Mental Health in context

Impact of social structures and the built environment on mental wellbeing and mental distress

Dissertation

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<th>Description</th>
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<tr>
<td><strong>CEE</strong></td>
<td>Central and Eastern European Countries</td>
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<td><strong>CESD</strong></td>
<td>Centre for Epidemiologic Studies Depression Scale</td>
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<td><strong>DSM-V</strong></td>
<td>Diagnostic Statistical Manual Version V</td>
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<td><strong>EQLS</strong></td>
<td>European Quality of Life Survey</td>
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<td><strong>EVI</strong></td>
<td>Energy and Vitality Index</td>
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<td><strong>FSU</strong></td>
<td>Former Soviet Union</td>
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<td><strong>GBD</strong></td>
<td>Global Burden of Disease</td>
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<td><strong>GHQ</strong></td>
<td>General Health Questionnaire</td>
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<td><strong>GME</strong></td>
<td>Health Monitoring Units in Bavaria (Gesundheits-Monitoring-Einheiten)</td>
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<td><strong>ICD 10</strong></td>
<td>International Classification of Diseases 10</td>
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<tr>
<td><strong>KIGGS</strong></td>
<td>German Health Interview and Examination Survey for Children and Adolescents (Studie zur Gesundheit von Kindern und Jugendlichen in Deutschland)</td>
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<tr>
<td><strong>KINDL</strong></td>
<td>Questionnaire to assess Health-Related Quality of Life in children and adolescents</td>
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<tr>
<td><strong>MHC-SF</strong></td>
<td>Mental Health Continuum-Short Form</td>
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<td><strong>MHI-5</strong></td>
<td>Mental Health Inventory scale</td>
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<td><strong>RANCH</strong></td>
<td>Road Traffic and Aircraft Noise Exposure and Children’s Cognition and Health: Exposure-Effect Relationships and Combined Effects study</td>
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<tr>
<td><strong>SDQ</strong></td>
<td>Strength and Difficulties Questionnaire</td>
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<tr>
<td><strong>SES</strong></td>
<td>socioeconomic status</td>
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<tr>
<td><strong>SF-36</strong></td>
<td>36-item Short Form Health Survey</td>
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<tr>
<td><strong>UK</strong></td>
<td>United Kingdom</td>
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<td><strong>WEMWBS</strong></td>
<td>Warwick-Edinburgh Mental Wellbeing Scale</td>
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<tr>
<td><strong>WHO</strong></td>
<td>World Health Organization</td>
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<td><strong>WHO-5</strong></td>
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English abstract

**Introduction:** Not only individual factors but also factors of the social and built environment influence mental distress and ill-health and mental wellbeing. This dissertation aimed to gain further insight into the relationship between individually attributed factors of the social and built environment and mental distress and mental wellbeing. The first objective was to investigate prevalences and variations in mental health by characteristics at the individual level. The second objective was to assess the relationship between social structures at the macro level (here the focused factor was on welfare regimes) and mental health. The third objective was to investigate the relationship between factors of the built environment at the meso level (here the focused factor was environmental noise) and mental health.

**Methods:** The three objectives were addressed by four conceptually independent but topic wise interrelated studies: i) material, psychosocial and sociodemographic determinants of mental wellbeing in Europe, ii) socioeconomic determinants of mental distress and mental wellbeing in school children iii) association between gender, welfare regimes and mental wellbeing, and iv) noise and mental distress in school-aged children. Data from the third wave of the European Quality of Life Survey (2011-2012) and the Health Monitoring Units in Bavaria served as the basis for these studies. Odds ratios were calculated using multilevel and multivariate logistic regression analyses. Poisson regression analyses were used to calculate relative risks for the incidences.

**Results:** In adults material, psychosocial and sociodemographic factors were independently associated with low levels of mental wellbeing. In children, the analyses showed that several indicators of families’ social disadvantage were associated with mental distress, in contrast to mental wellbeing, where only a few factors were associated. At the macro level prevalence of good mental wellbeing was in most instances higher among men compared to women at welfare regime level, with the exception of the Former Soviet Union welfare regime, where women report slightly higher prevalence of good mental wellbeing. Gender inequalities in good mental wellbeing were identified independent of further individual sociodemographic variables and independent of the welfare regimes that people lived in. People in the Former Soviet Union and the Central and Eastern European Countries welfare regimes showed statistically significantly lower chances to report good mental wellbeing compared to the Scandinavian welfare regime. Gender inequalities in good mental wellbeing were not modified by welfare regimes. At the individual level of the built environment, exposure to road traffic noise at day or night was the main risk factor for incident mental health problems in children. Exposure to noise by neighbours day and night also appeared to be a risk factor for some subcategories of the strength and difficulties questionnaire. Both noise from construction work and aircraft noise during the day were not associated with incident mental health problems.

**Discussion:** Findings of this dissertation highlight an association between individual factors, aspects of the social and built environment and mental wellbeing and mental distress. The study of mental wellbeing is relatively young, therefore, especially in this field further studies are needed to confirm and expand the findings of this dissertation. To plan effective prevention and health promotion interventions a thorough understanding of the underlying mechanisms and pathways is needed. Further studies are warranted to gain knowledge on the impact of (further aspects of) the social and built environment on mental wellbeing and mental distress in adults and in children to identify underlying mechanisms and to identify vulnerable groups for targeted preventions.
German abstract


gewinnen, um die zugrunde liegenden Mechanismen zu identifizieren und gefährdete Gruppen für eine gezielte Prävention zu identifizieren.
Articles in this dissertation

Four articles comprise this cumulative dissertation and are referred to in the main text. Three articles are published in an international peer-review journal. One article is submitted to an international peer review journal. All articles were conducted as the leading author. Full article manuscripts can be found in the appendix.

The following articles are the basis for this dissertation:


II. Dreger S, Meyer N, Fromme H, Bolte G, Study Group of the GME. Mental wellbeing and mental distress have different socioeconomic determinants in school children (submitted to the Central European Journal of Public Health as short communication)


Authors’ contributions to articles

Article I: Material, psychosocial and sociodemographic determinants are associated with positive mental health in Europe: a cross-sectional study

First author: Stefanie Dreger

Order of authors: Stefanie Dreger, Christoph Buck, Gabriele Bolte

Contribution statement: SD was in charge of designing, analysing and writing up for the manuscript. CB advised on statistical analyses and helped to draft the manuscript. GB participated in the conceptualisation of the analyses and in the revision of the manuscript. All authors read and approved the final manuscript.

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Article II: Mental wellbeing and mental distress have different socioeconomic determinants in school children

First author: Stefanie Dreger

Order of authors: Stefanie Dreger, Nicole Meyer, Hermann Fromme, Gabriele Bolte

Contribution statement: SD designed and performed the statistical analysis for this research question and wrote the paper. NM contributed to questionnaire development, conducted the cross-sectional study, and contributed to data management. HF and GB designed the entire study (GME cohort study) and acquired funding. GB coordinated the study, provided insights into the dataset, and contributed to the writing. All authors have read and approved the final manuscript.

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**Article III:** Gender inequalities in mental wellbeing in 26 European countries: do welfare regimes matter?

**First author:** Stefanie Dreger

**Order of authors:** Stefanie Dreger, Thomas Gerlinger, Gabriele Bolte

**Contribution statement:** SD had the main responsibility of drafting the manuscript and designed and performed the statistical analysis. TB participated in the conceptualization of analyses and contributed to the writing, GB participated in the conceptualisation of the analyses and in the revision of the manuscript. All authors read and approved the final manuscript.

**Manuscript status:** Published in the European Journal of Public Health.

**Article IV:** Environmental noise and incident mental health problems: A prospective cohort study among school children in Germany.

**First author:** Stefanie Dreger

**Order of authors:** Stefanie Dreger, Nicole Meyer, Hermann Fromme, Gabriele Bolte

**Contribution statement:** SD designed and performed the statistical analysis for this research question and drafted and revised the manuscript. NM contributed to questionnaire development, conducted the cross-sectional study, and contributed to data management. HF and GB designed the entire study (GME cohort study) and acquired funding. GB coordinated the study, provided insights into the dataset, and contributed to draft and revise the manuscript. All authors have read and approved the final manuscript.

**Manuscript status:** Published in Environmental Research
1 Introduction

Whenever we speak of mental health, we tend to think of mental illness and psychopathology. The term mental health is automatically associated with complaint, although the word health naturally means the opposite of complaints. In this dissertation, one of the aims is to highlight the positive aspect of mental health – looking at mental wellbeing. Mental wellbeing and good mental health is an integral part of an individual’s capacity to live a fulfilling life including the ability to form relationships, study, work or pursue leisure interests as well as to make day-to-day decisions and choices [1]. The World Health Organization (WHO) defines mental health as “... a state of wellbeing 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” [2, p.1]. Reference to this definition highlights that mental health is influenced not only by individual characteristics or attributes but also by circumstances in which persons live and the broader environment in which they find themselves in [1]. These factors interact with each other and may protect or threaten an individual’s mental health status [1]. Influencing external factors range from prenatal determinants to family environment and working conditions [3]. In this context, two aspects have gained increased attention in research recently – the social and the built environment. These two dimensions of the environment are not to be understood as separate determining factors but are interlaced with each other [4].

A good mental health is a prerequisite for a good general health and quality of life and may influence social and economic success in life [5]. On the other hand, mental health problems are a major public health issue worldwide, constituting an important source of disability, dependency as well as high economic costs for the health care system [6, 7]. Mental diseases have a major impact on quality of life. Expressed in Disability Adjusted Life Years, depression is already today the disease with the highest burden in the European Union [8]. In the German Health Interview and Examination Survey for Children and Adolescents (KiGGS) the prevalence of mental health problems in children was 21.9% [9]. The numbers in children are of particular importance as behavioral disorders in childhood increase the risk of poor mental health and social dysfunction in adulthood [10].

Therefore, from a societal perspective, it is of great public health relevance to examine the interplay of the social and built environment and mental health more closely and to identify potential starting-points for prevention strategies and health promotion activities. The aim of this thesis is to investigate the association between mental health and possible influencing factors of the social and built environment. Factors at different levels of influence (individual, meso, and macro) will be
analysed. In this context, a holistic view on mental health incorporating mental wellbeing and mental distress will be taken.
2 Mental health is more than the absence of mental disease

Mental health is a widely discussed concept but there is no universal consistent terminology. Historically, the focus in population-based studies has been on mental illness and distress. Often the term mental health is simultaneously taken for mental health problems. Often scales to estimate the prevalence of psychiatric problems have been used [11]. According to the WHO’s definition of mental health [2] a good mental health is more than the absence of disease. Research suggests that mental health consists of two distinct, though correlated, dimensions: mental distress and mental wellbeing, also described as the two-continua model [12]. The positive dimension of mental health ranges from a low to a high level of mental wellbeing [13, 14], and links to concepts of wellbeing and the ability to cope in the face of adversity. The negative dimension of mental health links to the presence of symptoms defined as mental distress as well as clinically diagnosed mental disorders [15]. Studies demonstrate that a one-dimensional approach of mental health does not adequately reflect reality [16] and that the two-continua model is more meaningful than the one-continuum model (in which mental wellbeing and mental distress are seen as two opposing end points of one continuum) [17-19]. Mental wellbeing and mental distress are related in the long term. Low levels of mental wellbeing are described as a substantial risk factor for depression [20] and changes in mental wellbeing predict the incidence and prevalence of depression, panic disorders, and anxiety disorders in a 10-year follow-up [21]. The two-continua model also recognizes that people with a mental health problem or mental distress can still experience high levels of mental wellbeing, and vice versa.

2.1 Mental distress

The negative dimension of mental health consists of symptoms of mental distress as well as diagnosed psychiatric disorders. It is important to clarify the relationship and the difference between these two concepts. Mental distress relates to the presence of symptoms as for example signs of depression or anxiety. These symptoms are measured by ‘checklists’, which calculate a score by adding the answers to different questions. The symptoms of mental distress are common and are often transient, for example, they can follow a negative or stressful life event. However, most of the time a person showing signs of mental distress does not fit into a category of psychiatric disorders and probably never will. Yet, people with a diagnosed psychiatric disorder usually also score high on symptoms checklists of mental distress [15]. On the other hand, psychiatric disorders are discrete entities described and classified as specific syndromes. These syndromes are clusters of symptoms, whose severity, duration, impairment on daily life correspond to different psychiatric diagnoses, obtained by recognized classification systems such as the International Classification of Diseases (ICD 10) or the Diagnostic Statistical Manual Version V (DSM-V) [15].
In population-based epidemiological studies, instruments to assess mental distress are often used. In this dissertation, the focus will be specifically put on mental distress and mental wellbeing and not on diagnosed psychiatric disorders.

2.2 Mental wellbeing – development of a new concept

In contrast to mental distress, mental wellbeing is a rather new approach in mental health research; therefore the development of the concept ‘mental wellbeing’ and its aspects will be described in more detail. Although the focus on mental wellbeing is relatively new in mental health research, researchers in social and psychological sciences have studied “something positive” in the domain of wellbeing research, based on individuals’ evaluation and judgement of their own lives, for about 50 years. These researchers agree that mental wellbeing is best conceived as a multidimensional phenomenon [22-24]. A long history of theories about positive aspects in life stems from the field of philosophy. Greek philosophers already theorized about what makes up a good life [13]. Their theories did not focus directly on mental health but they correspond to two views on wellbeing that are currently used in mental wellbeing research. According to Aristippus of Cyrene (435 to 355 BC) the way to live a good life is hedonism, that is to strive for the maximum amount of good feelings and pleasure [13]. The hedonic tradition of wellbeing research falls on Aristippus view on wellbeing and defines wellbeing as the maximization of positive and the minimization of negative feelings. On the other hand, Aristotle (384 to 322 BC) considered hedonic happiness to be a vulgar ideal, making people slavish followers of desire. He declares that a good life is not to have good feelings but instead that true happiness is found in the experience of virtue – doing what is worth doing [25]. This view on wellbeing is called eudaimonia: wellbeing is not a fine state but process of fulfilling one’s own potentials [13]. The eudaimonic tradition of wellbeing research encloses the theory of eudaimonia and defines wellbeing as optimal human-functioning and self-realization. In these two traditions of wellbeing research, three components of wellbeing can be distinguished: emotional wellbeing, social wellbeing, and psychological wellbeing. In the following subsections, these three dimensions will be further discussed.

2.2.1 Emotional wellbeing in the hedonic approach

The hedonistic view concentrates on emotional wellbeing, also known as subjective wellbeing [e.g. 26], and sees wellbeing as happiness or life satisfaction. Emotional wellbeing involves high levels of positive affect, low levels of negative affect, and an evaluation of life satisfaction [26]. There exist mainly two theories that explain levels of emotional wellbeing. The trait model or top-down model claims that levels of emotional wellbeing are relatively stable within one person, as they are a result of personal traits of people. In this view life events have no major influence on levels of emotional
wellbeing, as the representatives of this view argue that there is an element of stability in people’s level of wellbeing that cannot be explained by the stability of life circumstances [13, 27].

In contrast, according to the bottom-up model individual differences in emotional wellbeing are the result of positive life events or experiences. Individuals who experience more positive events will have higher levels of emotional wellbeing. Some theorists have suggested that emotional wellbeing is relatively stable and that although life events can influence emotional wellbeing, people will adapt to these changes and return to a determined ‘set-point’, this effect is also known as ‘hedonic adaptation’. One reason for the stability of emotional wellbeing is that there seems to be a genetic component in how people evaluate their lives and levels of wellbeing. In a complex study with monozygotic and dizygotic twins who were raised apart or raised together, Tellegen et al. estimated that 40% of the variability in positive emotionality and 55% of the variability in negative emotionality could be predicted by genetic variation [28]. Environmental influences can have an impact on these estimates [29], but genes appear to influence how people respond to life events emotionally. However, recent studies have challenged the idea of a ‘set-point’ as they have shown that people do not adapt to drastic life changes such as becoming divorced [30], disabled [31] or unemployed [32]. Some individuals, who experience such kind of life experiences, do not return to their ‘before’-level of wellbeing. Thus, the concept of a ‘set-point’ should not be deemed fixed.

2.2.2 Psychological and social wellbeing in the eudaimonic approach

Whereas the hedonic approach focuses on the emotional part of mental wellbeing, the eudaimonic tradition stresses meaning and optimal functioning of the individual itself (psychological wellbeing) and within the society (social wellbeing). According to the eudaimonic theory positive life events and good feeling such as happiness will not result in endurable wellbeing when achieved [33]. Wellbeing is achieved through self-actualization and tapping one’s potentials [34]. One of the most popular models within the eudaimonic approach has been developed by psychologist Carol Ryff. She claims that wellbeing consists of six dimensions: self-acceptance, personal growth, positive relations with others, purpose in life, environmental mastery, and autonomy. These dimensions showed to be not strongly associated with emotional wellbeing, which suggests that psychological wellbeing reflects an additional component to wellbeing [35].

However, wellbeing also consists of a social component, as each individual is embedded in social structures [36]. Keyes based his multidimensional model of social wellbeing on sociological theories and described five dimensions of social wellbeing: social contribution, social integration, social actualization, social acceptance, and social coherence. These dimensions were correlated but did not
overlap with measures of emotional and psychological wellbeing. Therefore, social wellbeing
describes another distinct component of wellbeing [36].

2.2.3 Conceptualisation of mental health in this dissertation

In this dissertation mental health is used as an umbrella term to refer to both the concept of mental
distress (often used interchangeably with negative mental health, mental illness, mental ill-health)
and mental wellbeing (often used interchangeably with positive mental health, psychological
wellbeing). Mental wellbeing consists of hedonistic wellbeing in conjunction with the social and
psychological aspects of eudaimonic wellbeing.
3 A public health view on environment

To describe the interplay between health and environment the traditional science-oriented definition of environment, which is based on abiotic (chemical and physical influences/factors) and biotic (influences of other living species) environment is too narrow. Based on the WHO’s [37] interpretation of environment a new and broader understanding of environment has been taken over in Public Health research. In this understanding, the environment includes all physical, chemical, biological as well as psychosocial environmental factors, which could potentially influence health [38]. It can be distinguished between natural, physical-built, and psychosocial environment. The natural environment consists of natural resources and ecological systems. Factors of the built environment are made up of the environment as it is built by humans (e.g. infrastructure, neighbourhoods in cities, green space). The physical environment consists of the natural and built environment. The psychosocial environment consists of groups, organizations, cultures and subjective environmental factors (as for example the subjective feeling of security/safety in the neighbourhood) [38]. These facets of the environment do not exist detached from each other [4, 39] and in practice, they often cannot be separated clearly [38]. However, they assist in mapping the multiple relations and interrelations between natural, physical-built, and psychosocial environment [40]. This view on the environment also enables researchers to investigate positive influences and resources for health, instead of only attributing the environment as consisting of harmful toxic or chemical substances [38].

3.1 Physical environment

The physical environment combines aspects of the ‘human-made’ environment such as buildings, land-use mix, street connectivity, transportation system, and spaces and the natural environment, like plants, topography, and weather [40, 41]. Aspects of the built environment can be homes, worksites, school, recreational settings, health care settings or other settings where the individual spends time. All settings where someone lives, works, plays, travels, or performs leisure time activities are parts of the physical environment [41]. The physical environment can have a negative or positive impact on health. Increasing attention has been put on the implication for social interaction and health behaviour that is promoted by the built environment [40]. The built environment encompasses the presence (and proximity to) health-relevant resources, but also aspects of how neighbourhoods are designed and built. Aesthetic elements of the built environment (e.g. trees, benches, good lighting) can improve community health by facilitating behavioural choices that are beneficial for health such as diet, physical activity, tobacco and alcohol use. On the other hand, the physical environment can also have negative impacts on health, when it exposes
individuals to toxic substances, stress-producing factors (e.g. noise), physical hazards, or infectious agents.

### 3.2 Social environment

The social environment or social context is defined as “the aggregate of social and cultural institutions, norms, patterns, beliefs, and processes that influence the life of an individual or community” [41, p.3]. The social environment includes social interaction with family, friends and colleagues and other members of the community. Also, norms, expectations, and cultural attitudes are considered in the social environment. Social relationships and policies in settings such as schools, places of workshop, business, recreation facilities, health care settings, neighbourhoods, and other public places are included. At the community-level, the social environment encompasses language, culture, political and religious beliefs, social attitude, social norms [41], and the stability of social connections including social cohesion, social capital, and social participation [40]. It also reflects socioeconomic conditions, exposure to violence and crime. Moreover, social aspects of health-related behaviour such as physical activity, substance use, eating behaviours in the community are encompassed. Another aspect is the degree and quality of social interactions in the family, neighbourhood, and other groups as well as social disorder. Examples of these are the presence of trash, degenerated houses, or graffiti. At the macro level policies made in governmental, non-governmental and corporate institutions can impact health and health behaviours in populations in a positive as well as negative way. Economic policy is an important aspect of the social environment. It includes social institutions, such as law enforcement (e.g. the presence or shortfall of community policing) and governmental as well as non-governmental organisations. Availability of various forms of resources to meet basic needs (for example job opportunities, health insurance, educational opportunities, stores that sell healthy food) is another aspect of the social environment [41]. Some of these aspects could also be attributed to the built environment, which shows that the boundaries between the different aspects of the environment are not clear-cut.
4 Assessing mental distress and mental wellbeing

Various instruments have been developed and are used to assess mental distress and mental wellbeing. Especially in the context of mental distress, most scales focus on clinical assessment and not on the use in population-based studies. The following paragraphs will give an overview of commonly used instruments to assess mental wellbeing and mental distress in epidemiological studies.

Mental distress

*General Health Questionnaire*

The General Health Questionnaire (GHQ) is a self-responds screening questionnaire with the aim to identify possible cases of mental disorder in non-psychiatric patients and in the general adult population [42]. Several versions are available, with 60, 30, 28, and 12 items. Currently, in population-based studies the 12-item version is most frequently used. Population surveys commonly use the GHQ with a score of >2 or >3 indicating negative mental health or mental distress [43]. Each item in the GHQ asks the respondent to rate the degree to which they have experienced a symptom during the last week with four response categories, typically worded: less than usual, no more than usual, rather more than usual, or much more than usual. It assesses changes in mood, feelings, and behaviours as breaks in normal functioning rather than lifetime traits. It focuses on the last four weeks and addresses mostly disorders or patterns of adjustment associated with distress.

