and 2012*

| Geographical Level | Reported crime | |
|---|---|---|
| | Composite | Five main domains |
| Data zone | 2006, 2009, 2012 (count, rate and rank) | - |
| Intermediate | 2006, 2009 (count and rate) | 2006, 2009 (count and rate) |

*Outcomes:* Different sources of data on depression and anxiety disorders will be included in the project. From the 2011 Census, self-reported mental illnesses are available. More importantly, linkage of SLS members with administrative data, held by the National Health Service (NHS) Scotland, would allow the inclusion of further information on depression and anxiety: (1) Use of outpatient care for mental disorders from the Mental Health Inpatient and Day Case dataset (SMR04); and (2) Prescription data from Prescription Information System (PIS).

*Ethical considerations:* The proposed project make use of extremely sensitive administrative data on mental health problems, which were collected for operational purposes by the NHS. No written consent of the participants explicitly allows the use of their data for secondary purposes.[118] Therefore, research on these contents must address privacy issues in order to protect confidentiality of individuals and to show that public benefits outweigh potential risks. During the project, data will be only analysed in safe settings after compulsory training and no results can be released which make participant potentially identifiable.

Furthermore, disclosure control has been already applied on reported crime data at data zone level: data zones with counts lower than 4 (2006) and lower than 5 (2009; 2012) have been

supressed. In order to avoid any further concern by linking this data to mental health outcomes, this project will only use aggregated groups of geographic areas.
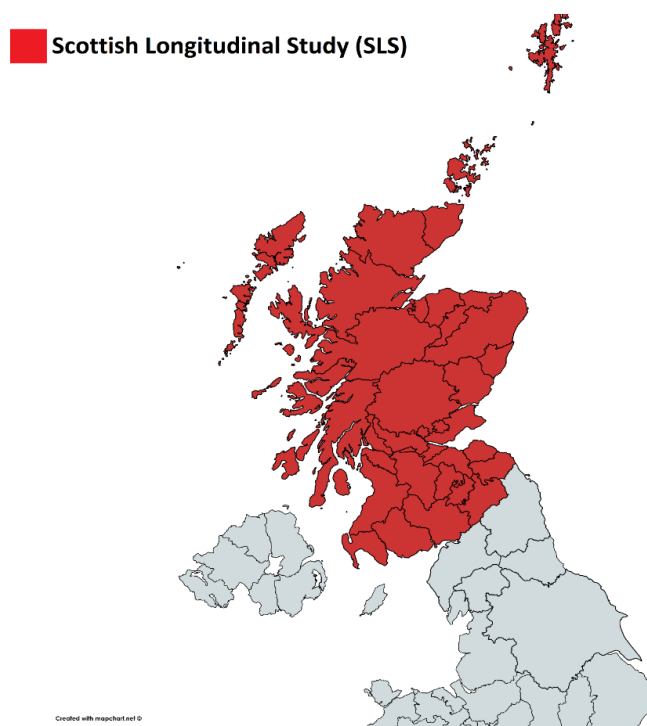


*Figure 4: Geographical coverage of the Scottish Longitudinal Study (SLS)*

*Progress:* Data on mental health service use and prescription has been already linked to SLS for an ongoing project on changes in neighbourhood deprivation and mental health.[iv] As information on reported crime at small scale geographic area was not available, I conducted a search for official sources of crime data in Scotland (Police of Scotland, Scottish Government, NHS etc.). Since the SIMD Crime Domain remained the best fit for the project, an application for data linkage has been sent, in order to include this data in the existing dataset. In the meantime, the preparation of recorded crime data for linkage is processing.

Using administrative data presents several challenges. Administrative data is not prepared for research purposes, therefore, significant amounts of time have to be invested in order to create appropriate variables for mental health, manage the dataset and prepare it for analyses. Furthermore, quality of administrative data is a major concern, which research has to take into account.[118]

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[iv] *"Recession, austerity and health: changing area socio-economic conditions and their relationship to individual health and wellbeing outcomes in Scotland"*

## 4.3 Neighbourhood disadvantage and mental health over the life course

Although epidemiological research on place and time has became more common in recent years, studies typically investigate short term changes among adults.[119] Only a few of them considered a longer period or used life course analysis,[92] and studies incorporating mental health are even more lacking.[29] Therefore, the aim of this study is to analyse the role of place in the development of mental health problems over an individual's life course: (1) Does neighbourhood deprivation in different life stages have an impact on later mental well-being and mental health problems? (2) How does neighbourhood affect mental health over the life course: are there sensitive periods where neighbourhood has stronger effect on mental health or does its effect accumulate over the life span?

**Methods**

*Sample:* This project aims to use the 1970 British Cohort Study (BCS70), which comprise study participants, born in England, Scotland and Wales during one single week in April, 1970.[120] To date, eight sweeps have been released; the last one at age 42, which included 9841 cohort members form the initial 17000 babies (Figure 5).[v]

*Exposure:* Geocoded information of cohort participants' living address is available on enumeration district level from the second sweep (1980, age 10) onwards, covering 32 years. Information about social deprivation (e.g. unemployment, overcrowding and house ownership) can be retrieved from the census and aggregated into Townsend or Carstairs scores. A crucial point is to create consistent geography over the entire time of study, which might be possible on Lower Super Output Area (LSOA; 1000-3000 household residents).[121]

*Outcome:* Outcome measures include mental health problems and mental well-being, both collected in the last available sweep at age 42 (2012). The Malaise Inventory is a validated scale for covering emotional disturbance, distress and related somatic problems.[122] In the 2012 Wave's questionnaire, 9 out of 24 items have been assessed by answering whether particular symptoms or feelings are generally present or not. The Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS) has been developed for assessing positive mental health over the last two weeks, by including emotional and cognitive aspects of mental well-being as well as psychological functioning.[123] The scale comprise 14 items with five response categories.

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[v] Northern Ireland was part of the initial investigation, but dropped from the subsequent sweeps.
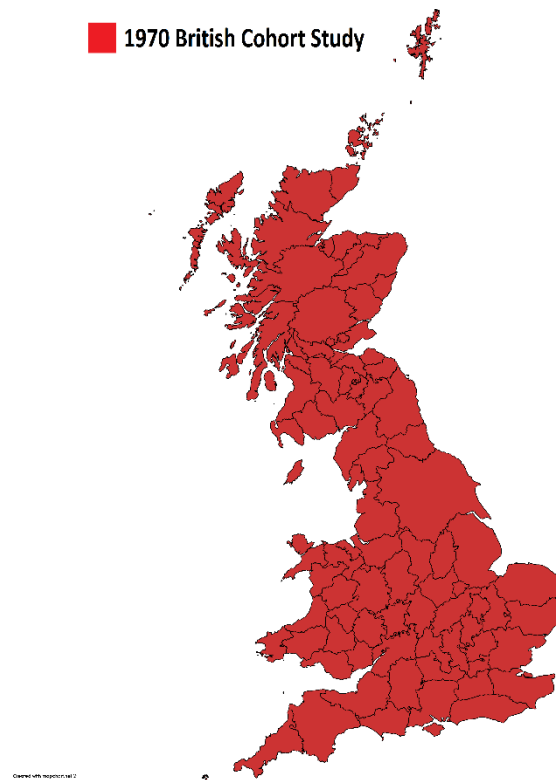
*Figure 5: Geographical coverage of the British Cohort Study (BCS70)*

## 4.4 Life course predictors of vulnerability and resilience to depression

Projects 1 and 2 aim to collect information on vulnerable groups, which show elevated risk for depression when living in adverse neighbourhoods. However, not everybody in these groups develops mental health problems. What leads to higher vulnerability or resilience? This work aims to examine whether earlier life factors such as family background and early social status, are related to higher resilience or vulnerability among older adults living in disadvantaged areas. A prospective Swedish study with a comparable framework studied the influences of early life factors (age 16) on living in disadvantaged neighbourhoods as an adult (age 42) and found that adolescence neighbourhood, family and school circumstances influence the neighbourhood in adulthood; but differently for men and women. Furthermore, they observed a continuity of one's residential context across the life course, which did not seem to be explained by lack of residential mobility.[124] My project aims to add mental health to these findings and address the following research questions: (1) Do disadvantaged neighbourhoods influence mental health? Are there any regional differences? (2) What are the life course determinants of older age vulnerability and resilience in adverse neighbourhoods?