*Centre for Epidemiological Studies-Depression Scale*

The Centre for Epidemiologic Studies Depression Scale (CESD) was created in 1977 by Laurie Radloff [44], and revised in 2004 by William Eaton and others [45]. It measures symptoms defined by the American Psychiatric Associations' Diagnostic and Statistical Manual for a major depressive episode in adults. It was developed to identify populations at risk of developing depressive disorders in the general population [44], it should not, however, be used as a clinical diagnostic tool by itself [44]. The items of the scale are depressive symptoms that have previously been used in longer scales [44]. Respondents are asked to indicate how often in the week before the survey they had felt or behaved in a certain way. Answer categories range on a 4-point Likert scale from ‘none or almost none of the time’ (0) to ‘all or almost all of the time’ (3), with higher scores indicating a higher frequency and severity of depressive complaints. There are 10 and 20 item versions of this scale.
5-item Mental Health Inventory scale of the 36-item Short Form Health Survey

The 5-item Mental Health Inventory scale (MHI-5) was developed in the US by Ware & Sherbourne in 1991 [46] as part of the National Health Insurance Study [47]. It is the mental health measure of the 36-item Short Form Health Survey (SF-36). This instrument yields an assessment of several domains of mental health in adults including anxiety, depression, positive affect, behavioural control, and general distress. The MHI-5 consists of the following five questions: over the last 4 weeks, how often: (i) ‘Have you felt so down in the dumps that nothing could cheer you up?’, (ii) ‘Have you felt downhearted and blue?’, (iii) ‘Have you been a happy person?’, (iv) ‘Have you been a very nervous person?’ and (v) ‘Have you felt calm and peaceful?’. Each item has six response categories ranging from ‘all the time’ (1 point) to ‘none of the time’ (6 points) which can be added to a sum score ranging from 5 to 30. This score is linearly transformed to a 0–100 scale according to the standard procedure for calculation of the MHI-5 scores [48]. Lower scores indicate more severe depressive symptoms.

Strengths and Difficulties Questionnaire

The Strengths and Difficulties Questionnaire (SDQ) [49] is the most widely used instrument to assess mental distress in children and adolescents in epidemiological studies. It is an internationally validated and disseminated behavioural screening instrument for the age group 3-16 years. It covers five dimensions: conduct problems, peer relationship problems, emotional symptoms, hyperactivity, and pro-social behaviour. All areas are covered by five questions each, resulting in 25 questions. A total difficulties score can be calculated by adding the scores of all four problem areas, excluding prosocial behaviour, and scores for each subscale can be calculated separately. There exist different international and national cut-offs to group individuals into normal, borderline, and abnormal. These groups can be built for all subcategories and the total difficulties score. The SDQ exists in several versions: self-reports, parent-reports, and teacher-reports.

Mental wellbeing

World Health Organization 5 – Mental Wellbeing Index

The 5-item World Health Organization Mental Wellbeing Index (WHO-5) [50] is among the most widely used questionnaires assessing subjective psychological wellbeing [51]. It was derived from the WHO-10 [52], which in turn was derived from a 28-item rating scale [53] used in a WHO multicentre study in 8 European countries [54]. The WHO-5 is a valid measure of the dimension of positive, psychological wellbeing [55]. It is calculated from responses to five items: a) ‘I have felt cheerful and in good spirits’; b) ‘I have felt calm and relaxed’; c) ‘I have felt active and vigorous’; d) ‘I woke up feeling fresh and rested’; e) ‘My daily life has been filled with things that interest me’. The extent to
which the aforementioned positive feelings were present in the last two weeks is scored on a 6-point Likert scale ranging from 0 (‘at no time’) to 5 (‘all of the time’). The scores to these five questions can add up to a maximum of 25, which is then multiplied by 4 to obtain a maximum of 100, where 0 corresponds with worst thinkable wellbeing and 100 equals best thinkable wellbeing. Although it has not originally been developed to measure the broader concept of mental wellbeing, which includes more than psychological wellbeing, it is often used in population-based studies to assess mental wellbeing, as appropriate instruments have been lacking for a long time.

*Warwick-Edinburgh Mental Wellbeing Scale*

The Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS) was developed to measure a wide concept of mental wellbeing and to be suitable in wide population surveys [56]. The scale consists of 14 positively worded statements that cover both functioning and feeling aspects of mental wellbeing. Examples of statements are ‘I have been feeling optimistic about the future’, ‘I have been feeling good about myself’, ‘I’ve been dealing with problems well’, or ‘I have been feeling interested in other people’. Respondents are asked to rank, how often in the past two weeks the statement was true. Answer categories can be given on a five-point Likert scale and range from ‘none of the time’ (score 1) to ‘all of the time’ (score 5). The overall score is calculated by summing the scores for each item. A higher score indicates a higher level of positive mental health or mental wellbeing. A 7-item scale (the Shorter Warwick-Edinburgh Mental Wellbeing Scale SWEMWBS) has been developed later [57]. WEMWBS has been validated for the use in adults and children aged 13 or older. It is increasingly used in national and international studies to assess mental wellbeing in the general population.

*Mental Health Continuum Short Form*

Keyes [12] developed the Mental Health Continuum-Short Form (MHC-SF) to present a comprehensive measure of mental wellbeing consisting of emotional, psychological, and social wellbeing. It consists of 14 items, which ask about the respondent’s experiences in the past month. Responses can be given on a 6-point scale (0=Never to 5=Every day). The MHC-SF can be scored categorically (flourishing, moderately mentally healthy, or languishing) or continuously as a total score and subscale scores. It has been used in adults and in youths aged 12-18.

All of these instruments work with scales. For mental distress and mental wellbeing, there are no universal definitions to produce prevalences as the ICD-10 diagnosis criteria. In the context of mental wellbeing and mental distress, prevalences can be calculated, based on cut-off points of the described scales, which are derived as distribution based cut-offs or based on a reference population. When comparing prevalences of mental wellbeing or mental distress it needs to be kept in mind that different scales can lead to different prevalences. Some instruments work with mean values; in this
case the value for one person can be interpreted in comparison to others. In comparative research often mean values of countries are compared to other countries.
5 Prevalences of mental health in adults and children

There is scarcity of data on prevalences of mental wellbeing and mental distress on a European level as studies and health monitoring are mostly carried out nationally or include only few countries. In addition, cross-sectional epidemiological studies that investigate symptoms of mental distress use screening instruments and often report mean values for specific populations in comparison to others, but no prevalence data. Moreover, different indicators or instruments are used, which makes it hard to compare data. In addition, most health monitoring systems to date are better developed to measure mental distress than mental wellbeing. Only recently health monitoring began to include the positive dimension of mental health in their reports, so there is a lack of reliable data of mental wellbeing. This is, even more, the case for children, where no validated instruments exist to assess mental wellbeing (see chapter 4). The following paragraphs will give an overview of what is known about the distribution of mental wellbeing and mental distress in adults and in children.

5.1 Mental distress in adults

A special Eurobarometer survey on mental health from 2004 reports prevalences of mental distress as measured with the MHI-5 scale of the SF-36 for different European countries [15]. A score of 52 or less on the MHI-5 was considered as mental distress. The results indicate significant discrepancies between countries. The highest prevalences of mental distress are observed for Italy (30.2%) and Portugal (29.3%) and lowest for Netherlands (10.9%) and Sweden (12.4%); Spain, Luxembourg, Belgium, Austria, and Germany all have prevalences between 17.6% and 23.4% [15]. Women generally had higher levels of mental distress than men [15]. The Eurobarometer report included a meta-analysis of previous studies which confirmed that women suffer from poorer mental health than men across most European countries [15]. A more recent study investigated mean scores of the CES-D from the third wave of the European Social Survey. The authors report highest scores of depressive symptoms [58] in Eastern European countries, lowest in Western and Northern European countries. Norway shows the lowest depression score, followed by Switzerland and Ireland, while the highest mean scores were reported in Hungary, the Russian Federation, and Ukraine. In all countries but Ireland, Slovakia, and Finland, women report higher levels of depressive symptoms than men.

For Germany, representative numbers are surveyed by the health monitoring system of the Robert Koch Institute. The most recent survey of the ‘Gesundheit in Deutschland aktuell’ from 2012 provides prevalences for mental distress in German adults aged 18 or older. Mental distress was assessed with the ‘Healthy Days Measures’ [59], a brief set of survey-based questions designed to assess health-related quality of life. Respondents were categorized as experiencing mental distress if they were
impaired in their mental health for at least 14 days within the past 4 weeks. In total, 13% of women
and 8% of men experience mental distress in Germany [60]. Biggest differences between men and
women are found in the age group of 18-29: more than twice as much women (15%) than men (6%)
experience mental distress in this age group [60]. In women, the highest prevalence of mental
distress is reported in the age of 18-29 years and in the age group of 45-64 years (both 15%) [60].

5.2 Mental distress in children

National and international studies report prevalences of 9-22% of abnormalities in experience and
behaviour in children [61-66]. The high variation in prevalences is due to different instruments,
different classification systems of abnormalities, different age groups of respondents, and the use of
different cut-offs [62, 67].

The European Health Related Quality of Life Questionnaire for Children and Young People and their
Parents (KIDSCREEN) study [68] is the first study to compare the distribution and prevalence of
mental distress from a cross-cultural perspective in children and adolescents (8 to 18 years). Mental
distress was assessed using the self-reported version of the SDQ. The categories ‘abnormal’ and
‘borderline’ are categorized by United Kingdom (UK) -cut-offs [69] and are count together as ‘mental
distress’ for better comparability to the German data here. In the total sample of 12 European
countries, 15.1% show signs of mental distress (borderline or abnormal). The prevalence of mental
distress varies across countries. High prevalence rates are found in Hungary (17.9%) and the UK
(23.4%). The lowest prevalence rates are observed for Switzerland (10%) and Germany (10%). In the
total sample higher prevalence rates are found for girls (16.3%) than for boys (13.8%) [70].

The first wave of the KIGGS investigated mental distress in children with SDQ [67]. Based on parental
reports and categorized by German cut-offs [71], one fifth of children and adolescents aged 3-17
show signs of mental distress (abnormal and borderline on the SDQ total difficulties score). Boys
experience mental distress significantly more often than girls (23.4% vs 16.9%). Boys between 3 and
6 and between 14 and 17 experience mental distress less often than boys between 11 and 13; in
girls, age differences are less pronounced. The higher the socioeconomic status (SES) of the family,
the less likely children are to experience mental distress – this is reported for boys and for girls.

5.3 Mental wellbeing in adults

Numbers of mental wellbeing in adults are mostly derived from studies that compare levels of
mental wellbeing between European countries. These studies do not give exact prevalences but draw
a picture of how mental wellbeing is distributed within Europe. In a Eurobarometer Survey on mental
wellbeing from 2006, the majority of respondents experienced positive and balanced feeling during
the 4 weeks preceding the interview, rather than negative emotions. Overall the survey reports higher levels of mental wellbeing in the old member states, especially in the Benelux and Nordic countries, than in the new member states [72]. Lehtinen et al. [73] analysed data from the Eurobarometer 2002 survey and assessed mental wellbeing with the Energy and Vitality Index (EVI). The results indicate differences between European countries. The mean EVI score is relatively low in Sweden, Italy, France, and Portugal, and above average in Belgium, West Germany, the Netherlands, and Belgium. Mental wellbeing is higher for men than for women in 8 of the 11 countries; only in Austria, West Germany, and the Netherlands, this is not the case. Also, in general, poorer mental wellbeing is found in older age groups [73].

The third wave of the European Quality of Life Survey (EQLS) provides the most recent numbers on mental wellbeing in Europe [74]. Mental wellbeing was assessed with the WHO-5 and mean scores on the index ranging from 0-25 are reported. The familiar pattern of high-scoring social democratic countries can be observed (see Figure 1). Austria and Germany rank second and third, respectively, in comparison with the other countries. At the other end of the scale, Latvia shows the lowest score on the WHO-5, and Romania is second from bottom. No separate analyses for men and women were performed.
To date, no large scale studies to describe levels of mental wellbeing in the adult population have been conducted in Germany. However, numbers for Germany can be derived from comparative European surveys such as the EQLS. In Germany, a mean of 65.7 on the WHO-5 is reported for the whole population, men report slightly higher levels of mental wellbeing (mean 66.3) compared to women (mean 65.1) [75]. It was not tested, whether the differences between men and women were statistically significant. Germany ranked third out of the 28 participating countries, behind Denmark and Austria. Highest levels were reported for the age group 25-34 years (mean 68.4), followed by those being older than 64 years (mean 66.2) and those aged 18-24 (mean 65.3). The age groups 35-49 and 50-64 years reported a mean of 64.9 and 64.4, respectively [75].

*Figure 1: WHO-5 index across Europe (scale 0-25) [74]*
5.4 Mental wellbeing in children

There is a lack of suitable validated scales to assess mental wellbeing in children younger than 13 years of age. A report of Health Scotland from 2012 [76] that investigated available indicators for mental health in children and young people recommends that a mental wellbeing scale suitable for the age of 8 up to 14 should be developed and included in routine national surveys. Moreover, the authors call for a scale to assess mental wellbeing for children aged 24-30 months and upon entry to primary school. The authors highlight the importance to focus on positive aspects in the assessment of mental health. As no instrument exists to assess mental wellbeing in children, no numbers on levels of mental wellbeing or the distribution of mental wellbeing in children are available.
6 Theoretical frameworks of environment and mental health

In recent years many models were developed that describe the relationship between environment, social position, and health. These models focus on two mechanisms that might explain the relationship between environment and health in the light of social position [77]: The first mechanism described in this context is based on social differences in environmental burden. The focus here is whether environmental burdens and resources are distributed equally and fairly within society. The second mechanism focuses on social differences in vulnerability concerning environmental hazards. The focus here is whether vulnerability for environmental health risks and their effect on health differ between social groups and factors, taken that the intensity of hazards stays equal. Special attention needs to be paid to cumulative exposure. It can be argued that social inequalities in living environments play a vital role for health chances in vulnerable life phases but also in a life course perspective [78]. These models explaining the relationship between social position, environment, and health suggest that actions to tackle inequalities in health risks and resources should be targeted on municipal meso level as well as on societal and political macro level, instead of focusing on individual lifestyles [77]. Moreover, if the living environment is not considered, there is a risk to blame individuals for their health problems. However, it is not always an individual's voluntary decision to live in the environment they live in. Social position and the environment in parts determine and limit the scope of decisions one can take [38]. For example, people with low income tend to live in neighbourhoods with higher exposure to health-damaging characteristics such as high levels of noise and noxious substances from cars compared to people with higher income [79]. Due to their small income, they do not have the opportunity to choose their residential location [80, 81]. Other factors that might limit their decision scope concerning their living environment are language barriers, social networks, and limited knowledge of the legal system [38]. In general, people cannot change everything about their context and exposures they may experience.

A comprehensive evaluation of existing models would be beyond the scope of this dissertation and is not the focus of this work. The focus will be on the description of two models and an evaluation of to what extent they are suitable for the specific topic of this dissertation and the analysed indicators of the environment. The WHO model is one of the most popular models that focuses on social inequalities and health and furthermore explicitly focuses on macrosocial policies such as welfare states, which are used as an indicator of social structures at the macro level in this dissertation. The second model that is described is a model proposed by Schulz and Northridge on social determinants of health and environmental health promotion, which describes different levels of health-influencing environmental factors.
The WHO model is a conceptual framework for action on the social determinants of health and is based on previous frameworks, especially on the model of “the mechanisms of health inequality” by Diderichsen [82]. It aims to provide a comprehensive conceptual framework to i) identify the social determinants of health and health inequalities; ii) illustrate how major determinants relate to each other; iii) explain the mechanisms by which social determinants generate health inequalities; iv) provide a framework for evaluating which social determinants of health are the most important to address; and v) map specific levels of intervention and policy entry points for action on social determinants of health [82]. Figure 2 shows the complete model. The model incorporates two core components: 1) structural determinants of health inequities, which is subdivided in a) socioeconomic and political context and b) indicators of the individual socioeconomic situation and 2) intermediary determinants of health [82]. The model illustrates how social, economic, and political mechanisms influence socioeconomic position, whereby populations are stratified according to factors such as gender, education, income, race/ethnicity, and occupation (“structural determinants”). Consecutively, socioeconomic position influences specific determinants of health status (“intermediating determinants”) depending on people’s position within social hierarchies. Based on their respective social status, individuals are affected by different exposures and have different vulnerability to health-impacting conditions. Impaired health can feed back on a given individual socioeconomic position to negatively impact and lower a person’s position [82]. In the model, context is broadly defined as all social and political mechanisms that generate, maintain, or configure social hierarchies [82]. These include the labour market, the educational system, political institutions, and other cultural and societal values. Among the contextual factors the most powerful factor that influence health is the welfare state and its redistribution policies (or the absence of such policies) [82]. By describing the health care system itself as a social determinant of health, the WHO model departs from many previous models [82].
Figure 2: The WHO conceptual framework on the social determinants of health and health inequalities [82]

In their model on ‘social determinants of health and environmental health promotion’ Schulz and Northridge [83] assume an unequal distribution of environmental hazards and resources. They propose four levels of environmental determinants of health, which are described as a functional chain (Figure 3). The fundamental or macro level includes the natural environment, macrosocial factors, and inequalities in the macrosocial factors. These factors influence health by influencing access to resources, which enable the individual to sustain health [83]. The intermediate or meso/community level comprises aspects of the social context and the built environment. The proximate or micro/interpersonal level consists of stressors, health behaviours, and aspects of social integration and social support. Health and wellbeing build the fourth level. The starting point in this model is social conditions on the fundamental level. They influence the intermediate level, which in turn influences the proximate level, which displays the direct link to health and wellbeing. However, the model also points out dynamic processes and interdependences between the different levels and within one level. Also, the model shows that changes at one level can result in changes on a subsequent level.
**Figure 3:** Model proposed by Schulz and Northridge on social determinants of health and environmental health promotion [83]

Comparing these two models, major distinctions include the specific focus on social determinants of health in the WHO model [82] versus the focus on aspects of the social, natural, and built environment in the model proposed by Schulz and Northridge [83]. Gender is not included in the model by Schulz and Northridge but is included as a structural determinant in the WHO model [82]. Both models have in common that they consider a macrosocial dimension. Both models also include factors at the individual level [82, 83]. The WHO model clearly emphasises the distinction between social determinants of health inequalities and social determinants of health and thereby discriminates between the mechanisms by which social inequalities are created and the conditions of life which then result and directly impact on health and wellbeing [82]. The WHO model displays social cohesion and social capital as intermediate factors which influence social determinants [82], whereas the model by Schulz and Northridge focuses on social integration and social support as direct determinants of health and wellbeing [83]. As the WHO model focuses on social determinants it comes as no surprise that noise is only implicitly mentioned among the living conditions as a health-influencing factor. Similarly, Schulz and Northridge do not include noise, which in this model
Based on these two models a conceptual model was developed illustrating potential pathways between environmental factors and mental health (Figure 4). In the model, three main levels exist that influence equity in mental distress and wellbeing but also the actual level of mental health. The macro level influences the meso level, which influences the individual level, which in turn influences equity and level of mental health. These relationships, however, are not to be understood as a straightforward path, but interrelations exist. The level of mental distress and mental wellbeing for example also influences factors on the individual level. Factors of interest at the macro level are the physical environment, macroeconomic policies, social policies and structures (e.g. welfare state), public services, and cultural and societal values. Also, factors at the macro level can have a direct impact on factors at the individual level. For example, cultural and societal values about the role of women in the society have a direct link on gender, or macroeconomic policies impact material circumstances. As said above, these factors at the macro level influence the built and social environment, which also influence each other. Social environment in this model comprises all social interaction of an individual in its different life settings. Factors that make up the social environment are for example social capital, social cohesion or social support. For children, in this context, family factors are of particular importance [84-86]. The built and the social environment have an impact on factors at the individual level and can also influence the level of mental wellbeing and mental distress. In the proposed model, determinants at the individual level are material circumstances, health behaviour, biological and psychological factors, gender/sex, education, occupation, and income. These factors are interrelated. Education influences occupation, which in turn influences income. Gender also influences the level of education, occupation, and income. Factors at the individual level display the direct link to equity in mental distress and mental wellbeing as well as the level of mental distress and mental wellbeing. Also, these factors can act as effect modifiers on the relationship between factors at the meso level and mental distress and mental wellbeing.
Figure 4: Conceptual model illustrating potential pathways between environmental factors and mental health (own work, based on [82, 83])
7 Determinants of mental health

Based on the above-described model, this chapter will give an overall picture of the current evidence on the association of macro, meso, and individual factors and mental distress and mental wellbeing. A comprehensive discussion on the methodological differences highlighting the heterogeneity of the described studies in terms of study population, instruments, or considered potential biases would be beyond the scope of this dissertation. Therefore, studies will be presented in a brief overview; studies with direct links to the results of this dissertation will be discussed in detail in the discussion. Results are presented separate for men and women if these were provided and discussed in the respective studies, otherwise, results will be presented for both genders together.