**Methods**

*Sample:* This project will make use of a panel study of European older adults over the age of 50. The Survey of Health, Ageing and Retirement in Europe (SHARE) was set up in 2002 in order to address the great challenges of the population ageing in European countries.[125] Data is collected approximately every 2nd year and to date there are five panel waves (Wave 1, Wave 2, Wave 4, Wave 5 and Wave 6) and one wave about life history (SHARELIFE) available. Although, the study includes 20 countries, the number of participating countries changed in each waves. Therefore, the project can make use of only those longitudinal samples, where information is available about neighbourhood and mental health, as well as early life history in SHARELIFE. As the sample size of the SHARELIFE was 26836 in 2008, a calculation with an average of 77% retention rate for each upcoming waves would yield an approximate sample size between 9,000 and 12,000 individuals.

*Exposure:* Neighbourhood level variables covering crime and vandalism, cleanness of area, social support in the neighbourhood, access to basic facilities (bank, grocery, GP, pharmacy) and feeling part of the area will be retrieved from SHARE.

*Early life exposure*: Potential early life factors will be retrieved from the SHARELIFE (2008), where prospective life history was assessed with each participants. Interviewers collected information on life course social, financial and work factors and childhood health and illnesses.

*Outcome:* For the purpose of the SHARE study, a mental health questionnaire was developed, in order to assess depressive symptoms in later life. The scale EURO-D has two dimensions (affective suffering and motivation) and comprises 12 items: depression, pessimism, suicidality, guilt, sleep, interest, irritability, appetite, fatigue, concentration, enjoyment and tearfulness.[126]
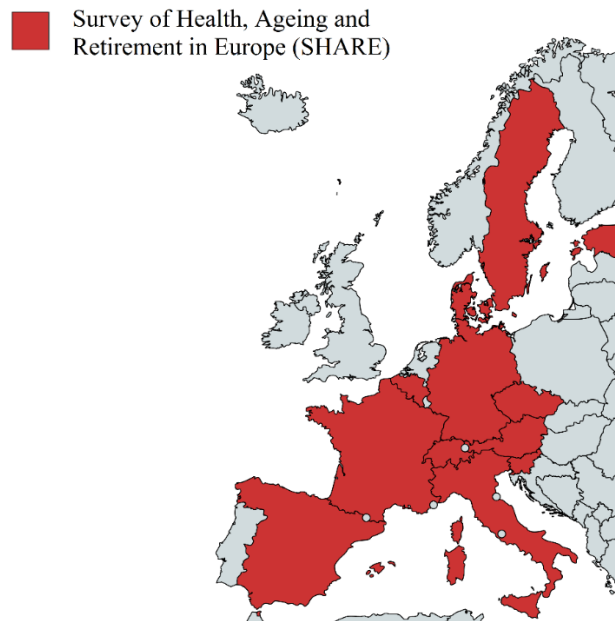
*Figure 6: Geographical coverage of Survey of Health, Ageing and Retirement in Europe (Wave 5, 6, SHARELIFE)*

## Risk analysis

The proposed project is inevitably associated with risks, which cannot be entirely avoided despite all diligence and planning. The risk analysis in Table 2 may identify the relevant risks and challenges for each individual project and give some recommendations that would help mitigate them, using preventive steps.