7.1 Macro level

Social policies as for example welfare policies or welfare regimes can have an impact on mental health and also on (un)equal distribution of mental health between different groups (for example between men and women) [87]. Evidence suggests that welfare regime policies are connected to depression [58] and mental wellbeing [87]. Moreover, studies show that mental health at the individual level is connected to cultural or societal values and beliefs [88, 89]. In this context, it has been found that collectivistic cultures do not appreciate people expressing their emotions, as more value is put on group harmony. For this reason, emotions are constantly denied or suppressed to maintain a harmonious atmosphere of the group [90, 91]. As a consequence, the burden of emotional pressure builds up over the long run and is detrimental to mental health [91]. Also, belief and values about gender roles may influence mental health outcomes. Women experience lower levels of mental wellbeing than men [87] and as said above, women have a higher risk of depression [58, 92], which is attributed to specific social role expectations as women [1]. It is further speculated whether women who explicitly do not conform to role patterns might have especially high levels of depression [92]. One major part of public services is health care services. To just mention one aspect, in several countries the so-called ‘early intervention services’ have been established [93-96] to improve care and support for adolescents with mental health problems. This organization of the health care system leads to improved effectiveness of the treatment and a reduction in chronic severe mental diseases [97]. Economic policies can influence various factors at the individual level, which in turn influence mental health. For example, taxation policies or other economic decisions at the policy level can influence material circumstances or lead to poverty of an individual. There is scarcity of studies that directly link economic policies and mental health outcomes. However, there is some research that addresses the effect of the economic crisis (as an economic factor at the macro level) on mental health outcomes. Two of the major consequences of economic crises are an increase
in unemployment and a lowering of income [98]. A meta-analysis of 237 cross-sectional and 87 longitudinal studies found that unemployment was linked to mental distress [99]. The average number of persons with psychological problems among the unemployed in the studies was 34%, compared to 16% among employed individuals. Gender, occupational status, and unemployment duration were significant moderators of the relationship between unemployment and mental distress. The effect sizes were larger among men, blue-collar workers, and long-term unemployed persons than among women, white-collar workers, and short-term unemployed persons. The negative effect of unemployment on mental health was stronger in countries with a weak unemployment protection system, which connects to social policies at the macro level.

7.2 Meso level
Determinants at the meso level are organised in factors of the built and factors of the social environment. However, this separation is not always possible as studies often analyse factors on both dimensions and, as discussed in chapter 3, the facets of the environment do not exist detached from each other and in practice they often cannot be separated clearly.

Built environment
One major focus in research concerning the built environment is green spaces and their relationship with mental health. Green space (e.g. such as parks or forests) is either operationalized as surrounding greenness, access to green spaces, or quality of green spaces. A recent review [100] investigated the association between green space and mental health. The authors report a reduced risk of poor mental health or related disorders with increased surrounding greenness in most studies [101-113], although some studies failed to find an association [114-117]. Limited access to green spaces or increased distance to green spaces was reported to be associated with the risk of depressive symptoms [118] and general mental health problems [119]. One study did not find an association between access to green space and different mental health indicators [112] and one study only found an association for ethical subgroups or specific age groups [120]. Evidence on the association between surrounding greenness and mental health problems in children is conflicting [121-123]. Of special interest here is a longitudinal study showing that moving to greener areas improved mental health scores and individuals who moved to less green areas showed significantly worse mental health in the year preceding the move but returned to baseline in the post-move years [101]. Astell-Burt et al. [103] showed that the beneficial effect of green space had different peaks throughout the life course for men and women. The evidence on a causal relationship between surrounding greenness and emotional or behavioural problems in children is conflicting [121-124] indicating that children might be less sensitive to variation in their built environment [106], at least
this might be true for the aspect of green space. In conclusion, there is limited evidence of mental health benefits of surrounding greenness or access to green spaces in adults and the evidence in children is inadequate due to the limited number of studies available.

The available evidence on the impact of blue space on mental health is still sparse. There is some indication that blue space could be associated with mental health outcomes [125], while another study did not find consistent associations [112]. One factor of the built environment observes special attention – environmental noise, which is the major environmental burden [126] and is a main cause for environmental annoyance [127]. Noise reduces the quality of the environment, leads to annoyance, and might affect health and cognition [128]. In adults, it is reported that noise is associated with mood disorder, neurodegenerative disease, and reduced neurocognitive function in long-term exposed adults [129]. Earlier research suggests that environmental noise appears to be linked to psychological symptoms [130-132], but not to clinical psychiatric disorders [130, 133, 134]. Also, research suggests that a simultaneous exposure to different noise sources (road traffic, aircraft traffic, and railway traffic) might lead to a higher increase in the chance for depression than exposure to a single noise source [135]. So far the results for the association between environmental noise and children’s mental health are inconsistent: some studies report an association of noise and mental health outcomes in children [136-140] while others did not find an association [141-143]. Consistent results have been found concerning noise exposure assessed at school and cognitive performance, such as reading, attention, and memory [142, 144-146]. In conclusion, evidence for an effect of noise on mental health suggests that for adults and children noise probably affects mental wellbeing and might affect mental distress and ill-health.

The urban environment has been in the spotlight of some research: In a review, Berry [4] investigates cities as environmental determinants and reports that the population density of a city or area is a risk factor for mental health if it is combined with other risk factors in the social environment. Moreover, accessibility by public transport and urban density have been found to be predictors for the prescription of antidepressants, independent of individual factors [147]. This was particularly relevant for women and the elderly, as they are thought to spend more time in the neighbourhood and are therefore more under the influence of factors of the built environment [147]. A study in the United States showed that the association between disadvantaged neighbourhoods and mental disorder in children was more than two times higher in urban areas compared to rural areas [148]. Mental wellbeing was found to be associated with living and environmental factors in a Scottish study among adults [149]. Concerning factors of the living environment, the perception of the living environment as a district with a good reputation, satisfaction with the landlord, and the impression that the neighbourhood and one’s home are determinants of wellbeing were especially important for
the mental wellbeing of study participants. Of the environmental factors, living in a house (compared to a flat), living in a house in a good state of repair, living in an area with nice buildings and living in a nice, quiet and peaceful environment, were associated with high mental wellbeing. The very proximate environment is the housing situation. Poor housing conditions have been linked to multiple negative health outcomes in both children and adults [150]. As one housing factor, crowding has been associated with impaired mental health for adults and children. Studies show a positive relationship between crowding and low mental wellbeing [151] and poorer mental health [152]. The effect of living in a crowded household on mental health may differ by gender [153, 154], with men expressing more externalizing responses such as aggressive behaviour and substance abuse and women expressing more internalizing distress (e.g. anxiety and depression) [155]. Likewise, evidence also shows an association between crowding and adverse mental health outcomes in children [156]. Another factor that deserves attention is the exposure to toxic substances at home. Lead is the most widely studied of all known potential neurotoxicants [157] and its toxicity has been assessed intensively [158]. It has been reported to influence the developing brain. Sensitivity to such an exposure is greatest in utero and throughout early childhood. Even very low levels of exposure can have meaningful adverse effects on brain development, behavioural functioning, aggression, anti-social behaviour, and attention deficit in children [158-162]. Neurohormonal alterations through lead exposure in children cause increased rates of attention-deficit/hyperactivity disorder (ADHD). Children with a blood lead level on the higher end of the 2-5 μg/dL spectrum have a 4-fold increased risk for ADHD [163, 164].

Some individual characteristics, such as gender, personality traits, or coping mechanisms can influence the relationship between environment and mental health as effect modifier. For example, studies showed a relationship between environmental pollution, such as garbage on the street, graffiti, or noise and depressive symptoms in younger boys, but not in older boys or girls [165]. Furthermore, ethnic background is discussed as a possible moderator. Research results suggest that young people from ethnic minorities are partially protected against adverse effect caused by poor neighbourhood by ethnic group solidarity [166].

Social environment

Studies investigating social relationships as aspects of the social environment pertain to three major domains: social networks, social support, and social connectedness [167-169]. A recent review found that perceived emotional support, perceived instrumental support, and large diverse social networks were protective factors against depression. Little evidence was found on the relationship between a feeling of social connectedness and negative interactions [170]. The literature distinguishes between received social support and provided social support and further between
emotional and instrumental support [170]. All these different forms of social support appear to have different implications for mental health [171], and it has been shown that the role and effect of social support on mental wellbeing vary depending on the source of the support [172, 173]. An often used umbrella term in this context is social capital, as a way of conceptualizing and measuring the social environment [174]. Social capital is the quality of relationships within communities or societies, including community networks, civic engagement, sense of belonging, and norms of cooperation and trust [175]. A review by Nyqvist et al. [176] reported that social capital is beneficial for mental wellbeing in older people. Other reviews focused on the association between social capital and the negative dimension of mental health and found that social capital could reduce the risk of mental ill-health and disorder [175, 177, 178]. Crime and fear of crime are widely recognized as potentially important influences on mental health and mental wellbeing [179]. As on a population level, the incidence of major crime victims is relatively low [179], it is especially the fear of crime, which is more prevalent in the general population that has been linked to poorer mental health [180, 181].

Another focus of studies may be summarised under the term ‘neighbourhood environment’. Living in an area with higher socioeconomic deprivation has been associated with an increased risk for depression [182, 183] and a greater likelihood of admission to a psychiatric hospital, independent of individual characteristics [184]. Moreover, mental wellbeing in older adults has been linked to neighbourhood cohesion and neighbourhood problems [185]. But these findings are not consistent. Studies form the Netherlands [186], Sweden [187], and the United Kingdom (UK) [188] found that neighbourhood deprivation had no or only little influence on the prevalence of depression or anxiety once the individual socioeconomic status was accounted for. A study from the UK found no association between area-level deprivation and mental wellbeing. In a review [189] the evidence on the impact of a decayed physical environment (measured by indicators such as garbage on the street, graffiti, and abandoned buildings) on common mental disorders in young people was reported to be weak. A few studies analysed changes in the physical environment prospectively: In a Norwegian study a socially disadvantaged district of Oslo, which improved over the years, was monitored over a longer period of time. It was observed that mental health problems decreased in this district [190]. Relocations could show similar effects: In the American intervention study ‘Moving to opportunities’ 5550 families from a socially disadvantaged area were relocated to an area that was socially better off. Three years later parents were happier and sons less anxious and less depressive compared to individuals in the control group, who still lived in social housing. Changes were only found in boys aged 8-13 years, but not in boys between 14-18 years of age, nor in girls in any age group, which suggests that environment could have a gender-specific effect on health [165].
7.3 Individual level

There is substantial evidence on individual and social factors of mental health. Poverty, financial problems, and social deprivation are described as major socioeconomic risk factors for mental health problems [191-193]. Poverty and associated with this unemployment, deprivation, and low educational status are strong markers of mental distress and mental illness [191, 194-198]. Moreover, mental distress and poverty are considered to interact in a negative cycle: not only is the risk of mental illness among people who live in poverty higher but similarly the likelihood that those living with mental illness will drift into or remain in poverty [194]. The results on age and indicators of mental wellbeing are controversial; some studies report that older age groups are at higher risk for poor mental wellbeing [73, 195, 196, 199], others find the opposite [200-202]. In terms of gender, the socially-defined role of women in many societies exposes them to greater stresses, which, together with other risk factors, leads to higher rates of depression and anxiety [1]. In the western world, for example, depression is approximately twice as high in women as in men [58]. In children, many studies report an association between socioeconomic status, the family environment and an impaired mental health of children [203-206]. Physical activity is a factor of health behaviour that is associated with mental health. Reviews suggest a positive effect of physical activity on mental wellbeing in adults [207] and depression in children [208] and adults [209]. Among the psychological factors, resilience received increased attention in recent research. Individual resilience has been described as the ability of a person to successfully adapt to or recover from stressful and traumatic experiences in life [210]. Studies suggest that resilience is linked to better mental health in adults [211] and adolescents [212]. The range of biological factors that are linked to mental health is extensive. For example, findings suggest that specific genes, especially those that code for neurotransmitter synthesis and functions, moderate the effects of abusive parenting [84]. In adults certain hormones (e.g. corticotrophin releasing factor) are elevated in brains of patients with depression and post-traumatic stress disorder [213, 214], where hypersecretion is speculated to be the causal factor [215].
8  Aim of this thesis

The overall aim of this dissertation was to get better insight into the relationship between individual, environmental, and social factors and mental health considered in its entity as mental wellbeing and mental distress. For this purpose adults as well as children were looked at. The main objectives were:

I.  To assess prevalences and variations in mental health by characteristics at the individual level

Available research provides information on important factors of mental ill-health. However, there is a lack of research on what factors are associated with mental wellbeing and how mental wellbeing is distributed between different social groups. The EQLS was the basis to give a conclusive overview of what sociodemographic, psychosocial, and material factors are associated with mental wellbeing in adults on a European level in article I. No instruments exist that measure mental wellbeing in children. One approach to demonstrate that mental ill-health and mental wellbeing are not simply two sides of one continuum is to show that they have different correlates and are influenced by different factors. Following this approach, article II draws on data from the Health Monitoring Units in Bavaria (GME), and, in an exploratory manner, investigates the correlates of mental ill-health (assessed with the SDQ) and psychological wellbeing (as one component of mental wellbeing) in children.

II.  To assess the relationship between mental health and social structures at the macro level

In current discussions in social epidemiology, the importance to explore how macro level social forces shape the health of populations is stated [216]. One characteristic that describes social structures at the macro level is welfare regimes. The WHO model on social determinants of health (cf. chapter 5) even describes welfare states as the most powerful contextual factor to influence health [82]. Therefore, the categorization of countries into welfare regimes was chosen to describe social structures at the macro level. Another important issue in social epidemiology is health inequalities between different groups of people. In this gender differences are an important topic [217-219]. To date, mental wellbeing has not been discussed in the light of welfare regimes, nor have gender inequalities in mental wellbeing. Therefore, in article III the relationship between gender, mental wellbeing, and welfare regimes is investigated. The data base for this study on adults was the EQLS.
III. To assess how mental health is associated with the built environment at the meso level

Environmental noise is perceived as the major environmental burden [126]. Approximately 20% of the population of the European Union are exposed to noise levels that are classified as unacceptable by health experts and researchers [220], and at least one million disability adjusted life years are lost because of environmental noise in Western Europe every year [128]. In European children aged 7-19 years about 45,000 disability adjusted life years are lost every year, because of cognitive impairment due to noise [128]. Therefore, noise was chosen as one example of the built environment at the meso level. Individual exposure to noise was assessed and operationalized as annoyance by noise. To date, no study exists that investigates the influence of environmental noise on children’s mental health using a cohort design. Data of the GME was used in article IV to assess the association between different noise sources and incident mental health problems in a longitudinal study in school-aged children.
9 Study populations, materials, and methods

This chapter gives an overview of the data sources, study populations, and the statistical methods applied.

9.1 Data sources

Two different data sources served as basis for conducting the four individual studies. The third wave of the EQLS (2011-2012) provided data for Article I and III. Data from the GME was the basis for paper II and IV.

9.1.1 EQLS

The European Quality of Life Survey is a bi-annual European survey, which is conducted in more than 30 countries. In this dissertation, data of the third wave of the EQLS was analysed. In this wave of the survey data of 34 countries was gathered in 2011 and 2012. The survey includes questions on environmental problems in the neighbourhood (e.g. noise, crime, traffic), housing problems (e.g. crowding, dampness, no toilet), and aspects of the social environment (e.g. social isolation, perceived quality of society). Mental wellbeing was assessed with the WHO-5 [221], which is considered a valid instrument to evaluate mental wellbeing in population-based studies [222] (cf. chapter 4). To assess the association between mental wellbeing and sociodemographic, psychosocial, and material correlates, different questions from the EQLS were used. This procedure is described in article I in further detail. More information on the questionnaire of the EQLS can be found in the reports of the EQLS [74, 223], the website gives further information on the questionnaire development [224].

9.1.2 Health Monitoring Units in Bavaria

The second source of data was data collected from children in one German city (Ingolstadt) and one county (Günzburg) in Bavaria. The data base of the Health Monitoring Units will be described in more detail, as unlike in the case of the EQLS no officially published report exists that could be consulted to retrieve more information. Health monitoring units have been established in summer 2004 and are linked to 5 public health departments in Bavaria [225, 226]. They include urban and rural areas. Selection of local public health authorities was organized such that several urban and rural regions of Bavaria were represented. Areas included in the health monitoring units are the counties Bamberg, Günzburg, and Schwandorf as well as the cities Bamberg, Ingolstadt, and Munich. Within the framework of the GME, a cohort study was established in one city and one county.

Coordination of the project was placed at the Bayerisches Landesamt für Gesundheit und Lebensmittelsicherheit in the unit ‘Arbeits- und Umweltepidemiologie’ in cooperation with the unit
Health promotion/prevention. The project was supported by the Bayerisches Staatsministerium für Umwelt und Gesundheit. The main focus of the health monitoring units is health and environment in children. Questionnaires were based on modules and each survey had a different focus topic. All surveys were linked to the compulsory school entrance examination in 2005 and 2006 for the children who entered school in summer 2006. In Ingolstadt and Günzburg a follow-up of children was conducted in 2009 and 2010. All children of the fourth grade in elementary school were invited to participate. Parents were asked for their consent to link that data to the data gathered before school entrance. In doing so a cohort was built for Günzburg and Ingolstadt with one follow-up.

In this dissertation, longitudinal data of the cohort (article IV) and cross-sectional data of the follow-up in fourth grade (article II) was analysed.

**Questionnaire**

At baseline, parental questionnaires were used and at follow-up parental questionnaires and additional questionnaires for children were applied. In this dissertation only parental data was analysed, therefore only this questionnaire will be described in detail. As far as possible questions in the questionnaire were based on established and validated questionnaires. Topics covered by the parental questionnaire included:

- General information on the child
- Quality of life
- Mental health
- Physical activity
- TV and media use
- Nutrition
- Neighbourhood environment, noise
- Second hand smoke exposure
- Sociodemographic information of parents

For this dissertation questions from all of the above-mentioned topics were used (some of them only as covariates) except for nutrition. The following part will describe the questions relevant for analyses of this dissertation:
Quality of life

The parental version of the validated revised questionnaire to assess Health-Related Quality of Life in children and adolescents (KINDL) [227] questionnaire was used to assess children’s quality of life. It consists of six subcategories: physical wellbeing, emotional wellbeing, family, school, friends, school/kindergarten, and self-worth. For this dissertation, the subcategory ‘emotional wellbeing’ was relevant, which consists of four items, that are scored from 1 (never) to 4 (often or always) with reversals according to the wording of the question, and summed to a total score.

Mental health

Mental Health was assessed with the parental version of the SDQ [49]. The SDQ is a brief behavioural screening questionnaire for children and adolescents. It consists of 25 items measuring five dimensions: emotional symptoms, conduct problems, hyperactivity, peer relationship problems, and pro-social behaviour that can be analysed separately or summed to a total difficulties score by summing up the scores in the problem areas without consideration of pro-social behaviour [49]. According to international cut-off points, scores of respondents can be classified as normal, borderline, and abnormal [228].

Physical activity

Questions on physical activity of the child assessed the frequency a child performed various forms of physical activity. The answer categories were ‘never’, ‘less than 1 time per week’, ‘1-2 times per week’, ‘3-6 times per week’, ‘every day’, ‘I don’t know’. Physical activities that were covered included climbing on trees or climbing walls, ball games, to play tag, take a bike or scooter, inline skates, skateboard or roller-skate, swimming, play outside. At t1 questions were slightly adapted after a pre-test with children aged 9-10. A question on rope skipping and other skipping games were added to adequately assess physical activity of girls of that age.

Noise

The questionnaire on noise annoyance was based on international standardized questions of the International Commission on Biological Effects of Noise [229]. Nine noise sources were investigated separately for day and night:

- road traffic
- aircraft traffic
- construction work
- rail traffic
- industry
• restaurant/club
• sport and leisure time facilities
• playgrounds
• neighbours

Five alternatives were given regarding the degree of annoyance: ‘not at all’, ‘a bit’, ‘moderately’, ‘strong’, and ‘very strong’; additionally parents could opt for ‘noise source does not exist’, which was grouped together with ‘not at all’ for analyses.

Environment

Questions on living environment of the child were based on the German Environmental Survey for children. Parents were asked, in which kind of house they lived in, at what kind of street, and what kind of living area they lived in. Parents were also asked to provide information on the size of the apartment and the number of rooms. A variable ‘crowding’ was defined as more than one person per room (not counting bathrooms) or less than 20 m² living space per person (including kitchen and bathroom).

Second hand smoke exposure

To assess second hand smoke exposure it was asked, whether people smoked in the apartment (or on the balcony) the child was living in.

Sociodemographics

Socioeconomic circumstances of the child were assessed by questions about the family situation, migration background, parental education, employment status, crowding, and the household equivalent income. The question on migration background was based on recommendations of the minimal set of indicators to adequately assess migration background in children by Schenk et al. [230]. Children were considered as having a migration background if both parents were born in another country than Germany, or if the child and at least one of the parents were born in another country, or if the language spoken at home was not German or German and another language [231].

The question on parental education was based on recommendations of the German Working Group of Epidemiology to quantify sociodemographics in epidemiological studies [232]. Parental education was assessed individually for mother and father and defined as highest completed education. It was categorized into ‘high’ (general qualification for university entrance), ‘middle’ (upper secondary school certificate) and ‘low’ (lower secondary school certificate or no graduation). Parental working status was categorized into ‘at least one parent employed’ (part- or full-time working) versus ‘both
parents only marginally employed or unemployed’. Single parenthood was assessed by combining answers relating to family status, living together with a partner, and being a single parent [233]. This combination of answers was done to minimize classification errors.

Household equivalent income was calculated by weighting the monthly household net income as disposable income after taxes and social transfers according to age and number of household members using the weighting factors of the Organisation for Economic Co-operation and Development scale [234]. Sixty percent of the regional median income was defined as the threshold of poverty risk.

9.2 Study population

An overview of the study populations analysed in the different papers of this dissertation is given below:

Article I - Material, psychosocial and sociodemographic determinants are associated with positive mental health in Europe: a cross-sectional study

Data of 21,066 men and 22,569 women aged 18 years and over, from 34 European countries (EU-27, Croatia, Iceland, Montenegro, Former Yugoslav Republic of Macedonia, Serbia, Turkey, Kosovo) participating in the third wave of the EQLS (2011–2012) were analysed for this paper. In all countries, data was collected via face-to-face interviews at respondents’ home, which were selected by multistage random sampling. The overall response rate was 41%. The prevalence of poor positive mental health was 30% in women and 24% in men.

Article II - Mental wellbeing and mental distress have different socioeconomic determinants in schoolchildren

This study is based on data from a cross-sectional study in which all parents of children in the fourth grade (9-10 years) in all primary schools in one urban region (Ingolstadt, Bavaria) and one rural area (Günzburg, Bavaria) were invited to participate. The survey was carried out from July to December 2009 and the response rate was 71 %. Overall, 899 girls and 872 boys were included in the analysis. Boys had significantly more often a high total difficulties score of the SDQ (17.4%) compared to girls (12.0%). Overall, 11.9 % of girls and 9.3% of boys reported high emotional wellbeing.