*Table 2: Potential risks during the PhD projects*

| | Potential risks | How to mitigate them? |
|---|---|---|
| **Project 1** | (1) Studies in the field were operationalised very differently, therefore including-excluding the samples and synthesizing them, can influence final results. | A study protocol with exact inclusion and exclusion criteria, sensitivity analysis, and including the work of several reviewers might help to overcome potential risks. |
| | (2) As several reviews are available in the field, this work has to clearly demonstrate its unique perspective and differentiate itself from earlier reviews. | Furthermore, a detailed time plan for each phase, along with deadlines, would help to finish this project within a reasonable time period. |
| | (3) A systematic review is long-lasting and thorough work and it is "hard to finish", as there are always newer studies to include or new aspects to consider for interpreting the results. | |
| **Project 2** | (1) Because of confidentiality and ethical concern, all research outputs (e.g. presentation, paper) must be approved by the SLS Team before making them publicly available. | It is important to plan a general time buffer within this project and for all related research outputs. Not only analysis or managing data can take more time than expected, but also understanding how data was collected and how this can influence the quality of collected information (meta data). Therefore, a certain flexibility in the time schedule of the entire PhD |
| | (2) Managing, cleaning and analysing data might take more time than previously planned. | |

| | | |
|---|---|---|
| | (3) Quality of information can often be a serious concern when using administrative data for research purposes. | project is needed in order to manage any time delays arising from this individual project. |
| **Project 3** | (1) The outcome measures of this study are depressive symptoms and mental well-being. Literature is controversial with regards to the interpretation (one and two dimensions explanations) of these constructs.<br><br>(2) This project has a very long follow-up time and therefore high attrition rates among participants, which might influence the results. | The paper has to carefully discuss positive and negative mental health and conduct analysis accordingly.<br><br>Analysis has to take into account different sources of missing data (random, completely random, not random) and try to statistically overcome these. |
| **Project 4** | (1) Data for this project will be available only at the University of Geneva. All analysis has to be conducted onsite.<br><br>(2) This work will be conducted through a collaboration with the University of Geneva. | Before the start of this project, a research plan has to be prepared, which will enable a quick start when arriving in Geneva. Furthermore, it would be useful to make an agreement regarding publications, authorship and any other research outcomes, in order to avoid any inconveniences between the collaborating partners. |

# 5. Training and other resources

## Formal training

The presented project is supported by a Marie Skłodowska-Curie Innovative Training Network on *"Methodologies and Data mining techniques for the analysis of Big Data based on Longitudinal Population and Epidemiological Registers"* (LONGPOP), which provides participating researchers with several training opportunities as well as with an ongoing lecture series on epidemiological, geographical and demographical topics.[vi] In order to address methodological and statistical challenges occurring from the research questions and implement a successful project, several training opportunities within and outside of the LONGPOP were identified. Table 3 shows attended and *upcoming* trainings and conferences until summer 2018.

*Table 3: Attended and upcoming trainings/ conferences*

| | Title | Date | Keywords, comments |
|---|---|---|---|
| | **Trainings** | | |
| 1. | Introduction to Big Data* | 22/11/2016 - 24/11/2016 | Use of Big Data in social sciences, data from telecommunication |
| 2. | Introduction to Structural Equation Modelling with MPlus | 05/12/2016 - 06/12/2016 | Path analysis, confirmatory factor analysis, item response theory, building SEM |
| 3. | ADRN Accreditation Training (SURE) | 13/12/2016 | Disclosure control, administrative data, DPA; essential for using administrative data |
| 4. | Introduction to ArcGIS* | 09/01/2017 - 13/01/2017 | GIS, coordinate system, integration of data, spatial analysis, labelling features |
| 5. | Introduction to Longitudinal Data Analysis | 10/04/2017 | Longitudinal versus cross-sectional, APC approach, missing data handling |
| 6. | Longitudinal Data Analysis | 11/04/2017 | growth curve modelling, mixed models, (event history analysis) |
| 7. | Introduction to Data Linkage | 16/05/2017 | Probabilistic and deterministic linkage, linkage evaluation, |
| 8. | Introductory Training Workshop for Scottish Longitudinal Study* | 07/06/2017 | SLS |
| 9. | Introductory Training Workshop on Survival Analysis* | 08/06/2017 | Survival analysis, Kaplan-Meier plots, Cox proportional hazards regression |
| 10. | *Propensity Score Matching (online)* | *01/06/2017 - 30/06/2017* | *Causal inference, matching methods, estimation of propensity scores* |
| 11. | *A life course approach to neighbourhood effects* | *28/06/2017 - 29/06/2017* | *British Cohort Studies, life course, neighbourhood* |
| 12. | *Summer School on Longitudinal and Life Course Research* | *21/08/2017 - 25/08/2017* | *Life course, multilevel models, event history analysis, sequence analysis* |
| 13. | *Training module Sequence analysis with TraMineR** | *28/08/2017 - 31/08/2017* | *Sequence analysis (advance), clustering, binominal logit models* |
| 14. | *Adding the geographic context to longitudinal analysis** | *11/09/2017 - 05/092017* | *GIS, Survival analysis with geographic factors, creating and analysing geographic context variables* |