Article III - Gender inequalities in mental wellbeing in 26 European countries: Do welfare regimes matter?

The article studied the same study population as analysed in article I but solely included individuals
from countries that could be assigned to a type of welfare regime according to predominant welfare typologies. Therefore, the sample for this article consisted of 19,366 women and 14,338 men from 26 countries.

**Article IV - Environmental noise and incident mental health problems: A prospective cohort study among school children in Germany**

Longitudinal data of 1,185 children (583 boys and 602 girls) in a cohort study of children from first (t0) to fourth grade (t1) of primary school was analysed for this paper. The cohort consisted of children entering school in the city of Ingolstadt and the more rural county of Günzburg, Germany in 2006. Children were aged 6-7 years at entry to the cohort. The response rate of the baseline survey was 84.7%.

The noise source that most children were exposed to at t0 and t1 was road traffic day (11.4% and 17.7% resp.) The lowest exposure prevalence was reported for playgrounds at t0 (0.1%) and sport/leisure time facilities night at t1 (0.6%) both during night time. Lowest prevalence of abnormal problem scores in the subcategories of the SDQ was reported for the total difficulties score at both times (t0=3.6%; t1=6.3%), and highest for conduct problems at t0 (9.8%) and peer relationship problems at t1 (10.1%).

More detailed information on the study populations can be found in the respective articles (see Appendix)

**9.3 Statistical methods**

Different statistical methods were used in the articles included in this dissertation depending on the research question and the data structure. Article I and III analysed cross-sectional data of the EQLS applying multilevel logistic regression analysis. Article II analysed cross-sectional data from GME applying logistic regression analyses. Article IV analysed longitudinal data of the GME, applying Poisson regression analyses. A more detailed description is given below and in the respective articles (see Appendix).

**Mental wellbeing in adults**

For Article I and III, data of the third wave of the EQLS was analysed. The EQLS allows for three hierarchic levels to be used. The level 1 units comprise individual people, level 2 regions within countries, while units at level 3 represent European countries. Therefore, a random intercept multilevel model was applied taking into account the hierarchical structure of data, which was due to the sampling procedure: Individuals nested in regions, which are organized in countries. Multilevel
models are particularly appropriate for research designs where data for participants are organized on more than one level. By doing so, one can take into account the between- and within variability of hierarchically organized data [235]. The models contain a so-called fixed part and a random component. Individual determinants were introduced as fixed effects, and country and region were used as random intercepts in the multilevel analysis.

To assure representativity in terms of gender, age, urbanization level, region and household size, two types of weighting coefficients were used: a design weight and a post-stratification weight [236]. Descriptive analyses were performed using the product of the design weight and post-stratification weight. For the regression analysis, sensitivity analyses were conducted with weights (product of design weight and post-stratification weight). The parameter estimates were substantially similar to unweighted estimates. Therefore, the unweighted parameter estimates (odds ratios) are presented because they are more efficient and the standard error is correct [237].

Article I

Based on the proposed model in this thesis, in article I, independent factors of mental wellbeing at the individual level were investigated. For the material, psychosocial, and sociodemographic determinants that were studied, dichotomous variables were built out of several questions per determinant if the variables were not included as a categorical variable in the dataset. For the newly built variables, an average scores of the included items was calculated and the median was used as cut-off point to create dichotomised variables. Determinants were organized in three groups: sociodemographic, psychosocial, and material. In article I and III, mental wellbeing was the outcome and was assessed with the WHO-5. As there is no official cut-off for the WHO-5 it was decided for a distribution-based approach. For article I, an average score of the WHO-5 index was calculated for the study population and those with values below the 25% percentile were considered to have low mental wellbeing. The binary variable is based on the whole dataset, including all countries. Although the focus was on mental wellbeing, it was decided to look at low levels of mental wellbeing, as most of the influencing factors were conceptualised as risk factors in the dataset. This allowed for a more straightforward interpretation of the results.

Descriptive statistical methods were used to firstly describe the distribution of the factors separately for men and women. Afterwards a random intercept multilevel logistic regression analyses was performed to examine the association between the potential determinants and poor mental wellbeing as outcome. Factors included in the analyses as potential influencing factors on mental wellbeing were chosen, based on a literature search of determinants of self-rated health. Firstly, general models stratified by gender were computed to study the association between the groups of
determinants and mental wellbeing independently. The first model included all sociodemographic factors, the second model all psychosocial factors, and the third model included all material factors. All variables that were significant at $\alpha=0.05$ for at least one gender were included in a final model. Odds ratios were calculated to describe the association between the determinants and poor mental wellbeing. Since determinants of mental wellbeing have only rarely been studied no literature on potential interactions was available. Therefore, a main effect model, without consideration of interactions was run.

Article III

One factor in the proposed theoretical model (cf. figure 4) is social policies and structures at the macro level. The approach to assort countries into welfare regimes applies well to the context of this dissertation and the research question. The outcome variable was mental wellbeing, as assessed with the WHO-5. Unlike article I, in article II the focus was put on those individuals who reported values above the 75% percentile of the WHO-5. The reason for this is that the focus was on the positive part of mental health, conceptualised as mental wellbeing [12, 17], which was also the case in article I; but in article III the associations that were investigated were conceptualized in a way that made this cut-off point more reasonable. Those individual who had values above the 75% percentile were interpreted as having very good or good mental wellbeing, those with values below the 75% were interpreted as having normal or poor mental wellbeing. This dichotomization is similar to the common categorization of self-rated health, where ‘very good’ and ‘good’ self-rated health on the one side and ‘normal’, ‘bad’ and ‘very bad’ self-rated health on the other side are grouped together.

The main independent variable was gender measured as man or woman. Several individual sociodemographic factors were used as control variables. At the contextual level, countries were grouped according to the predominant welfare regimes. For this purpose, an adapted classification [238, 239] of Ferrera [240] welfare regime classification was used. It was distinguished between six types of welfare regime: The Scandinavian, Anglo-Saxon, Bismarckian, Southern, Former Soviet Union, and Central and Eastern European Countries. The analyses were restricted to 26 countries with established welfare regime classification. After basic sample description, a random intercept multilevel logistic regression analyses was performed. First, the association between gender and mental wellbeing in each country was investigated separately. Bivariate analyses of the association between gender and good mental wellbeing and multivariate analyses to adjust for sociodemographic variables were conducted. Then, the variation of good mental wellbeing between countries and possible explanations for such variation was investigated. Four models were calculated, starting with an ‘empty model’. In the second model, individual variables were added and in the third welfare regimes. In model 4, interactions between welfare regime and gender were
included. Additionally, a first exploratory analysis testing the interaction between gender and educational level as one indicator for social position were performed.

Mental wellbeing and mental distress in children

Article II

Bivariate and multivariate associations between a range of socioeconomic characteristics and children’s mental wellbeing and mental distress, respectively, were examined using logistic regression analysis. The analyses were conducted separately for boys and girls as previous studies have shown that the prevalence of high SDQ scores differs substantially between boys and girls [9]. As effect estimates, crude and adjusted odds ratios (OR) with 95% confidence intervals (CI) were calculated.

Article IV

For descriptive analyses, children were categorized as ‘exposed’ (parents were ‘moderately’, ‘strong’ or ‘very strong’ annoyed), or as ‘not exposed’ (parents were ‘not at all’ or ‘a bit’ annoyed) by a specific noise source. For the analyses of the association with mental health outcomes an exposure variable was coded. Since there is no strict classification at what specific levels of annoyance start to be harmful, a change in annoyance in negative direction was calculated as main exposure variable (further mentioned as ‘increased-exposure’), indicating an increase of exposure at a fine scaling, of at least one point in negative direction on the 5-point Likert scale for each noise source separately between t0 and t1.

In most analyses, the SDQ is dichotomized into ‘normal’ and ‘borderline or abnormal’ in cross-sectional study designs. In contrast to this procedure, in the present cohort study incident cases were defined if a child moved from ‘normal’ to ‘borderline’ or ‘abnormal’ or from ‘borderline’ to ‘abnormal’ between t0 and t1. By doing so, it was possible to also detect only slight negative changes in mental health that would have been concealed if the SDQ had been dichotomized. The total difficulties score and the four problem areas were analysed in separate models. Children who were classified as ‘abnormal’ in one of the subcategories or the total difficulties score at t0 were excluded from the respective analyses.

To decide what confounders should be included in the analyses a two steps approach was conducted: First, potential confounders were assessed based on previous literature [138, 140]. Second, a $\chi^2$ test was conducted to investigate associations of variables at t0 (except for migration background, which was only assessed in t1) with the increased-exposure variables. A variable was retained in the analyses if there was a significant association with at least one of the increased-
exposure variables (p < 0.05). For the association of increased noise exposure bivariate and multivariate analyses were conducted applying Poisson Regression Analysis. Separate models were built for all noise sources where at least 10% of children reported increased-exposure during the study period. These were road traffic (day and night), aircraft noise (day), construction work (day), and neighbours (day and night). Two models were run for each of the mental health outcomes. In model 1 the bivariate association between noise source and the respective mental health outcome was analysed and in model 2 covariates were added. Results are presented as relatives risk (RR) with corresponding 95% confidence intervals. Although differences in prevalences of mental health problems between boys and girls exist [9], no differences concerning the exposure were found in the sample of this study. Therefore, no separate analyses for boys and girls were conducted.
10 Main results

This chapter provides a summary of the main results observed in the conducted studies, organised according to the objectives of this dissertation. A more detailed description of the study results can be found in the respective articles (see Appendix).

10.1 Objective I - Prevalences and variations in mental health by characteristics at the individual level

The prevalence of poor mental wellbeing in adults was 30% in women and 24% in men in a sample of 34 European countries participating in the third wave of the EQLS (article I). Key results with respect to the correlates of mental wellbeing at the individual level include that material as well as psychosocial, and sociodemographic factors were independently associated with low levels of mental wellbeing. Concerning the sociodemographic factors, higher age, lower educational status, and not working were associated with lower mental wellbeing among both genders. Of the psychosocial factors, among both genders practicing religion rarely or never, low social support, low levels of trust, high social exclusion, and living alone were associated with low levels of mental wellbeing. Not having children had a protective effect against low mental wellbeing for women but not for men. Concerning the material factors neighbourhood problems, material deprivation, financial problems, and quality of public services showed to be factors associated with low levels of mental wellbeing. The highest chance for low mental wellbeing was observed for higher age among the sociodemographic factors, for social exclusion among the psychosocial factors and material deprivation among the material factors.

Looking at the correlates of mental health in children (article II) the analyses showed that several indicators of families’ social disadvantage were associated with mental distress, in contrast to mental wellbeing. In detail, mental distress was associated with migration background and relative poverty among both genders. Mental distress was associated with parental unemployment in girls and with single parenthood in boys. Mental wellbeing was inversely associated with low paternal education in girls and with crowding in boys.

In conclusion, the results for adults showed independent associations between various sociodemographic, psychosocial, and material determinants and mental wellbeing. In contrast, only few associations between an indicator of mental wellbeing and socioeconomic factors were found in children. Notably, several indicators of social disadvantage in families were associated with higher chances for mental distress in children.
10.2 Objective II - Mental health and social structures at the macro level

The categorization of countries into welfare regimes was chosen as an example for social structures at the macro level (article III). Prevalence of good mental wellbeing differed between welfare regimes and between men and women. In most instances, the prevalence of good mental wellbeing was higher among men compared to women at welfare regime level, with the exception of the former Soviet Union (FSU) welfare regime, where women report slightly higher prevalence of good mental wellbeing. The highest prevalence of mental wellbeing was found in the Scandinavian welfare regime for men (17.1%) and women (15.0%). Lowest prevalence was found in the FSU welfare regime with 7.7% reporting good mental wellbeing among men and 7.8% among women. Inequalities in good mental wellbeing by gender were observed for 7 out of 26 European countries. In the UK, France, the Netherlands, Spain, Portugal, Bulgaria, and Romania women had significantly lower chances to report good mental wellbeing than men. Finland, Estonia, and Slovakia showed trends for women being more likely to report good mental wellbeing than men. In analyses considering all countries together, gender inequalities in good mental wellbeing were identified independent of further individual sociodemographic variables and independent of the welfare regimes that people lived in. People in the FSU and the Central and Eastern European countries (CEE) welfare regime showed statistically significantly lower chances to report good mental wellbeing compared to the Scandinavian welfare regime as reference. Gender inequalities in good mental wellbeing were not modified by welfare regimes.

In conclusion gender inequalities in the prevalence of good mental wellbeing exist in European countries independent of other sociodemographic and individual characteristics. Type of welfare regime at the macro level does not modify the association between gender at the individual level and good mental wellbeing in the analyses.

10.3 Objective III - Mental health and the built environment at the meso level

Environmental noise is perceived as the major environmental burden [126]. Therefore, the association between environmental noise, as an important factor of the built environment, and mental health is investigated to answer objective III. In a cohort of 583 boys and 602 girls, the SDQ was used to assess mental health problems (article IV).

Three main findings result from the analyses. First, exposure to road traffic noise at day or at night was the main risk factor for incident mental health problems as measured with the SDQ in children aged 9-10 years. Second, exposure to noise by neighbours at night and during the day also appeared to be a risk factor for some subcategories of the SDQ. Third, noise by construction work and aircraft noise during the day were not associated with incident mental health problems. In detail, road traffic
at night increased the risk to show incident problems on the total difficulties score of the SDQ as well as on the subscales emotional symptoms and conduct problems. Noise by neighbours during the day increased the risk to develop problems on the subscales conduct problems and hyperactivity. Aircraft noise and construction work during the day were not associated with any of the SDQ categories at a significant level. In sensitivity analyses, the association with incident mental health problems in children who had constantly high levels of exposure at t0 and t1 was assessed. The results showed the same pattern as reported above and the associations were even more distinct as relative risks were higher; however confidence intervals were wider because this group of children was smaller. In sum, these results suggest an association between noise and incident mental health problems in children. Moreover, an increase of noise does not automatically result in mental health problems; the source of noise does matter.
11 Discussion

In this dissertation, various elements of the proposed conceptual framework (cf. Figure 4) and their impact on mental health was investigated. The present findings highlight that a range of factors at the individual level is associated with prevalences and variations in mental wellbeing in adults and with mental distress and mental wellbeing in children. Welfare regimes, as an example of social structures at the macro level, are associated with mental wellbeing in adults. In children, mental distress is associated with environmental noise, which is a factor of the built environment at the meso level.

The present discussion is organised according to the three objectives of this dissertation, followed by comprehensive considerations on the assessment of mental wellbeing (cf. Chapter 11.4.) in the described studies, which will not be discussed in the discussion of the single objectives.

11.1 Prevalences and variations in mental health by characteristics at the individual level

The first objective was to assess prevalences and variations in mental health by characteristics at the individual level, focusing on mental wellbeing in adults and mental wellbeing and mental distress in children. In adults, characteristics were summarized into three groups: sociodemographic, psychosocial, and material factors. In children, the focus was on socioeconomic factors.

Interpretation of key findings

Two studies (article I and II) included in this dissertation assessed prevalences and variations of mental health by characteristics at the individual level in adults and in children. First, the focus in this discussion will be on the specific factors of interest, followed by more general considerations and implications of these studies.

Although different factors were assessed in children and adults, the presented results point to social inequalities in mental distress and mental wellbeing in both age groups: if social determinants of health are unevenly distributed, this may create social inequalities in health [241]. In this line, adverse social conditions such as being poor, unemployed and underprivileged are important determinants of mental health [242]. A recent review on inequalities in mental health problems in children concluded that socioeconomic inequalities are associated with mental health problems [243]. In particular, persistently low SES or a negative change in SES were major predictors of the onset of mental health problems. Children from socioeconomically disadvantaged families were two to three times more likely to develop mental health problems than their peers from
socioeconomically advantaged families. Interestingly, the review revealed that low parental education and low household income were the strongest predictors of mental health problems among children and adolescents [243]. Moreover, even though socioeconomic disparities in mental health were visible in all age groups, the impact of low SES on mental health was stronger in early childhood than in adolescents [243].

There is scarcity of studies that assess correlates of mental wellbeing in adults as well as in children. To date, most studies addressed correlates of mental illness. Other studies in adults covering positive aspects of mental health used single questions about happiness or life satisfaction, which is not the same as assessing mental wellbeing, since life satisfaction and happiness only cover the hedonistic perspective of wellbeing [34]. As described in chapter 4, instruments to assess mental wellbeing in children do not exist; therefore there are no studies available describing correlates of mental wellbeing in children. As a consequence, for children, it can only be referred to other studies analysing mental distress.

Looking at the specific characteristics that were investigated, the finding that not working was associated with low levels of mental wellbeing in adults (article I) and parental unemployment (article II) was associated with mental distress in girls is in line with previous studies [195, 197]. Moreover, it has been found that men have less mental health problems than women regardless of their employment status. Similarly, in the present study (article I) men had lower prevalences of poor mental wellbeing than women. Gender and employment status have been considered as key factors when determining the prevalence of mental health problems in a society [244-247]. This is in line with the intersectionality theory, which considers these factors as axes of social inequalities, which interact with each other and influence mental health inequalities.

In the present study (article I) individuals with higher education had a decreased chance for low mental wellbeing. Women with a tertiary level of education had a 35% decreased chance to report low levels of mental wellbeing compared to women who have a primary level of education or less. In men, a tertiary level of education compared to primary level or less resulted in a 29% decreased chance to report low levels of mental wellbeing. Moreover, low education of the father was associated with low mental wellbeing in girls in the children study (article II). These results are in line with previous studies reporting that low educational level is associated with poor mental wellbeing [195-198]. Also, lower education or less years of education have been linked with mental distress, specifically with higher prevalences of mental disorders [248-250]. Prevalences of mental disorder have been reported to be higher among those with less than 5 years of education [250], and lower educational attainment to be associated with a higher prevalence of mental disorders [248-250]. Moreover, a negative correlation between depression and education has been described: the ratio of
depression for those with a college level education was 4:1 compared with those who are illiterate. This gradient was stronger for women than for men [251]. In a Finnish study among children, an examination of various indicators of SES revealed that a low paternal education was a main predictor of mental health problems in children and adolescents [252].

The results on age and mental wellbeing are controversial. Some studies report that older age groups are at higher risk for poor mental wellbeing [73, 195], which would be in accordance with the results of the present study on adults (article I), while others find the opposite [12, 202]. All of these studies had a cross-sectional design. The studies supporting the view that older age groups experience higher mental wellbeing had smaller samples (n=1,015 [202], n=3,032 [12]) than the studies supporting the view that younger age groups experience higher levels of mental wellbeing (both approximately 10,500 participants [73, 195]). All but one study analysed representative population samples. In contrast, Meisenhelder et al. [202] analysed a very specific social group, namely Presbyterian church lay leaders. Of the studies suggesting that older individuals have higher levels of mental wellbeing, one study only calculated correlations and did not control for other variables [202]. Of the studies suggesting that younger age groups experience higher mental wellbeing, one study only found a significant association at the bivariate level [195], the other only adjusted for gender [73]. One of the studies, supporting that older age groups experience higher mental wellbeing, controlled for a number of socio-demographic variables [12]. This demonstrates that the cited studies are heterogeneous in their design and quality. Summarizing the evidence for both sides, the studies suggesting that older age groups experience higher mental wellbeing have performed better in controlling for other variables, whereas the studies suggesting that younger age-groups experience higher levels of mental wellbeing have used larger sample sizes and achieved better in terms of population representativeness.

When classifying living area into two categories - urban or rural – in the present study (article I) no significant association between living area and poor mental wellbeing was observed. Findings of the mental health of rural and urban populations are contradictory. In previous studies associations between living area and mental wellbeing have been reported, however, the direction of this relationship is not clear: living in a rural area [195] and living in a large city [73] have been associated with poor mental wellbeing. For mental distress, the National Psychiatric Morbidity Surveys of Great Britain found a strong positive association between living in urban areas and psychiatric morbidity [253]. And a review reported that the odds of having generalized anxiety disorder, depressive episodes or phobia was increased in urban areas compared to rural or semi-rural areas [254]. When comparing results concerning living area between studies, it is important to note that difficulties
emerge when comparing different categories of region considered (e.g. rural/urban, number of inhabitants) [242].

In the children study (article II), migration background was the strongest predictor of mental distress in boys and girls. It is widely assumed that migration and migration-related processes affect mental health of adults and children [255]. However, research has just started to understand this phenomenon. Early studies state that children with migration background have an increased risk of mental health problems [256]. Predominantly, three pathways are postulated for this effect [257].

The first and most common explanation is that the migration process causes stress, not only because migration includes extensive loss of friends and family, surroundings, and customs [258, 259], but also because migrants have to adapt to a new cultural environment, which often includes different moral values and standards and a new language [260, 261]. A second explanation points to stress caused by restrictive processes in the host country. Migrant populations often take the minority position in their host society, and as such hold a weaker social position at the bottom of the existing hierarchy [262, 263]. This is not so much because of a lack of personal, educational, or cultural resources in their ethnic group, but more because their integration in the host society is hindered by discrimination and restrictive policies regarding newcomers [257]. The third explanation states that the particular cultural background of specific migrant groups contributes to the development of their children’s mental health problems. In this line of argumentation it is not the migration or the minority position, but the specific cultural background of the migrant population itself that increases the risk of mental distress [264, 265].

In contrast to the opinion that migrant children are imposed to an increased risk of mental distress, others argue that migrant youth in general, may be at decreased risk of mental health problems [257]. The ‘healthy migrant effect’ holds that overcoming the immigration hurdles before migration leads to a selection of the fittest people, and therefore to migrants having good physical and mental health [266, 267]. It has also been stated that there is often a supportive and coherent family culture within migrant families which protects them against the development of mental health problems [268, 269]. A review on mental health in children with migration background did not unequivocally confirm that migrant youth are at higher risk of developing mental health problems. In the included studies of this review both higher and lower levels of problem behaviour were found [257]. When looking at the study population in the present study in children (article II) it has to be acknowledged that a very wide definition of migration background was applied. In fact, 90% of the children with migration background were born in Germany: therefore, the first explanation, which focuses on the stress caused by the migration process, and the ‘healthy migrant effect’ is only applicable in parts to this specific study population.
In the study among adults (article I) living alone was associated with low mental wellbeing. This is supported by previous research. In their analyses of the Eurobarometer 2002 survey Lehtinen et al. [73] showed that people who live alone report lower levels of mental wellbeing, as assessed with EVI. A study in Great Britain even showed that living with a partner at the age of 42 predicted levels of mental wellbeing eight years later [197]. Moreover, low levels of social support were associated with low levels of mental wellbeing in adults (article I). This confirms previous research, which showed that social support was linked to better mental wellbeing across a range of different indicators [73, 185, 195, 198, 270]. The results on an association between loneliness and low mental wellbeing go together with the findings of Van Lente et al. [195], who reported that loneliness was by far the strongest predictor of mental distress in their study. Similarly, social exclusion and low levels of trust have been associated with poor emotional health in a Russian study [271].

In the study among adults (article I), neighbourhood problems, housing problems, material deprivation, financial problems, and quality of public services were associated with low levels of mental wellbeing. And among children (article II) a medium relative household income was associated with mental distress in boys. Poor economic condition [73] and neighbourhood problems [151, 185] have previously been associated with poor mental wellbeing in adults. A study in Great Britain found that there was an independent association between a low standard of living and the prevalence of mental disorders [249]. In children, the above-mentioned Finnish study [252] found that low household income increased the risk for mental distress in children and adolescents. An Irish study showed that income was a predictor for mental wellbeing as well as mental distress in adults, the relationship for mental distress being stronger than that for mental wellbeing [195].

Several theoretical approaches were proposed to explain the differences in mental health problems in different social groups. The social causation hypothesis [272] states that mental health problems are a result of socioeconomic deprivation. The social selection hypothesis [273] assumes that people with mental health problems drift down in socioeconomic position because of their mental problems. Study findings indicated that the causation and selection hypothesis are not mutually exclusive and that there is a cycle of deprivation and mental health problems across generations [243]. The latter hypothesis is challenging for mental health problems in children, as their mental health problems would not affect their socioeconomic position, at least not in childhood, as the socioeconomic position of a family is ensured by parental indicators.

In the study among children (article II) there were fewer and different socioeconomic predictors of mental wellbeing than mental distress in the model. This appears to support previous findings in adults in suggesting that mental wellbeing and mental distress are two discrete dimensions of mental health rather than two ends of one continuum. Studies by Huppert and Whittington [17] and Keyes
[12, 16] provide support for the independence of mental wellbeing and mental distress. Thus, the absence of mental health disorder does not equal the presence of mental health and individuals without a mental disorder may experience varying degrees of mental wellbeing.

**Strengths, limitations, and methodological considerations**

The study in adults presents, for the first time, a broad range of correlates of mental wellbeing in a European population. Secondly, the study among children is the first study to portray determinants of mental wellbeing and mental distress in a population of school aged children. Both studies are of cross-sectional nature. This may be seen as a limitation because no causal interpretation can be inferred from these results. However, as the aim of both studies was to show prevalences and variations of mental health according to individual characteristics, cross-sectional data is deemed sufficient.

Other strengths and limitations relate to the single studies. In the study among adults (article I), analysing data of the third wave of the EQLS, the response rate (41%) was lower than aspired and differed across countries [223]. It has been argued that non-participants may be more likely to belong to low social groups and to have poorer health outcomes [274], which would result in a selection bias and the prevalence of low mental wellbeing as well as the association between some determinants, especially material determinants, might be underestimated. Strengths of this study include the large dataset with comparable data across Europe, which allowed studying each gender separately. Comparability of data between 34 European countries, and, for the first time, the inclusion of a variety of influencing factors enabled a comprehensive overview of determinants of mental wellbeing among the European population.

When looking at the specific characteristics of the study among children (article II), firstly there is a great need to develop a scale that adequately assesses mental wellbeing considering both eudaimonic and hedonic wellbeing in children. This call has already been put forward in 2012 in a report of Health Scotland [76]. Having said this, the present study is meant to be a first attempt to compare social determinants of mental distress and mental wellbeing in children. All data in this study is derived from parental reports. As self-reports are always subject to bias because people tend to give socially desirable answers, this might also hold for parents who report for their children. Moreover, although parents have a good knowledge of how their child feels, they are still outsiders and cannot know for sure how their child feels. It has been further shown that internalizing disorders were underestimated by external observers (parents and teachers) while external problems were
amplified [275, 276]. On the other hand, self-reports of children in such a young age, as they were in this study, do not always tend to be reliable [277].

This study, on the other hand, has various strengths. It is a comprehensive population survey including all children entering school in one year in the study region. The response rate of 71 % was high, which suggests that results may be representative for the target population. Furthermore, the survey comprises rural as well as urban populations. The association of the KINDL total score with the socioeconomic determinants were tested, and these associations were consistent with a German wide sample of children [278], which suggests that the data of this study is comparable to other study populations. Reverse causation, which is a limitation of cross-sectional studies, is unlikely in this study since most of the socioeconomic factors lie chronologically before the outcome per se.

**Conclusion**

Taken together, the two studies showed independent associations between various sociodemographic, psychosocial, and material determinants and mental wellbeing in adults and between socioeconomic determinant and mental distress and mental wellbeing in children, which also point to social inequalities in mental health. For adults, this study provides a first overview of the distribution of determinants and their association with mental wellbeing in Europe. Thereby, it can be used as a first basis for confirmatory and more specific analysis on determinants of mental wellbeing as well as for the development of preventive and health promotion programs or policies in this context. The study among children is meant to be a first attempt to compare social determinants of mental distress and mental wellbeing in children, as this has never been done before. By showing that mental wellbeing and mental distress had different determinants, it suggests that what has been found in adults, in whom mental wellbeing can be measured with better instruments than in children, could be true for children as well: mental wellbeing and mental distress appear to have different determinants [195], which further emphasizes that mental wellbeing and mental distress are two discrete dimensions of mental health rather than two ends of one continuum [12, 17]. Further examination of the determinants of mental wellbeing using a more comprehensive suite of measures (especially in children) is warranted. A first important step would be to develop a validated scale that adequately assesses mental wellbeing in children considering both eudaimonic and hedonic aspects.
11.2 Mental health and social structures at the macro level

The second objective was to analyse the association between social structures at the macro level and mental health. Thereby, the focus in this dissertation was on welfare regimes and mental wellbeing, acknowledging claims in social epidemiology research to investigate macrosocial determinants of population health [216]. A focus on gender inequalities in mental wellbeing was additionally integrated.

Interpretation of key findings

The results of this study (article III) point to visible cross-national variations in good mental wellbeing. Individuals in the FSU and CEE welfare regime showed significantly lower levels of mental wellbeing compared to individuals living in the Scandinavian welfare regime as reference group. Findings further indicate gender inequalities in mental wellbeing, independent of individual sociodemographic variables. Moreover, gender inequalities were independent of the welfare regime that people lived in. The type of welfare regime did not modify gender inequalities in mental wellbeing.

The present findings on cross-country variations in the prevalence of mental wellbeing are supported by results of previous research based on the EQLS from 2007 and the Eurobarometer Survey [73, 279]. The inclusion of different countries in each analysis makes direct comparison difficult. Common findings of this study and previous research [73, 279] highlight that the Netherlands, Germany, and Denmark show relatively high levels of mental wellbeing.

This study observed that individuals in the FSU and CEE welfare regimes showed significantly lower levels of mental wellbeing compared to individuals from the Scandinavian welfare regime. An increasing number of studies have shown that population health differs substantially by welfare regime [238, 280-283]. Studies almost invariably concluded that a population’s absolute level of health is enhanced by the comparatively generous and universal welfare provision of the social democratic countries. Furthermore, social democratic countries rank more positively on various population health indicators than other regimes. The results of the present study of the low levels of mental wellbeing in the two Eastern European welfare regimes may be related to the basic provision of social welfare in these countries [284]. In contrast to other welfare regimes, the social welfare systems of the former communist countries have not yet been redeveloped on the basis of general principles or characteristics [283, 285]. Moreover, their welfare programmes differ widely and have changed quickly due to extensive economic upheavals and social reforms throughout the 1990s [285-287]. In comparison with the other member states of the European Union, these countries have limited health service provision and overall population health is described as relatively poor [288].
In this study gender inequalities in mental wellbeing that were independent of further individual sociodemographic characteristics and independent of welfare regimes were observed. These results support previous studies: Schütte et al. [279] reported gender inequalities in mental wellbeing, analysing data of a previous wave of the EQLS from 2007. Comparing levels of mental wellbeing, assessed by the EVI, in the Eurobarometer Survey, Lehtinen et al. [73] also reported lower levels of mental wellbeing for women compared to men. A gender gap is also reported for mental distress. A study comparing 23 European countries indicated that women report higher levels of depression than men in all investigated countries [58]. Likewise, a study analysing data of the world values survey [289] investigated gender differences in depression in a global sample. The authors found that in almost all countries women are more likely to report feeling depressed or sad than men. Only in three countries (India, Nigeria, and Mexico), all non-western, very low gender equity societies, did males have a greater tendency towards depression than females. Results of this study also suggest that the differences between men and women in depression are greatest in high gender equity countries, and lowest in low gender equity countries [289].

Gender inequalities are also well documented for other health outcomes [290]. Women have higher morbidity [291] in a range of non-fatal diseases and have fewer years in good health, despite having a longer life expectancy [290]. Several epidemiological studies have shown that gender inequalities in health outcomes can be explained by inequalities between men and women in some key social determinants of health [292]. Gender inequalities in health can be attributed to women’s lower socioeconomic position [293], resources [294], and power [295], less participation in the public sphere [293] as well as weaker labour market attachment, and the double burden of paid work and household responsibilities [217, 296]. This pattern shows that gender inequalities in health are mainly socially produced. Thus, they may be improved through policy changes [297]. Equality in health can be promoted by valuing female and male attributes more equally, by holding less rigid gendered stereotypes of behavioural patterns [298], or by access to health promoting resources [217, 298].

Although rarely studied in epidemiological research [299, 300], macrosocial determinants of health, such as social protection, the welfare state, political power, and economic and labour market policies, are major drivers of social structures and power relations within societies [301, 302]. In this context, policy arrangements in terms of how the state interacts with the family structure [303] and thereby reduces the welfare burden on women [304] are especially important to gender equality in health. This is supported by a study of Chandola et al. [305], who analysed the relationship between work-family conflicts and mental health. The authors concluded that the better mental health of Finnish women could be attributable, in part, to their lower conflicts between work and family which
may arise from their family-friendly employment conditions. Lahelma et al. [293] analysed health status by family type, differentiating between couple mothers with children, couples without children, divorced lone mothers, single lone mothers, and single women. It was found that lone mothers had worse health than other women, which may be explained by the multiple attachment hypothesis (having less social support and having financial problems). Comparing Finland and Great Britain, it was further reported that a greater part of the health disadvantages of lone mother in Great Britain was explained by structural characteristics.

In this study, no gender differences in mental wellbeing were found in any country of the Scandinavian or the FSU welfare regime. However, it should be noted that there is a relevant difference: in the countries of the Scandinavian welfare regime, there was gender equality of mental wellbeing, with both men and women reporting high levels of mental wellbeing. In contrast, the observed gender equalities in the countries of the FSU regime can probably be attributed to extremely low levels of mental wellbeing in men compared to mental wellbeing in men in other countries. These differences in absolute levels of health have previously been found in other health outcomes. Comparative studies suggested that the social democratic countries have the highest absolute health status [281-283]. Low prevalence in mental wellbeing in men from the FSU regime goes together with findings that men from Eastern European countries are worse off in a number of health outcomes, such as heavy drinking, smoking- and alcohol-related mortality [306, 307].

The fact that welfare regimes do not modify the association between gender and mental wellbeing is intriguing. This is the first study to investigate gender inequalities in mental wellbeing in different countries. There is some evidence on the association between welfare regimes and gender equality in self-rated health [217-219]. These studies reported differences in gender equality for self-rated health between countries of different welfare regimes. They show that women’s self-rated health was poorer compared to men in the Southern, Eastern, and Scandinavian welfare regimes, no differences were found in the corporatist welfare regime. However, comparability is limited due to methodological differences. One possible explanation for the absence of differences in gender inequality in mental wellbeing by welfare regime in this study is that the mechanisms behind gender inequalities in mental wellbeing cannot be overcome by welfare regime policies. On the other hand, it could be argued that welfare regimes do not influence the association between gender and mental wellbeing as they do for other health outcomes. It has to be noted that these results can be sensitive to the countries included in the different welfare regimes in this study, which is due to countries participating in the EQLS. Results between countries were heterogeneous in some welfare regimes. Therefore, findings could have been different if there were data available for other countries in the different welfare regimes. For example, no data were available for Norway, which would have been
part of the Scandinavian regime, and if included could have changed the results. The same may be applied to the FSU regime, where results for Estonia differ from the two other countries of this welfare regime. If no data had been available for Estonia, the conclusion would have been different for this welfare regime.

**Strengths, limitations, and methodological considerations**

This study was the first to assess the relationship between welfare regimes, gender and mental wellbeing. Several limitations concerning this study need to be addressed. One limitation is the response rate of 41% in the EQLS 2012, which was lower than aspired and differed across countries [223]. Although the EQLS sample is demographically representative, selection bias may have occurred: it is possible that only participants of a certain social position, health status, or opinion tended to participate in the study. Moreover, it is important to be aware of possible artefacts due to cultural differences in European countries. Variations in mental wellbeing between countries could be based on different perceptions of what mental wellbeing is. However, firstly although this may have an effect on the actual levels of mental wellbeing, it is unlikely to have a relevant effect on gender inequalities and secondly, the WHO-5 is validated for different languages and across cultures [51]. The approach to cluster countries into welfare regimes has been criticised as too crude by some authors, as these ideal types would not fit the complex reality [308, 309]. Yet, the regime approach is by far the most common to group countries [310], which enables comparison with other research. Finally, due to the cross-sectional design of the study associations between individual and macrosocial factors on the one hand and mental wellbeing on the other hand could only be analysed at one point in time. The flexible nature of social categories, processes, and structures [247] and its impact on mental wellbeing could not be analysed with the available data.

By using data of EQLS 2012, the main strength of this study was to conduct analyses for mental wellbeing in 26 European countries, taking individual and welfare regime characteristics into account. Moreover, the newest thoughts on welfare regime categorization [238, 239] were applied, namely adding two distinct Eastern European welfare regimes to the classical welfare typology of Ferrera [240].

**Conclusion**

This study suggests that welfare regimes, as an example of social structures at the macro level, are associated with mental wellbeing but results need to be interpreted with caution and should be
replicated by other researchers. Moreover, cross-national variations in good mental wellbeing were visible. Gender inequalities in the prevalence of good mental wellbeing exist in European countries independent of other socio-demographic characteristics. The type of welfare regime at the macro level did not modify the association between gender and mental wellbeing.

11.3 Mental health and the built environment at the meso level

The third objective was to study the association between environmental noise, as a factor of the built environment at the meso level, and mental health. This objective was studied in a longitudinal study focussing on children aged 9-10 years at follow-up and the outcome was mental distress as assessed with the SDQ.

Interpretation of key findings

In this study (article IV), the association between exposure to a number of different environmental noise sources at the children’s homes and incident mental health problems among children aged 9-10 years was investigated. The main findings indicated firstly, exposure to road traffic noise during the day or at night was the main risk factor for incident mental health problems. Secondly, exposure to noise caused by neighbours at night or during the day appeared to be a risk factor for some subcategories of the SDQ, and thirdly, noise by construction work and aircraft noise both during the day were not associated with incident mental health problems.

Previous studies have considered some of the noise sources and mental health outcomes in cross-sectional study designs. However, comparisons of results have to be interpreted with caution due to methodological differences. In the current study, exposure to road traffic noise during the day or at night was related to the SDQ total difficulties score, emotional problems, conduct problems and peer relationship problems. The relationship was more distinct for night-time road traffic noise than for day-time road traffic noise. Previous studies investigating the association between road traffic noise and mental health in children found mixed results: a recent study also investigated noise exposure at children’s homes and its association with mental health outcomes in Germany [140]. In contrast to the measured subjective noise annoyance used in the present study, this study had address specific data on noise pollution. The authors found that higher noise levels during the day and at night at the most exposed façade were associated with increased hyperactivity symptoms, and higher noise levels at the least exposed façade were associated with increased emotional symptoms; no significant association was found between noise and overall SDQ problem score. Lercher et al. [139] who investigated the effects of residential exposure to overall ambient day-time and night-time noise reported slightly lower values for children’s mental health, assessed with two subscales of the KINDL [311], but only in children who were born preterm or had a low birth weight.
Associations between road traffic and aircraft noise at schools and children’s mental health have been assessed in the study ‘Road Traffic and Aircraft Noise Exposure and Children’s Cognition and Health: Exposure-Effect Relationships and Combined Effects’ (RANCH) investigating schools located around major airports in three European countries. In one of this study’s publications, which focused on the total SDQ difficulties score, the authors reported no association between road traffic noise and the overall difficulties score [142]. One explanation for this may be that the duration of exposure could be relevant [140]. German children in primary schools mainly attend half-day schools. In a representative survey of German children, Conrad et al. [312] reported that children aged 9-11 spend slightly more than 15h per day at home on average. The time spent at home is thus considerably higher than the time spent at school, even if it is a full day school as it is the case in other countries. The findings of the present study were contradicted in parts by another RANCH publication as the authors reported that road traffic noise at school was associated with decreased conduct problems; again no association between road traffic noise and overall SDQ, emotional problems, and hyperactivity was found [138]. The finding of reduced conduct problems with increased road traffic noise was unexpected for the authors and they acknowledged that it was not consistent with theory. They argue that this finding could be due to chance or due to difficulties in accurately measuring road traffic noise [137, 138]. The finding that the results of the present study were more distinct for road traffic noise at night than during the day might be explained by the fact that children are more occupied during the day, for example by playing, and thus do not pay attention to noise. Moreover, parents may not be at home during the day, which could have led to underreporting of the true burden of noise during the day. Also, noise exposure at night may be more harmful than daytime noise exposure [140]. At night, the human organism needs to rest and disturbed sleep has adverse effects on health and wellbeing [313].

In this study, it was observed that aircraft noise during the day at children’s homes was not related to mental health problems. In other studies, the results have been inconsistent. In The West London School Study, Haines et al. observed a weak association between aircraft noise at school and hyperactivity/inattention scores of the SDQ [136]. Evans et al. [314] reported that children living in aircraft-exposed communities showed lower levels of psychological wellbeing measured by a quality of life instrument. Based on the results of Lercher et al. [139] described above, who found an interaction between early biological risk and ambient neighbourhood noise in children, Crombie et al. [138] investigated the potential modification of the association between noise exposure at school and children’s mental health by early biological risk in the RANCH study. Associations between aircraft noise exposure at school and higher values on the hyperactivity scale were observed. Contrary to their hypotheses, the authors did not find an interaction effect between aircraft noise at school and early biological risk for mental health outcomes. Nevertheless, a main effect of early
biological risk on mental health was found. In the present study, early biological risk was included as a potential confounder. In the RANCH study, which deliberately chose regions that were exposed to high aircraft noise, aircraft noise at schools was linked with a higher hyperactivity score [136-138] and a higher total SDQ difficulties score [136]. In contrast, another analysis of the RANCH study aircraft noise found no association with the SDQ total difficulties score or subcategories of the SDQ [142]. In the London subgroup of the RANCH study, neither nocturnal exposure to aircraft noise at home nor exposure to aircraft noise at schools affected children’s mental health, neither on the total difficulties score of the SDQ nor on any of its subscales [141, 143]. The differences in results of the RANCH study publications are probably due to analyses of subgroups and to different analytic methods. It has been argued that aircraft noise, due to if its intensity, the location of the source, and its variability, is likely to have a greater effect on children’s cognitive function (such as reading) than road traffic noise, which is more of a constant intensity [315, 316]. In adults, sound that shows appreciable variation over time (changing state) impairs cognitive function whereas sound that does not vary has little effect [316, 317].

In light of this argumentation, it may seem puzzling that findings of the current study suggest that aircraft noise is not associated with any of the subscales of the SDQ or with the SDQ total difficulties score. The main reason may be due to the fact that the study area of the present study consisted of regions that were not exposed to high levels of aircraft noise. Therefore, the degree of objective exposure was presumably lower compared to the RANCH study. Moreover, the absolute number of individuals that felt annoyed to an at least moderate degree by aircraft noise was relatively low compared to road traffic noise in this study. For annoyance during the day, the numbers of people that felt annoyed to an at least moderate degree even decreased between t0 and t1, it could be therefore argued that the objective exposure to aircraft noise was very low in this study region and maybe too low to affect mental wellbeing. Also, the RANCH study focused on areas that were in proximity to large airports, and such noise exposures are mainly from starting and landing aircrafts, which have different noise characteristics than the aircraft noise observed in the study area in the present study, where no airport was close. Another explanation might be that the former argumentation focuses on cognitive abilities and not on mental wellbeing. It could be argued that cognitive performance is impaired more immediately by inattention to the task because of distracting noise. Impaired mental wellbeing could be considered a long-term result, hence the ways of influence might not be the same and the argumentation might not hold for mental wellbeing.

No study so far has investigated the relationship between noise caused by neighbours and mental health in children, therefore the results can only be related to findings in adults. In a study among adults aged 18 years or older in London, Guite et al. [151] found that noise from neighbours was
independently associated with mental health and vitality. A study by Grimwood [318] among adults found that concerning neighbourhood noise people mostly objected noise from radio, barking dogs, human voices, banging doors, television, or hi-fi. Two types of emotional response to noise were observed: outwardly directed aggression, as for example feelings of bitterness, annoyance, aggravation, and anger towards the source of the noise, and a more emotional response of anxiety, tension, and feelings of pressure [318]. The fact that in the present study an association between noise and hyperactivity was found is supported by theory, as it is thought that noise affects hyperactivity through arousal [138]. The arousal theory states that noise exposure changes arousal levels, which may lead to raised physiological activity levels, and might become manifested as psychological difficulties [319]. However, it has to be questioned whether with regard to neighbourhood noise annoyance from parental self-reports is a suitable proxy for children’s exposure. Especially annoyance caused by neighbours might be linked to psychological factors, which influence the degree of annoyance in adults, but may not be relevant for children.