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| 15. | *Architecture and Development (GIS)* [*] | *11/12/2017 - 22/12/2017* | *Information will be later available* |
|-----|------|------|------|
| 16. | *Agent based modelling*[*] | *15/01/2018 - 19/01/2018* | *Information will be later available* |
| 17. | *Spatial regression models*[*] | *22/01/2018 - 26/01/2018* | *Information will be later available* |
| 18. | *Workshop Methodologies and techniques for the analysis of surveys and longitudinal registers*[*] | *18/06/2018 - 20/06/2018* | *Information will be later available* |
| **Conferences** | | | |
| 1. | ADRN Conference | 01/06/2017 - 02/06/2017 | Administrative data, health inequalities, health geography |
| 2. | *17th International Medical Geography Symposium* | *02/07/2017 - 07/07/2017* | *Medical geography, GIS, healthy ageing, spatial justice* |
| 3. | *International Conference on Spatial Statistics, Spatial Epidemiology and Spatial Aspects of Public Health* | *07/09/2017 - 09/09/2017* | *Spatial, spatial-temporal data, GIS in Public Health, spatial epidemiology (more methodological)* |

*\* Provided by the LONGPOP network*

## Research Exchange

The LONGPOP Network encourages active research exchange between Early Stage Researchers from different network sites. My project will strongly benefit from a longer secondment conducted in the first half of 2018 at the University of Geneva under the supervision of Professor Matthias Kliegel. First, through the ongoing LIFETRAIL project (*Life course influences on health trajectories at older age: longitudinal analyses using retrospective data of SHARE and SH*), I will be able to access the European SHARE study (Project 4). Second, as researchers at the University of Geneva have a stronger focus on mental health, ageing and the life course trajectories of old age vulnerability, my project can receive valuable inputs in order to create an interdisciplinary framework of this work.

On the other hand, an incoming research fellow from the University of Geneva will be involved as second reviewer in the systematic review (Project 1) and in the project conducted during my secondment in Geneva (Project 4). In the second half of 2018, I will support the same incoming researcher with her PhD project during her second stay in Edinburgh.

A detailed timeline for the main research projects, milestones as well as outgoing and incoming secondment can be found in Table 4.

**PhD Plan**

*Table 4: Detailed PhD Plan - 10/2016-9/2019*

| 2016 | 2017 | 2018 | 2019 | |
|---|---|---|---|---|
| | | | | **I. Stages** |
| | | | | Preparation, literature review |
| | | | | Research |
| | | | | Dissertation |
| | | | | **II. Projects** |
| | | | | Project 1 (Sys. Rev.)    (13 months) |
| | | | | Project 2 (SLS)    (12 months) |
| | | | | Project 3 (SHARE)    (12 months) |
| | | | | Project 4 (BCS70)    (12 months) |
| | | | | **III. Milestones** |
| | | | | 1-year report |
| | | | | Secondment in Geneva |
| | | | | Incoming secondment in Edinburgh |
| | | | | Submission |

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