In this study, no association of noise by construction work during the day and any of the SDQ subcategories or the SDQ total difficulties score was found. Annoyance by construction work as a potential risk for mental health problems has not been studied in previous studies. Although almost 20% of respondents reported an increase of annoyance by construction work, only 7% felt annoyed at an at least moderate rate at the follow-up. It could be argued that although an increase of noise annoyance can be observed, this probably took place at low levels (e.g. from ‘not at all’ to ‘a bit’), which might not be enough to actually affect mental health.

Studies in adults have found that noise annoyance does not habituate over time if the noise source persists [320]. Moreover, it has been proposed that health is impaired by prolonged noise exposure either via increased annoyance and/or directly via chronically augmented arousal levels [313, 321]. Therefore, in addition to the main analysis focusing on an increase of exposure, the risk for children that had constantly high levels of noise exposure has been assessed. The results revealed that children who experienced constantly high levels of exposure and therefore were continuously exposed for a long time, had a higher risk for mental health problems than children who experienced an increase of noise during the study period.

**Strengths, limitations, and methodological considerations**

This is the first study to assess the association between various environmental noise sources and incident mental health problems in children in a longitudinal study design. Several limitations concerning this study need to be stated. Firstly, only subjective assessment of noise exposure was available in the dataset. Subjective noise exposure assessments are always influenced by noise
sensitivity, which is generally accepted as one of the most important non-acoustical modifiers of the noise-reaction relationship [322, 323]. In an ideal situation, there would be objective and subjective assessments, as they complement each other. For objective noise assessment, noise maps have been developed for cities with more than 250,000 inhabitants (from 2012 on for cities >100,000 inhabitants) according to the Environmental Noise Directive (Directive 2002/49/EC) [324]. For small towns and for more rural areas included in this study noise maps were not available, and objective assessment of noise was therefore not possible in this study. However, parental annoyance reports of noise have been shown to be a good proxy for the extent of the exposure to noise at the home address [325]. It may be argued that children’s annoyance would be a more precise measure than the parental reports that were analysed in this study. Yet, on the side of the outcome, the SDQ was only available as parental reports. Also, annoyance reports of the children were only available for t1, as the children were too young to fill in a questionnaire at t0. Therefore, it was chosen to stay consistent in the source of information and consider exposure as well as outcome from one reporting source at both points in time, instead of mixed sources.

Exposure misclassification may be a concern in the current study. As stated above children at this age spend much of their time at home [312], nonetheless, they do spend a considerable amount of time at school as well. Thus noise levels solely assessed at their home may not accurately reflect children’s true daytime exposure [326]. Moreover, no information on the hearing levels of the children was available. Although the proportion of children with hearing deficiencies is likely to be low in the age group 6-10 years, it remains possible that children with and without hearing deficiencies may be differently affected by similar noise levels, which may introduce bias into the results [327]. Parental reports of the SDQ may underestimate internalising disorders, as they are less visible and children may not always disclose their feelings to their parents [328]. However, a self-reported version is not available for this age group and children’s self-reports have been shown to be less reliable [329]. Thus, internalising disorders may be under-reported in this study, but it seems unlikely that this would have varied by noise exposure.

Analyses were conducted for boys and girls together and no sex-stratified analyses were conducted. Although differences in prevalences of mental health problems between boys and girls exist [330], no differences regarding the exposure were found in the study sample. It was therefore decided to perform no separate analyses for boys and girls. After all, it cannot be ruled out that the association between environmental noise and mental health problems may differ between boys and girls. Another limitation refers to the fact that no information on parental psychopathology was available which may be a source of residual confounding [140]. Another limitation concerns a possible selection bias: the follow-up was only conducted among those school children, who attended the
fourth grade at the time they should. Children who repeated a school year were not assessed in the follow-up. One reason for a child to repeat a class could be mental health problems. Unfortunately, no data on these children was available.

This study also has several strengths. First, this is the first study to assess a broad range of environmental noise sources and their effect on children’s mental health. Another key strength relates to the longitudinal design. The study setting provided access to a large unselected cohort of children using baseline data from a population survey with a high response rate of 85%. Noise data for a variety of different noise sources and separately for day and night was available and allowed to investigate whether the source of the noise and the time of exposure mattered for the development of mental health problems. A further strength is that the exposure variable was operationalized as an increase in children's exposure between t0 and t1, instead of grouping children in cruder groups of high and low exposure. Mental health problems were assessed with a validated questionnaire (SDQ), which is the most common instrument to assess mental distress in children, which makes this study comparable to other research. Another strength is that a comprehensive set of sociodemographic confounders, as well as other potential biological and environmental risks from the literature, were included to control for their influence on the association of exposure to environmental noise and children’s mental health problems.

**Conclusion**

In conclusion, this study suggests an association between noise and incident mental health problems in children. Notably, an increase of noise does not automatically result in mental health problems; the source of the noise appears to matter as well. More cohort studies are needed to confirm these results in children. Ideally, these should complement objectively assessed noise exposure with additional data on annoyance and noise insulation of the apartment. Also, it would be worthwhile to continue to study whether constant levels of noise (e.g. road traffic noise) have the same effect on mental health as noise peaks (e.g. road traffic noise or aircraft noise). The presented results further strengthen the need to prevent environmental noise exposure because noise and noise annoyance is an important issue for public health. The mechanisms by which noise exposure might influence mental health in children deserve further attention. Children may be more vulnerable to noise effects because they have less capacity than adults to anticipate or cope with stressors [319]. Moreover, conduct problems at childhood increase the risk for impaired mental health and psychosocial outcomes (crime, substance use, sexual/partner relationships) in adulthood [10]. Therefore, children display an important target group for the prevention of environmental noise.
11.4 Limitations in the assessment of mental wellbeing

Several limitations arise because for all studies in this thesis data sources were not explicitly established for the objectives of this dissertation. Therefore, at some points compromises had to be made, with regard to what would have been the best possible choice and what was possible with the existing data sources. One important point in this is the measurement of mental wellbeing. As discussed in chapter 4, a unique scale to specifically assess mental wellbeing in children does not exist, which is why it was chosen to approximate mental wellbeing with the subscale emotional wellbeing of the KINDL because it has been identified as one indicator for mental wellbeing [12]. It has to be kept in mind though, that emotional wellbeing only covers the hedonistic view of mental wellbeing [26] and does not take into account eudaimonic aspects such as meaning and optimal functioning [33, 34]. However, as no unique instrument to assess mental wellbeing in children exists, this is considered the best possible approach.

In large scale studies among adults only very short questionnaires are used to assess mental wellbeing, albeit there would be more comprehensive ones [12, 56], which are started to be used in population surveys. The instrument used in the studies for this dissertation for mental wellbeing in adults was the WHO-5, which is a short but validated measure of mental wellbeing [222]. As for the WHO-5 no official cut-off points exist to specify high and low mental wellbeing a distribution-based approach was chosen. Using median or quartiles as cut-off points when no official cut-off points are available is common practice. For this study, an average score of the index was calculated for the study population based on all individuals of the respectively included countries. Individuals with values below the 25% (in article I) were considered to have low levels of mental wellbeing and individuals with values above the 75% percentile (in article III) were considered to have high mental wellbeing. This procedure does not derive a hard outcome but numbers within and relative to the population. On the one hand, this does not produce prevalences of mental wellbeing, which can directly be comparable to other studies. Other studies might have different cut-off points when they use a distribution-based approach based on their respective study population. On the other hand, scales that do offer clear categories and cut-off points are all based on a reference population, which might not be suitable for the actual population under investigation. Research on mental wellbeing is relatively young and there is still discussion on a common definition. It will take some years to achieve agreement on the appropriate measurement and definition of mental wellbeing [331]. If new comprehensive instruments to assess mental wellbeing were developed in the future, it would be highly desirable to also test if instruments are gender sensitive.
12 Conclusion and perspectives

Environmental factors at different levels impact mental health in children and adults. To target these diverse influencing factors of mental health, the WHO calls for collective efforts of all organizations and sectors that may have a direct or indirect impact on mental health to promote mental wellbeing and prevent mental distress [332].

Findings of this dissertation suggest that the well-known inequalities in health, with socially deprived individuals reporting worse health status, can also be seen in mental health. In this dissertation, different individual sociodemographic, economic, and psychosocial factors were associated with mental wellbeing and mental distress. Theories offer explanations for the underlying pathways for some of these factors, however to date in most instances there is not one commonly accepted theory. For most factors, knowledge of the causal pathways is sparse. Knowledge on the underlying pathways would enable preventive strategies to be evidence-based and increase their chance for success. Moreover, it has to be distinguished which individual factors are involved in the development of mental wellbeing and mental distress, and what the relative contribution of each of these factors is. This would enable identification of vulnerable groups and tailoring of specific interventions.

Furthermore, results of this dissertation suggest that even factors that might seem very distal to health impact mental health, such as macrosocial policies. Explanations or underlying pathways of this association cannot be derived from the work of this dissertation, as these investigations were not designed for this purpose. However, a better understanding of the underlying pathways is needed as these might be relevant not only for welfare regimes, which were one focus in this dissertation but also for other political or macrosocial factors. Knowledge of these underlying pathways would enable to intervene and attenuate the effect of political systems or policies, given that the change of political structures might be an unrealistic aim. Also, it needs to be investigated whether these pathways are the same for mental wellbeing and mental distress or whether different mechanisms are involved. Other policies (e.g. economic and social) were not the focus of this dissertation, however, evidence suggests relationships between mental health and other political areas, which has been addressed in chapter 7. This highlights the need to assess the effectiveness of policy and practice interventions in diverse health- and non-health-related areas regarding their impact on mental distress and mental wellbeing [332]. Also, as part of the development of new policies the claim ‘health in all policies’ [333] should definitely include mental health.
Further findings of this dissertation highlight that elements of the built environment such as
neighbourhood problems, housing problems and in particular environmental noise impact mental
health. More knowledge is needed on the determinants of the built environment and mental health,
as in many areas results are not consistent or evidence on specific factors is sparse. However, sound
evidence is needed to influence political decision-making and demand changes and protection of
factors of the built environment. These should ideally be acquired in longitudinal studies so that
causal inference can be drawn from the results.

In line with other researchers, results of this dissertation indicate that mental wellbeing and mental
distress are two different continua. It has to be acknowledged that not being mentally ill does not
equal to experiencing mental wellbeing. In this context, whereas in most population-based studies or
surveys to date, the focus in mental health is on mental distress, these surveys should integrate
indicators of mental wellbeing as well in order to gain a holistic picture of mental health. This is of
particular importance to increase knowledge on the specific determinants of mental wellbeing and to
identify population groups with low levels of mental wellbeing, as these groups are at elevated risk to
develop mental illness. Identification of these subgroups would allow for preventive strategies to
start early on. In doing so, levels of mental wellbeing could be increased and mental health of these
vulnerable groups would be strengthened potentially decreasing the risk for these individuals to
develop mental diseases. In terms of prevention efforts, mental disorder and promotion of mental
wellbeing are distinct, but overlapping aims. Many interventions designed to prevent mental distress,
especially in the field of environmental factors, are also relevant in the promotion of mental
wellbeing [332].

Lastly, depression is the leading cause of disability worldwide, and a significant contributor to the
global burden of disease [334, 335]. The global burden of mental distress exceeds the treatment
capacities of developed and developing countries [332]. This makes mental health an important
public health problem. The results of this dissertation have highlighted that there is a complex
picture of associations, suggesting that factors influencing mental health are manifold. Therefore,
responses to them need to be multi-sectoral and multi-layered. Mental distress can be improved and
mental wellbeing can be promoted through the collective action of society. Improving mental health
requires policies and programmes in government and societies including environment, welfare,
housing, transport, education, labour and justice [332]. Especially important are governmental
decision-makers at local and national levels whose actions and decisions affect mental health in ways
that they are often not aware of [332]. In conclusion, the political aim should be to ensure high
quality care and treatment for those individuals with mental distress while at the same time
developing a greater focus on the promotion of mental wellbeing and prevention of mental illness.
13 Literature


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14 Appendix
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Article I

Material, psychosocial and sociodemographic determinants are associated with positive mental health in Europe: a cross-sectional study

Stefanie Dreger, Christoph Buck, Gabriele Bolte

Material, psychosocial and sociodemographic determinants are associated with positive mental health in Europe: a cross-sectional study

Stefanie Dreger, Christoph Buck, Gabriele Bolte

ABSTRACT

Objectives: To investigate the association between psychosocial, sociodemographic and material determinants of positive mental health in Europe. Design: Cross-sectional analysis of survey data. Setting: 34 European countries. Participants: Representative Europe-wide sample consisting of 21 066 men and 22 569 women aged 18 years and over, from 34 European countries participating in the third wave of the European Quality of Life Survey (2011–2012). Outcome: Positive mental health as measured by the WHO-5—Mental Well-being Index, while the lowest 25% centile indicated poor positive mental health. Results: The prevalence of poor positive mental health was 30% in women and 24% in men. Material, as well as psychosocial, and sociodemographic factors were independently associated with poor positive mental health in a Europe-wide sample from 34 European countries. When studying all factors together, the highest OR for poor positive mental health was reported for social exclusion (men: OR=1.73, 95% CI 1.59 to 1.90; women: OR=1.69, 95% CI 1.57 to 1.81) among the psychosocial factors. Among the material factors, material deprivation had the highest impact (men: OR=1.96, 95% CI 1.78 to 2.08; women: OR=1.73, 95% CI 1.59 to 1.90). Conclusions: This study gives the first overview on determinants of positive mental health at a European level and could be used as the basis for preventive policies in the field of positive mental health in Europe.

BACKGROUND

According to the definition of the WHO mental health is a ‘state of well-being in which the individual realises his skills, copes with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to his community’. Studies provide empirical support that mental health consists of two independent dimensions: mental ill-health and positive mental health (PMH) or mental well-being. Recent studies that have explicitly considered levels of PMH in populations have illustrated that good mental health is more than just the absence of disease, and that people can experience PMH even if diagnosed with a mental illness. This is because mental well-being or PMH and mental illness are caused by different factors. It has also been shown that low PMH is a risk factor for depression and absence of PMH has been associated with an increased risk of mortality.

The study of PMH is relatively young and there is still discussion on a common definition of PMH or mental well-being. There are two (complementary) traditions in conceptualising well-being: the hedonic approach emphasises feeling good (happiness, pleasant affect, life satisfaction) whereas the eudaimonic approach focuses on optimal social and psychological functioning. A valid measure of PMH should include items that assess the hedonic and eudaimonic domain. Whereas various studies examined determinants of mental ill health, profound knowledge of determinants of PMH is lacking. PMH can be influenced by
sociodemographic, psychosocial or material factors. However, until now studies that have focused on PMH have investigated only few determinants and looked at one country or at a very limited number of countries. Whereas prevalences of PMH in European countries have been reported before, no study so far has analysed a broad set of determinants of PMH considering a high number of European countries. The objective of our study was therefore to examine the association between sociodemographic, psychosocial and material factors and PMH at a European level taking gender differences into account.

**METHODS**

**Sample**
This study is based on the European Quality of Life Survey (EQLS), which is run every 4 years by the European Foundation for the improvement of living and working conditions. The third wave of the EQLS, which was carried out in 2011–2012, included people aged 18 years and older from 34 countries (EU-27, Croatia, Iceland, Montenegro, former Yugoslav Republic of Macedonia, Serbia, Turkey, Kosovo). In all countries, data were collected via face-to-face interviews at respondents’ home, who were selected by multistage random sampling. The overall response rate was 41%. A more detailed description of the EQLS 2012 can be found elsewhere.

**Positive mental health**
Positive mental health was measured with the WHO-5—Mental Well-being Index (WHO-5). It is calculated from responses to five items: (1) I have felt cheerful and in good spirits; (2) I have felt calm and relaxed; (3) I have felt active and vigorous; (4) I woke up feeling fresh and rested and (5) my daily life has been filled with things that interest me. The degree to which the aforementioned positive feelings were present in the past 2 weeks is scored on a six-point Likert scale ranging from 0 ‘at no time’ to 5 ‘all of the time’. The scores to these five questions can total to a maximum of 25, which is then multiplied by 4 to get to a maximum of 100, where 0 corresponds with worst thinkable well-being and 100 equals best thinkable well-being. The WHO-5 is considered a valid instrument to evaluate PMH in population-based studies and assesses PMH with items covering the eudaimonic perspective on well-being as well as items covering the hedonic dimensions of well-being. An average score of the index was calculated for the study population and those with values below the 25% centile were considered to have poor PMH.

**Potential determinants of PMH**
Three groups of determinants of PMH were studied: sociodemographic, psychosocial and material factors. This classification of determinants was inspired by studies that have used this classification in the field of self-rated health.

**Sociodemographic factors** were age, educational level (categorised into three groups according to the International Standard Classification of Education), urbanisation level (living in rural/urban area) and citizenship (European/non-European). All these variables were categorical variables. Since potential risk factors might have different meaning for men and women, gender was not considered as a potential risk factor but as a structural variable and thus potential effect modifier. Therefore, all analyses were stratified by gender.

**Psychosocial factors** were marital status, presence of children, social support (help from family/friends/neighbor/service provider in case of need for help around the house, advice, looking for a job, feeling depressed, financial problems; 5 items), social network (frequency of contact with family/friends/neighbours; 8 items), political participation (attended a meeting of a trade union/political party/political action group, attended protest or demonstration, signed a petition, contacted a politician/public official; 4 items), trust (in parliament/legal system/press/police/government/local authorities; 6 items), religion (frequency of attending religious services), social exclusion (feelings of lack of recognition/confusion in life/exclusion/inferiority; 4 items). Marital status, presence of children and religion were categorical variables. For social network, social support, political participation, trust and social exclusion, average scores were calculated and the median was used as cut-off point for the creation of dichotomised variables.

**Material factors** were household tenure, housing problems (shortage of space, rot in windows/doors/floors, damp/leaks in walls/roof, lack of bath or shower, indoor flushing toilet, place to sit outside; 6 items), neighbourhood problems (noise/air pollution/quality of drinking water/crime/vandalism/litter/traffic; 6 items), material deprivation (not able to afford the following amenities/activities: heating/vacation/furniture/meal with meat, chicken, fish every second day/new clothes/having friends and family for drinks or meals at least once a month; 6 items), financial problems (problems paying bills for rent/informal and consumer loans/electricity; 4 items), quality of public services (health services/education system/public transport/long-term care/child care services/state pension system/social housing; 6 items).

Household tenure was a categorical variable. Housing problems, neighbourhood problems, financial problems, material deprivation and quality of public services were dichotomised at the median of the average score of the items.

**STATISTICAL METHODS**
First, the distribution of sociodemographic, psychosocial and material factors was described separately for men
### Table 1 Percentages of men and women with poor positive mental health (PMH) by sociodemographic, psychosocial and material factors*

<table>
<thead>
<tr>
<th></th>
<th>Men</th>
<th></th>
<th>Women</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Per cent</td>
<td>Poor PMH (%)</td>
<td>N</td>
</tr>
<tr>
<td><strong>PMH</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Good</td>
<td>15 997</td>
<td>76</td>
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<td>15 751</td>
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<tr>
<td>Poor</td>
<td>5069</td>
<td>24</td>
<td></td>
<td>6818</td>
</tr>
<tr>
<td><strong>Sociodemographic factors</strong></td>
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<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>18–24</td>
<td>2707</td>
<td>13</td>
<td>2539</td>
<td>11</td>
</tr>
<tr>
<td>25–34</td>
<td>3919</td>
<td>19</td>
<td>3742</td>
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<tr>
<td>35–49</td>
<td>5847</td>
<td>28</td>
<td>5925</td>
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<tr>
<td>50–64</td>
<td>4932</td>
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<td>5227</td>
<td>23</td>
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<tr>
<td>65+</td>
<td>3662</td>
<td>17</td>
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<td>3090</td>
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<td>67</td>
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<td>5366</td>
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</tr>
<tr>
<td>Yes</td>
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<td>55</td>
<td>8955</td>
<td>40</td>
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<tr>
<td>No</td>
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<td>45</td>
<td>13 614</td>
<td>60</td>
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<td>Countryside or village</td>
<td>9774</td>
<td>47</td>
<td>10 325</td>
<td>46</td>
</tr>
<tr>
<td>Town or city</td>
<td>11 247</td>
<td>54</td>
<td>12 187</td>
<td>54</td>
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<td>98</td>
<td>22 094</td>
<td>98</td>
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<tr>
<td>Non-European</td>
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<td>409</td>
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<tr>
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<td>57</td>
<td>11 678</td>
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<tr>
<td>Living alone</td>
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<td>43</td>
<td>10 749</td>
<td>48</td>
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<tr>
<td>Children</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Present</td>
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<td>62</td>
<td>16 272</td>
<td>72</td>
</tr>
<tr>
<td>Absent</td>
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<td>6297</td>
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<td>Religion</td>
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<td>Practicing often</td>
<td>4831</td>
<td>23</td>
<td>6854</td>
<td>31</td>
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<tr>
<td>Rarely</td>
<td>6875</td>
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<td>7637</td>
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<tr>
<td>Never</td>
<td>9255</td>
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<td>7976</td>
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<td>4563</td>
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<td>16 969</td>
<td>81</td>
<td>18 007</td>
<td>80</td>
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<td>Low</td>
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<td>12 102</td>
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<td>4818</td>
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<tr>
<td>No</td>
<td>15 268</td>
<td>74</td>
<td>17 380</td>
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<tr>
<td>Level of trust</td>
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<tr>
<td>High</td>
<td>10 359</td>
<td>49</td>
<td>10 947</td>
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<tr>
<td>Low</td>
<td>10 708</td>
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<td>Social exclusion</td>
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<td>Low</td>
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<tr>
<td>High</td>
<td>13 266</td>
<td>63</td>
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<td>Neighbourhood problems</td>
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<td>8547</td>
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<tr>
<td>High</td>
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<td>62</td>
<td>14 022</td>
<td>62</td>
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<tr>
<td>Absent</td>
<td>13 381</td>
<td>64</td>
<td>13 893</td>
<td>62</td>
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Continued
and women, and the percentage of poor PMH was reported for each category. We performed random intercept multilevel logistic regression analyses to examine the association between the potential determinants and PMH.

Multilevel models are particularly appropriate for research designs where data for participants are organised on more than one level to take into account the between-variability and within-variability of these hierarchically organised data (individuals, region, country). The model contains a so-called fixed part and a random component. Individual determinants were introduced as fixed effects, and country and region were used as random intercepts in the multilevel analysis taking into account three levels of data: individuals (level 1) nested in 330 regions (level 2), which are nested in 34 countries (level 3). Three separate models for women and men were computed to study the association between the groups of determinants (sociodemographic, psychosocial and material factors) and PMH independently (models 1–3). After that, all variables that were significant at $\alpha=0.05$ for at least one gender were included in the final model (model 4). Median ORs (MOR) were computed to quantify the country-level variation. MOR is defined as the median value of the OR between the country at highest risk and the country at lowest risk when randomly picking out two countries. The MOR equals 1 if there is no variation between countries and gets larger if the between-country variation increases. The measure is directly comparable with fixed-effects ORs.

Although inter-relations between factors were found, no collinearity was detected as the variance inflation factor was never greater than 1.9. Variance inflation factors greater than 2.5 may be problematic.

Since determinants of PMH have only rarely been studied, no literature on potential interactions was available. However, gender differences have been suggested in this context and men and women have different life circumstances. Therefore, we studied men and women separately.

All statistical analyses were conducted using SAS statistical software V9.3. The product of the design weight and post-stratification weight was used as the weighting factor as recommended in the EQLS guidelines. In sensitivity analyses multilevel logistic regressions were conducted without weights and with weights. The parameter estimates were substantially similar. Therefore the unweighted ORs are presented, as advised by Winship and Radbill, because they are more efficient and the SE is correct.

RESULTS

Overall, 21,066 men and 22,569 women participated in the study and were considered for the present analysis. Table 1 shows the distribution of sociodemographic, psychosocial and material factors and the percentage of people with poor PMH in each category for men and women separately. Overall, the proportion of poor PMH was higher in women than in men (30% vs 24%). Furthermore, women in the study sample were slightly older, more often had low education, did not work, had children, practiced religion, did not engage in political participation and were affected by material deprivation.

Table 2 presents the results for the multilevel logistic regression analyses, with each set of factors being studied separately for men and women. In model 1, which included sociodemographic factors, lower educational level, older age and not working were significantly associated with poor PMH among both genders. Additionally being citizen of a non-European country was associated with poor PMH among both genders. Furthermore, women in the study sample were slightly older, more often had low education, did not work, had children, practiced religion, did not engage in political participation and were affected by material deprivation.

Models 1–3

Table 2 presents the results for the multilevel logistic regression analyses, with each set of factors being studied separately for men and women. In model 1, which included sociodemographic factors, lower educational level, older age and not working were significantly associated with poor PMH among both genders. Additionally being citizen of a non-European country was associated with poor PMH in women. In model 2, including sociodemographic and psychosocial factors, living without a partner, practicing religion rarely or never, low social support, low levels of trust and high

<table>
<thead>
<tr>
<th>Table 1 Continued</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Per cent</td>
</tr>
<tr>
<td>Household tenure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tenant</td>
<td>14 606</td>
<td>75</td>
</tr>
<tr>
<td>Owner</td>
<td>4832</td>
<td>25</td>
</tr>
<tr>
<td>Material deprivation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>9843</td>
<td>51</td>
</tr>
<tr>
<td>Present</td>
<td>9592</td>
<td>49</td>
</tr>
<tr>
<td>Financial problems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>16 207</td>
<td>77</td>
</tr>
<tr>
<td>Yes</td>
<td>4859</td>
<td>23</td>
</tr>
<tr>
<td>Quality of public services</td>
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<td></td>
</tr>
<tr>
<td>Good</td>
<td>5699</td>
<td>27</td>
</tr>
<tr>
<td>Poor</td>
<td>15 367</td>
<td>73</td>
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*Product of the design weight and the post-stratification weight was applied.
<table>
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<th>Sociodemographic factors</th>
<th>Men</th>
<th>Women</th>
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</thead>
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<tr>
<td><strong>Model 1</strong></td>
<td><strong>Model 2</strong></td>
<td><strong>Model 3</strong></td>
</tr>
<tr>
<td><strong>Age (years)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18–24</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>25–34</td>
<td>1.78 (1.51 to 2.08)</td>
<td>1.85 (1.37 to 1.98)</td>
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<td>35–49</td>
<td>2.33 (2.00 to 2.70)</td>
<td>2.26 (1.88 to 2.71)</td>
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<td>50–64</td>
<td>2.17 (1.88 to 2.50)</td>
<td>2.44 (2.03 to 2.93)</td>
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<tr>
<td>65+</td>
<td>1.77 (1.92 to 2.06)</td>
<td>2.47 (2.03 to 3.01)</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary or less</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Secondary</td>
<td>0.66 (0.58 to 0.74)</td>
<td>0.73 (0.64 to 0.83)</td>
</tr>
<tr>
<td>Tertiary</td>
<td>0.50 (0.43 to 0.57)</td>
<td>0.71 (0.61 to 0.83)</td>
</tr>
<tr>
<td><strong>Working</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>No</td>
<td>1.66 (1.52 to 1.81)</td>
<td>1.27 (1.15 to 1.40)</td>
</tr>
<tr>
<td><strong>Urbanisation level</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Countryside or village</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Town or city</td>
<td>1.01 (0.93 to 1.09)</td>
<td>1.01 (0.95 to 1.07)</td>
</tr>
<tr>
<td><strong>Citizenship</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>European</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Non-European</td>
<td>1.22 (0.94 to 1.56)</td>
<td>1.01 (0.77 to 1.33)</td>
</tr>
<tr>
<td><strong>Psychosocial factors</strong></td>
<td></td>
<td></td>
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<tr>
<td><strong>Marital status</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Living with partner</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Living alone</td>
<td>1.20 (1.09 to 1.31)</td>
<td>1.18 (1.07 to 1.30)</td>
</tr>
<tr>
<td><strong>Children</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Present</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Absent</td>
<td>0.96 (0.86 to 1.08)</td>
<td>1.00 (0.89 to 1.12)</td>
</tr>
<tr>
<td><strong>Religion</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Practicing often</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Rarely</td>
<td>1.11 (1.00 to 1.23)</td>
<td>1.27 (1.14 to 1.42)</td>
</tr>
<tr>
<td>Never</td>
<td>1.27 (1.15 to 1.41)</td>
<td>1.13 (1.01 to 1.26)</td>
</tr>
<tr>
<td><strong>Social network</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Low</td>
<td>1.03 (0.93 to 1.13)</td>
<td>1.04 (0.96 to 1.12)</td>
</tr>
<tr>
<td><strong>Social support</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Low</td>
<td>1.30 (1.20 to 1.41)</td>
<td>1.20 (1.10 to 1.31)</td>
</tr>
<tr>
<td><strong>Political participation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>No</td>
<td>0.99 (0.91 to 1.08)</td>
<td>1.03 (0.95 to 1.11)</td>
</tr>
<tr>
<td><strong>Level of trust</strong></td>
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<td></td>
</tr>
<tr>
<td>High</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Low</td>
<td>1.66 (1.53 to 1.79)</td>
<td>1.43 (1.31 to 1.55)</td>
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<tr>
<td><strong>Social exclusion</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>High</td>
<td>1.62 (1.68 to 1.98)</td>
<td>1.73 (1.59 to 1.90)</td>
</tr>
<tr>
<td><strong>Material factors</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Neighborhood problems</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>High</td>
<td>1.16 (1.07 to 1.27)</td>
<td>1.13 (1.04 to 1.23)</td>
</tr>
<tr>
<td><strong>Housing problems</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Present</td>
<td>1.46 (1.34 to 1.60)</td>
<td>1.40 (1.30 to 1.52)</td>
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</tbody>
</table>
levels of social exclusion were significantly associated with poor PMH among both genders, independent of sociodemographic factors. Having no children was additionally associated with poor PMH in women. The strongest effect in model 2 was seen for high social exclusion with an OR of 1.82 (95% CI 1.68 to 1.98) for men and 1.80 (95% CI 1.68 to 1.92) for women. In model 3, including sociodemographic factors and material factors, all material factors, except household tenure, were associated with poor PMH among both genders, controlling for sociodemographic characteristics. The highest OR was seen for material deprivation in both genders: the OR for men was 2.13 (95% CI 2.00 to 2.41) and for women was 2.17 (95% CI 2.01 to 2.35). Urbanisation level and social network were not associated with poor PMH in both genders in the respective models, and were therefore not included in model 4.

Model 4

In model 4 the strongest associations with poor PMH among both genders were observed for higher age, social exclusion (men: OR=1.73, 95% CI 1.59 to 1.90; women: OR=1.69, 95% CI 1.57 to 1.81) and material deprivation (men: OR=1.96, 95% CI 1.27 to 1.58; women: OR=1.93, 95% CI 1.79 to 2.08). Moreover, living without a partner, lower education status, not working, practicing religion rarely or never, low social support, social exclusion and all material factors were significantly associated with poor PMH among both genders. Not having children was independently associated with poor PMH in women only. Being citizen of a non-European country was no longer significant when taking into account all other factors in model 4.

Country-level variation

MOR differed only slightly between men and women, but decreased from model 1 to model 4, where more individual-level information was included. The MOR in model 1, where sociodemographic factors are included, was 1.50 for men and 1.45 for women. However, when studying all factors together in model 4 the MOR was lower, namely 1.31 for men and 1.30 for women. Thus, country-specific variation was larger with regard to effects of sociodemographic factors on mental health, but smaller considering psychosocial (MOR=1.40 for both genders) or material factors (MOR=1.32 for both genders).

DISCUSSION

This is one of the first studies to examine PMH in a large Europe-wide sample and to the best of our knowledge the first to report on a wide range of determinants. We grouped the determinants that have individually been reported in the literature with regard to mental health. Our study found a broad range of risk factors for poor PMH and our results are mainly in line with previous research that showed similar associations in single
countries or single correlates, not controlling for other factors. However, most studies so far have looked at mental illness and not at PMH. Other studies covering positive aspects of mental health used single questions about happiness or life satisfaction. This approach is not the same as the concept of PMH, since it only covers the hedonistic perspective of well-being, in the sense of feeling happy.31

A large number of associations between sociodemographic, psychosocial and material risk factors and PMH in citizens from 34 European countries were found in this study. Higher age, lower educational status and not working were associated with poor PMH among both genders. Of the psychosocial factors, practicing religion rarely or never, low social support, low levels of trust and high social exclusion were associated with poor PMH among both genders. Living alone was associated with PMH in both genders. Not having children had a protective effect against poor PMH for women but not for men. All material determinants were associated with poor PMH among men and women.

Our results are in line with previous studies reporting that low educational level,14 32–34 and not working,14 35 are associated with poor mental well-being. The results on age and indicators of mental well-being are controversial, some studies reporting that older age groups are at a higher risk for poor mental well-being.14 16 32 35 which would be in accordance with our results, others finding the opposite.36–38 Associations between living area and mental well-being have been reported; however, the direction of this relationship is not clear: living in a rural area14 and living in a large city16 have been associated with poor PMH. When classifying living area into two categories—urban or rural—we did not find a significant association between living area and PMH. Living alone,13 16 33 35 low social support,13 14 16 30 34 39 loneliness14 and exclusion40 have been associated with poor positive mental or emotional health and a study in Russia found associations between high levels of trust and high emotional health.10 We found that not or rarely attending religious services was associated with poor PMH. A previous study reported that frequency of prayer is associated with mental well-being.38 There are some studies investigating the associations of material factors and mental illness. Poor economic condition16 and neighbourhood problems15 39 have been associated with poor mental well-being or PMH before. However, research on the effect of other material factors on PMH is lacking.

In the intermediate models 1–3, age, social exclusion and material deprivation showed the strongest association with poor PMH among men and women. These three factors also appeared to have the strongest association with poor PMH in our final model (model 4), examining the effect of all determinants together. Particularly, all material factors were significantly associated with poor PMH in the separate as well as in the complete model, taking further sociodemographic and psychosocial factors into account. This group of determinants has not been studied extensively yet in the context of PMH but rather with regard to self-rated health21 22 or mental illness.41 The fact that these factors stayed significant throughout all models is in agreement with the belief that material factors may have a direct (through biological pathways) or indirect effect (through eg, behavioural factors) on health outcomes.22 We might not have found a significant association of household tenure and PMH because there are cultural differences between countries in the approaches of buying a house or living on rent. Hence household tenure might not be an indicator for material prosperity in all countries.

One of the limitations of this study is its cross-sectional nature. When interpreting the relationship between the determinants, it needs to be kept in mind that no causal interpretation is possible. The response rate of 41% in the third round of the EQLS was lower than aspired and differed across countries.18 It has been argued that non-participants may be more likely to belong to low social groups and to have poorer health outcomes.42 This would be a selection bias and the prevalence of poor PMH as well as the association between some determinants, especially material determinants, might be underestimated. This study did not take into account (mediating) behavioural factors (eg, physical activity), which may play a role in the association with PMH. Physical activity has a positive effect on PMH43 and it could be hypothesised that living in areas with high neighbourhood problems might hinder leisure-time physical activity, hence physical activity could be a mediating factor in the association between material factors and PMH. For future studies it would be highly desirable to also include behavioural factors. Although the WHO-5 is a validated and relatively short measure of PMH in population surveys, there are more comprehensive measures to assess this complex construct, which should be used in future studies. Moreover, in this study the cut-off point for poor PMH has been set at the 25% centile to look at people who have low levels of PMH. Using medians or quartiles as cut-off points when no official cut-off points are available is common practice. However, a standardised cut-off point for the WHO-5 would be desirable. The study of PMH is relatively young and there is still discussion on a common definition of PMH and different measurements exist. It will take some years to achieve agreement on the appropriate measurement and definition of PMH.10 In this context it would be highly desirable to also test if instruments are gender sensitive. This study, on the other hand, has many strengths. The large dataset with comparable data across Europe, allowed us to study each gender separately and comparability of data between 34 European countries enabled us to give an overall view of determinants of PMH among people in Europe. It used the WHO-5 as a validated measure for PMH and has analysed a broad picture of potential risk factors.

CONCLUSION
This study showed independent associations between various sociodemographic, psychosocial and material determinants and PMH. Our study provides the first overview of the distribution of determinants and their association with PMH in Europe. Therefore, it can be used as the basis for confirmatory and more specific analysis of determinants of poor PMH as well as for the development of preventative programmes in this context.

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Contributors
SD was in charge of designing, analysing and writing up for the manuscript. CB advised on statistical analyses and helped to draft the manuscript. GB participated in the conceptualisation of the analyses and in the revision of the manuscript. All authors read and approved the final manuscript.

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Competing interests
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Provenance and peer review
Not commissioned; externally peer reviewed.

Data sharing statement
We analysed data of the European Quality of Life Survey (EQLS). Permission to analyse data of the EQLS can be requested at Eurofund (http://www.eurofound.europa.eu/surveys/faq/index.htm).

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Material, psychosocial and sociodemographic determinants are associated with positive mental health in Europe: a cross-sectional study

Stefanie Dreger, Christoph Buck and Gabriele Bolte

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Mental wellbeing and mental distress have different socioeconomic determinants in school children

Dreger S, Meyer N, Fromme H, Bolte G, Study Group of the GME

Submitted to the Central European Journal of Public Health
Mental Wellbeing and mental distress have different socioeconomic determinants in school children

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Summary

Aim

According to the two-continua model, mental health consists of two dimensions: mental distress and mental wellbeing. Mental distress is known to be associated with socioeconomic status and family environment in children. Research on determinants of mental wellbeing in childhood is lacking. Studies in adults suggest that mental distress and mental wellbeing are influenced by different aspects of social position, which support the concept of the two-continua model. The aim of this study is to investigate associations with socioeconomic characteristics of both dimensions of mental health, mental distress and mental wellbeing, in school children.

Methods

We analyzed parental reports of 1771 children aged 9-10 years (51% girls) from one city and one county in southern Germany. Associations between socioeconomic characteristics and children’s mental wellbeing, assessed with the subscale ‘emotional wellbeing’ of the KINDL-R, and mental distress assessed with the strength and difficulties questionnaire (SDQ), were examined using logistic regression analysis.

Results

Several indicators of families’ social disadvantage were associated with mental distress, in contrast to mental wellbeing. In multivariate analyses mental distress was associated with migration background and relative poverty among both genders. Mental distress was associated with unemployment in girls and with single parenthood in boys. Mental wellbeing was inversely associated with low paternal education in girls and crowding in boys.

Conclusions

This study is a first attempt to picture socioeconomic determinants of mental distress and mental wellbeing in children. The results suggest that mental wellbeing and mental distress have different associations with socioeconomic characteristics in children and thus are not simply two ends of one continuum but built independent constructs.
Keywords: mental wellbeing, mental health, children, mental distress, socioeconomic determinants
Background

Studies among adults suggest that mental health consists of two independent, though correlated, dimensions: mental wellbeing and mental distress (1, 2). This is sometimes called the two-continua model (2). Similar results were found in adolescents: Wilkinson and Walford (3) showed that adolescents’ psychological health is distinguishable as two separate, though highly correlated constructs – ‘mental wellbeing’ and ‘mental distress’. These findings suggest that mental wellbeing and mental distress should not be viewed as a single continuum, whereby the presence of one assumes the absence of the other (4). Thus, the absence of mental disorder or distress does not equal the presence of mental wellbeing. However, the majority of research in the field of mental health focuses mostly on forms of psychopathology. The field of mental wellbeing is relatively young and little is currently known on determinants of mental wellbeing. International Studies among adults showed that mental distress and mental wellbeing have different determinants, which is an additional indication that mental health does not consist of one continuum. Findings on mental wellbeing and mental distress all built on research in adults or adolescents. However, there is scarcity of research in children to examine, whether this is also the case at young age. Therefore, this study attempts to fill this gap and aims to investigate socioeconomic determinants of both sides of mental health in children taking into account indicators of mental distress and indicators of mental wellbeing. If mental distress and mental wellbeing had different determinants in children, this would suggest that mental health can be conceptualized with the two-continua model in children as well.

Material and Methods

Sampling Method

This study draws on data of a cross-sectional study that was conducted within the framework of the health monitoring units implemented in Bavaria, Germany. Within this cross-sectional study all parents of children of the fourth grade (9-10 years) in primary schools from one German city (Ingolstadt) and one county (Guenzburg) were invited to participate. Questionnaires and information
material were handed out to children at school. Parents could fill in the questionnaire and the consent form at home. The survey among parents was conducted from July to December 2009 and the response rate was 71%. Additionally, if parents gave their consent, children were interviewed at schools. Ethical approval was given by the Ethical Committee of the Bavarian Chamber of Physicians in June 2009.

Mental distress and Wellbeing Measures
Mental distress was assessed using the strength and difficulties questionnaire (SDQ) collected from parents. The SDQ is a brief behavioral screening questionnaire for children and adolescents (5). It consists of 25 items measuring five dimensions: emotional symptoms, conduct problems, hyperactivity/inattention, peer relationship problems, and pro-social behavior. A total difficulties score can be calculated by summing up the scores in the problem areas without consideration of pro-social behavior. According to cut-off points, scores of respondents can be classified as normal, borderline, and abnormal. For the following analysis children were considered as having a high SDQ total problem score, if they fell into the categories borderline or abnormal. The presented results are based on parental ratings. The SDQ has been shown to be valid and reliable.

As to date no scale exists to measure mental wellbeing in children, the subscale ‘emotional wellbeing’ of the ‘KINDL Questionnaire for Measuring Health Related Quality of Life in Children and Adolescents’ (6) was used as a proxi variable. This seems defensible as emotional wellbeing is one dimension of mental wellbeing. The scale ‘emotional wellbeing’ consists of four items, which were scored from 1 (never) to 4 (often or always) with reversals according to the wording of the question, and summed to a total score. This score was transformed to a scale of 100 and dichotomized into low-medium or high scores by the upper 25% percentile.
Socioeconomic Variables

Socioeconomic circumstances of the child were assessed by questions about family situation (parents’ marital status, family size, single-parent family), migration background, parental education, employment status, crowding, and the household equivalent income. Migration background was operationalized according to the recommendations of Schenk et al. (7): Children were considered as having a migration background if both parents were born in another country than Germany, or if the child and at least one of the parents were born in another country, or if the spoken language at home was not German or German and another language. Parental education was assessed individually for mother and father and defined as highest completed education. It was categorized into ‘high’ (general qualification for university entrance), ‘middle’ (upper secondary school certificate) and ‘low’ (lower secondary school certificate or no graduation). Parental working status was categorized into ‘at least one parent employed’ (part- or full-time working) versus ‘both parents only marginally employed or unemployed’. Single parenthood was determined by combining answers relating to family status, living together with a partner, and being a single parent. This combination of answers was done to minimize classification errors. Crowding was defined as more than one person per room (not counting bathrooms) or less than 20 m² living space per person (including kitchen and bathroom). Household equivalent income was calculated by weighting the monthly household net income as disposable income after taxes and social transfers according to age and number of household members using the weighting factors of the OECD scale (8). Sixty percent of the regional median income was defined as threshold of poverty risk.

Statistical Analysis

Bivariate and multivariate associations between socioeconomic characteristics and children’s mental wellbeing and mental distress, respectively, were examined using logistic regression analysis. The analyses were conducted separately for boys and girls as other studies have shown that the
prevalence of high SDQ scores differs substantially between boys and girls (9). As effect estimates, crude and adjusted odds ratios (OR) with 95% confidence intervals (CI) were calculated. All cases that had missing values on one of the outcome variables were not considered. If more than 3% of the cases had missing values for one of the explanatory variables a separate category ‘not indicated/refused’ was used in the analyses. All statistical analyses were conducted using SAS statistical software V.9.3.

**Results**

Overall 899 girls and 872 boys were considered for the present analyses. Boys were significantly (chi\(^2\) 0.0013) more likely to have a high SDQ total difficulties score (17.4 %) compared to girls (12.0%). Overall, 11.9 % of the girls and 9.3% of the boys showed high emotional wellbeing according to parental reports.

*Place table 1 here*

Table 1 presents the results from the bivariate and multivariate logistic regression models for the association of socioeconomic factors and mental distress (i.e. high total SDQ score) and mental wellbeing (i.e. subscale emotional wellbeing of the KINDL) for boys and girls separately.

Both in girls and boys, indicators of social disadvantage were associated with a high SDQ total problem score. Whereas in girls parental unemployment was independently associated with a high SDQ total problem score, in boys single parenthood and low household income were relevant. Migration background was independently associated with mental distress, measured with the SDQ, in boys and girls.
In contrast to mental distress assessed with the SDQ, migration background, single parenthood, and paternal unemployment were not associated with mental wellbeing measured with the KINDL subscale emotional wellbeing. In girls, low paternal education was inversely associated with a high score of mental wellbeing, and in boys crowding.

We also tested whether number of siblings was associated with mental wellbeing or mental distress, but no significant associations were observed. In a sensitivity analyses we conducted a complete-case analysis, this did not change the results substantially.

**Discussion**

This study is a first approach to describe socioeconomic factors if mental wellbeing and mental distress in children. In our study we found that several indicators of social disadvantage of families are associated with mental distress in contrast to only few associations with mental wellbeing. In both outcomes there were differences between boys and girls in regard to which socioeconomic determinants were relevant.

Up to now the research base on mental wellbeing and it’s determinants in children is limited. This relation has been examined more extensively among the adult population. With regard to determinants of mental distress or mental ill-health our data is in line with previous research, finding a higher prevalence of probable mental health problems in children of lower socioeconomic status (9). In contrast to other findings in adults with strong associations between high levels of mental wellbeing, gender, and social and economic factors (10), we only found two associations between mental wellbeing and socioeconomic determinants in children - low paternal education in girls, and crowding in boys. These however, also emerged as being independently associated with mental wellbeing, when the analysis was controlled for other social factors. One reason for the fact that there were relatively few association with mental wellbeing could be that results in adults cannot simply be compared with children, as determinants of mental wellbeing in adults do not necessarily
need to be comparable to determinants of mental wellbeing in children. It could be argued that 
socioeconomic factors are less important for children’s level of mental wellbeing than for adults 
mental wellbeing. For children family environment or factors such as support and a good family 
climate could be of greater importance.

There were fewer and other socioeconomic determinants of mental wellbeing than mental distress in 
the model. This suggests that what has been found in adults (1, 2), may be true for children as well 
namely that mental wellbeing and mental distress are two discrete dimension of mental health 
rather than two ends of one continuum.

When looking at the limitations of this study, firstly it has to be mentioned that, since the study of 
mental wellbeing is relatively young, to date, a unique scale to explicitly assess mental wellbeing in 
children does not exist. Therefore, we used the subscale ‘emotional wellbeing’ of the KINDL to 
approximate mental wellbeing, as emotional health has been identified as one indicator of mental 
wellbeing (2). If an instrument for children exited that next to emotional wellbeing, also included the 
other two dimension of mental wellbeing (social wellbeing and psychological wellbeing), we might 
have found more or other associations. Having said this, this study is meant to be a first attempt to 
compare social determinants of mental distress and mental wellbeing in children. All data in this 
study is derived from parental reports. Moreover, it has to be kept in mind that because of the cross-
sectional study design no causality can be inferred.

This study on the other hand has many strengths. We conducted a comprehensive population survey 
including all children entering school in one year in the study region with a high response rate. 
Furthermore, the survey comprises rural as well as urban population. We tested the association of 
the KINDL total score with the socio-demographic determinants (results not shown) and these 
associations were consistent with a German wide sample of children (11) which suggest that our data 
is comparable to other study populations. Reverse causation, which is a limitation of cross sectional
studies, is unlikely in our study, since most of the socioeconomic factors lie chronologically before the outcome per se.

Conclusion

This study is meant to be a first attempt to compare socioeconomic determinants of mental distress and mental wellbeing in children, as this has never been done before. Further examination of the determinants of mental wellbeing using a more comprehensive suite of measures is warranted. As a first step a validated scale that adequately assesses mental wellbeing considering both eudaimonic and hedonic wellbeing for children should be developed.

Acknowledgements

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Competing interests

The authors declare that they have no competing interests.

Authors’ contributions

SD designed and performed the statistical analysis for this research question and wrote the paper.

NM contributed to questionnaire development, conducted the cross-sectional study, and contributed to data management. HF and GB designed the entire study (GME cohort study) and acquired funding. GB coordinated the study, provided insights into the dataset, and contributed to the writing. All authors have read and approved the final manuscript.
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Table 1: Socioeconomic determinants of mental distress and mental wellbeing in bivariate and multivariate analyses for boys and girls

<table>
<thead>
<tr>
<th>Migration background</th>
<th>Girls</th>
<th>Boys</th>
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<td>medium</td>
<td>1.38 (1.35-3.58)</td>
<td>2.16 (1.38-3.58)</td>
<td>2.00 (1.40-3.38)</td>
<td>1.76 (1.18-2.57)</td>
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<td>1</td>
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<tr>
<td>low</td>
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<td>1.73 (1.27-3.05)</td>
<td>1.58 (0.86-2.53)</td>
<td>1.25 (0.70-2.22)</td>
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<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>medium</td>
<td>2.07 (1.04-4.11)</td>
<td>1.30 (0.64-2.74)</td>
<td>1.37 (0.83-2.25)</td>
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<td>low</td>
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<td>1.65 (1.04-2.65)</td>
<td>1.17 (0.67-2.05)</td>
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<td>both parents only marginally employed or unemployed</td>
<td>3.95 (1.97-7.90)</td>
<td>2.31 (1.25-4.22)</td>
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<tr>
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<td></td>
<td></td>
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<tr>
<td>&gt; 60% of median income</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>60% to 80% median income</td>
<td>1.82 (0.94-3.32)</td>
<td>1.08 (0.54-2.16)</td>
<td>2.52 (1.47-4.34)</td>
<td>2.11 (1.18-3.75)</td>
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<tr>
<td>&lt; 60% of median income (relative poverty)</td>
<td>3.50 (1.86-6.92)</td>
<td>1.24 (0.57-2.70)</td>
<td>3.90 (1.73-5.50)</td>
<td>1.95 (0.98-3.82)</td>
</tr>
</tbody>
</table>


Article III

Gender inequalities in mental wellbeing in 26 European countries: do welfare regimes matter?

Dreger, S., Gerlinger, T., & Bolte, G.


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Gender inequalities in mental wellbeing in 26 European countries: Do welfare regimes matter?

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ABSTRACT

Background: Nature and extent of welfare regimes and social policies are important determinants of health and health inequalities. This study examines the association of gender and mental wellbeing in European countries and investigates whether type of welfare regime plays a role in this association.

Method: Data of 19,366 women and 14,338 men of the third round of the European Quality of Life Survey (2011-2012) was used to analyse mental wellbeing, assessed by the World Health Organization 5 - Mental Wellbeing Index. Multilevel logistic regression analyses were performed to analyse the association between gender and good mental wellbeing firstly at country-level, and secondly the between country variation was analysed and welfare regimes were included as explanatory variables.

Results: We observed cross-national variation in good mental wellbeing. At country levels gender inequalities in good mental wellbeing were observed in 7 out of 26 countries. In analyses considering all countries together gender inequalities in good mental wellbeing were identified independent of further individual socio-demographic variables and independent of the welfare regimes that people lived in (women versus men: OR=0.76; (95% CI=0.71- 0.81)). Gender inequalities in good mental wellbeing were not modified by welfare regimes.

Conclusion: There are cross-national differences in good mental wellbeing between European countries. Gender inequalities with a lower prevalence of good mental wellbeing among women are common in European countries. This study suggests that welfare regimes do not modify these gender inequalities in mental wellbeing.

Keywords: welfare state regime, welfare regime, mental wellbeing, mental health, gender, inequalities
INTRODUCTION

It is well documented that nature and extent of welfare regimes and social policies are important determinants of health and health inequalities, as they modify the impact of the socioeconomic position on health. Welfare regimes have increasingly been considered within social epidemiology to analyse cross-national variations in population health. However, up to now it is not clear which welfare regime arrangements are associated with smallest health inequalities.

Recently the welfare regime categorization has also increasingly been used to analyse gender inequalities in health between men and women. Women might have worse health due to lower socioeconomic position, power, and resources, weaker labor market attachment, double burden of paid work and household responsibilities as well as less participation in the public sphere. Gender inequalities in health are mainly socially produced. Thus they can be improved through policy changes. Welfare regimes differ in the degree to which they influence the above-mentioned factors to ensure that opportunities and resources are granted to women and men equally and by this they might moderate the relationship between gender and health. Also it has been shown that social provisions of welfare regimes, for example decommodification and redistribution, might have different effects on men and women. Equality in health can be promoted by valuing female and male attributes more equally, by holding less rigid gendered stereotypes of behavioural patterns, or by access to health promoting resources. Welfare regime typologies place those countries that are most similar together into clusters of welfare regimes, emphasising within regime coherence and between regime differences. Welfare regime arrangements are especially important to gender equality in health in terms of how the state interacts with the family structure and thereby reduces the welfare burden on women. Welfare regime policies aiming at gender equality may contribute to gender inequalities in health being smaller, or non-existent. There are few European cross-national studies on gender inequalities in health. A recent review partially supports the hypothesis that gender inequalities in health are smaller in the social democratic welfare regime.
The analysis of the impact of welfare regimes on gender inequalities in health is an intersectionality-informed approach. Within an intersectionality framework for analysis of health inequalities, the focus on only a single analytical category of social difference (e.g. gender) has limited explanatory power. Thus, the complexity of social inequalities has to be addressed by considering interactions between social determinants both at individual and structural levels. Moreover, at the individual level diversity between different groups of women and men has to be included rather than quantifying exclusively independent effects of inequality dimensions.21,22

Although welfare regime arrangement and social policies are increasingly studied as macrosocial determinants of health and inequalities in health,23,24 there is scarcity of research on the association between welfare regimes and mental wellbeing. Mental health is namely more than the absence of disease but it includes a reflection of the presence of functioning in life and positive affect.23,24 Studies provide empirical support that mental health consists of two dimensions: mental ill-health and mental wellbeing.23,24 These two concepts are not two opposite sides of one continuum but rather constitute distinct, though correlated, axes.24,25 Especially whether welfare regime structures modify gender inequalities in mental wellbeing is not known. Thus, the aim of this study is to generate evidence on the relationship between welfare regimes and gender inequalities in mental wellbeing in European countries. By this it complies with the claim in social epidemiology research to investigate macrosocial determinants of population health.26
METHODS

Data

We used data of the third round of the European Quality of Life Survey (EQLS 2012). In all countries, data was collected via face-to-face interviews at respondents’ home, selected by multistage random sampling. Response rates ranged from more than 60% (Bulgaria, Poland, Slovakia) to below 30% (Luxembourg, UK). The overall response rate was 41% (Supplementary table A). Details on the survey and the sampling procedure are provided elsewhere. The study sample used in this analysis consisted of 19,366 women and 14,338 men.

Variables

Individual variables

Our dependent variable mental wellbeing was measured with the World Health Organization 5 – Mental Wellbeing Index (WHO-5). An average score of the index was calculated for the study population, based on all individuals of the 26 countries. Individuals with values above the 75% percentile were considered to have good mental wellbeing.

Our main independent variable was gender measured as man or woman. Age (in years), educational status (according to the International Standard Classification of Education (ISCED), merged into ,primary or less’, ,secondary’ and ,tertiary’), working status (‘working’ and ‘not working’), marital status (‘living with a partner’ and ‘not living with a partner’), and having children (‘having children’ and ‘not having children’) were considered as individual socio-demographic factors.

Contextual variables

At the contextual level countries were grouped according to the predominant welfare regimes. For this purpose we used the classification of Ferrera that has been highlighted as one of the most empirically accurate welfare regime typologies as adapted by Bambra and Eikemo and Lunau et al. We distinguished between six types of welfare regime: The Scandinavian, Anglo-Saxon, Bismarckian,
Southern, Former Soviet Union (FSU), and Central and Eastern European Countries (CEE) (see supplementary table B for classification of countries).

**Statistical Analysis**

We restricted our analyses to 26 countries with established welfare regime classification. After basic sample description, we performed random intercept multilevel logistic regression analyses. Multilevel models are particularly appropriate for research designs where data for participants are organized on more than one level to take into account the between- and within- variability of these hierarchically organized data. The EQLS allows for three hierarchic levels to be used. Level 1 units are individual people; level 2 units are regions within countries, while countries are level 3 units. First we investigated the association between gender and mental wellbeing in each country separately. These analyses included two levels: individuals on level one and regions on level two. We conducted bivariate analyses of the association between gender and good mental wellbeing and multivariate analyses to adjust for socio-demographic variables. Afterwards, we investigated the variation of good mental wellbeing between countries and possible explanation for such variation. In these analyses three levels of data were considered: individuals, regions, and countries. We calculated four models, starting with an ‘empty model’. In the second model individual variables were added. In model 3 welfare regimes were added. In model 4 interactions between welfare regime and gender were included. Additionally we present the Median Odds Ratios (MOR), the between country variance and between region variance. According to the intersectionality paradigm it is important to take heterogeneity among men and women, respectively, into account. Therefore, we performed a first exploratory analysis testing the interaction between gender and educational level as one indicator for social position with fewest missing values within the available data. Since the amount of missing data was considerably low (< 1.3%), we conducted a complete case analysis. Although interrelations between factors were found, no collinearity was detected. To assure representativity in terms of gender, age, urbanisation level, region and household size, two types of
weighting coefficients were used: design weights and post-stratification weights. In sensitivity
analyses multilevel logistic regressions were conducted with weights (product of design weight and
post-stratification weight). The parameter estimates were substantially similar to unweighted
estimates. Therefore, the unweighted Odds Ratios are presented because they are more efficient
and the standard error is correct. All statistical analyses were conducted using SAS statistical
software version 9.3.
RESULTS

Sample characteristics are given in Table 1. The welfare regimes differed in the distribution of educational achievements. However men and women within the welfare regimes were comparable in terms of educational achievements. Prevalence of good mental wellbeing differed between welfare regimes and between men and women. Prevalence of good mental wellbeing was in most instances higher among men compared to women at welfare regime level, with the exception of the FSU welfare regime, where women report slightly higher prevalence of good mental wellbeing. Highest prevalence of mental wellbeing was found in the Scandinavian welfare regime for men (17.14%) and women (14.96%). Lowest prevalence was found in the FSU welfare regime with 7.74% reporting good mental wellbeing among men and 7.82% among women.

In table 2 we present prevalences of good mental wellbeing in single countries and odds ratios for the association between gender and good mental wellbeing. Statistically significant inequalities in good mental wellbeing by gender were observed for 7 out of 26 European countries after controlling for individual factors. In the UK, France, the Netherlands, Spain, Portugal, Bulgaria, and Romania women had significantly lower chances to report good mental wellbeing than men. The OR for women ranged from 0.42 (CI 0.30-0.59) in Romania to 0.72 (CI 0.53-0.96) in Spain. Finland, Estonia, and Slovakia showed trends for women being more likely to report good mental wellbeing than men, but these results were not statistically significant.

Next we present results from multilevel logistic regression analyses with good mental wellbeing as dependent variable (table 3) including all countries. In the empty model between-country variance are observed with a MOR of 1.35. In model 2 individual level variables (age, education, working situation, having children, marital status) are introduced. The chances for women to report good mental wellbeing compared to men is significantly lower, independently of further individual level socio-demographic variables (OR=0.75; 95% CI 0.70-0.81). The inclusion of individual level variables did not reduce the between-country variance of good mental wellbeing. In the next model the welfare regimes typologies are introduced, which leads to a reduction of the between country
variance. Women have a significantly lower chance to report good mental wellbeing compared to men independently of welfare regimes. People in the FSU and the CEE welfare regime showed statistically significant lower chances to report good mental wellbeing compared to the Scandinavian welfare regime. We tested potential effect modification of the association between gender and good mental wellbeing by welfare regime. There was no significant interaction (see supplementary table C). In a further explanatory intersectionality-informed analysis we tested potential interaction between gender and educational level. Again, there was no significant interaction (results not shown).
DISCUSSION

Our results point to visible cross-national variation in good mental wellbeing. We identified gender inequalities in good mental wellbeing; these were independent of further individual socio-demographic variables and did not vary among groups with different educational degree. Moreover, they were independent of the welfare regime that people lived in. Type of welfare regime did not modify gender inequalities in good mental wellbeing.

Our findings on cross-country variations in the prevalence of good mental wellbeing supports results of previous research based on the European Quality of Life Survey from 2007 and the Eurobarometer Survey. 33, 34

We observed gender inequalities in good mental wellbeing that were independent of further individual socio-demographic characteristics and independent of welfare regimes. These results confirm previous studies. Schütte et al. 33 reported gender inequalities in mental wellbeing, also assessed by the WHO-5, analysing data of the European Quality of Life Survey from 2007. Comparing levels of mental wellbeing, assessed by the Energy and Vitality Index (EVI), in the Eurobarometer Survey, Lehtinen et al. 34 also report lower levels of mental wellbeing for women than for men. Gender inequalities in health are also well documented for other health outcomes. 35 Women have a higher morbidity 36 in a range of non-fatal diseases and have a fewer years in good health, despite having a longer life expectancy. 35 It is argued that these inequalities could be attributed to women’s weaker labor market attachment, lower socioeconomic position, lesser participation in the public sphere 9 as well as the double burden of paid work and household responsibilities. 12, 13

In our study no gender differences in good mental wellbeing were found in any country of the Scandinavian or the FSU welfare regime. However, it should be noted, that there is a relevant difference: We observed gender equalities on a high level of mental wellbeing in the three countries of the Scandinavian welfare regime in contrast to the countries of the FSU regime where the
observed gender equalities are probably due to extremely low levels of good mental wellbeing in men. Comparative studies have suggested that the social democratic countries have the highest absolute health status\textsuperscript{1,4,5}. Low prevalence in good mental wellbeing in FSU men go together with findings that men in Eastern European countries are worse off in a number of health outcomes, such as heavy drinking, smoking, and alcohol-related mortality.\textsuperscript{37,38}

The fact that welfare regimes did not modify the association between gender and good mental wellbeing is intriguing. To the authors knowledge this is the first study to investigate gender inequalities in mental wellbeing in different countries. There are some studies that investigate the association between welfare regimes and gender equality in self-rated health, however comparability is limited due to methodological differences. These studies reported differences in gender equality for self-rated health between countries of welfare regimes.\textsuperscript{13,19}

One possible explanation for the absence of differences in gender inequality in mental wellbeing by welfare regime is that the mechanisms behind gender inequalities in mental wellbeing cannot be overcome by welfare regime policies. Also it could be argued that welfare regimes do not influence the association between gender and mental wellbeing as they do for other health outcomes.

It has to be noted that these results can be sensitive to the countries included in the welfare regimes. Results could have been different if there was data available for other countries in the welfare regimes. For example, no data was available for Norway, which would also be part of the Scandinavian regime. Inclusion of Norwegian data could have changed the results for the Scandinavian regime. The same could apply to the FSU regime, where results for Estonia differ from the two other countries. If no data had been available for Estonia, conclusion would have been different for this welfare regime. These findings highlight the continuing need to identify social structures and mechanisms leading to gender inequalities in mental wellbeing and their variation across countries.\textsuperscript{13}
**Strengths and limitations**

The main strength of this study is that by using data of EQLS 2012 we were able to conduct analyses for mental wellbeing in 26 European countries, taking individual and welfare regime characteristics into account. Moreover, the newest thoughts on welfare regime categorization were applied. One limitation is the response rate of 41% in the EQLS 2012 which was lower than aspired and differed across countries.\(^{28}\) Although the EQLS sample is demographically representative, selection bias may have occurred: it is possible that only participants of a certain social position, health status, or opinion tended to participate in the study. Another limitation may be seen in the operationalization of the dependent variable mental wellbeing. However, WHO-5 is a validated measure of mental wellbeing in population surveys\(^ {39} \). To increase knowledge more comprehensive measures (see for example\(^ {23,40} \)) to assess this complex construct should be used in future surveys. The approach to cluster countries into welfare regimes has been criticised as too crude by some authors, as these ideal types would not fit the complex reality\(^ {7} \). However, the regime approach is by far the most common to group countries\(^ {7} \), which enables comparison to other research. Future research should link welfare regime theory to specific gender policy to understand their effect on women’s health.\(^ {20} \) Finally, due to the cross-sectional design of the study we could only analyse associations at one point in time between individual and macro-social factors on one hand and mental wellbeing on the other hand. The flexible nature of social categories, processes, and structures\(^ {21} \) and its impact on mental wellbeing could not be analysed with the available data.

In conclusion gender inequalities in prevalence of good mental wellbeing exist in European countries independent of other socio-demographic characteristics. Type of welfare regime at the macrosocial level does not modify the association between gender at the individual level and good mental wellbeing.
Acknowledgements

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Conflict of interest

The authors declare that they have no competing interests.

Key-points

• Prevalence of good mental wellbeing differed across countries in Europe.

• In most countries women reported lower prevalence of good mental wellbeing.

• Gender inequalities in good mental wellbeing were independent of further individual socio-demographic factors and of welfare regimes.

• Type of welfare regime did not modify gender inequalities in good mental wellbeing.
Table 1. Characteristics of the study sample by welfare regime*

<table>
<thead>
<tr>
<th></th>
<th>Scandinavian</th>
<th>Anglo-Saxon</th>
<th>Bismarckian</th>
<th>Southern</th>
<th>FSU</th>
<th>CEE</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Men n=1475</td>
<td>Women n=1541</td>
<td>Men n=1567</td>
<td>Women n=1665</td>
<td>Men n=4434</td>
<td>Women n=4728</td>
</tr>
<tr>
<td>Mean Age</td>
<td>51.15</td>
<td>51.28</td>
<td>51.60</td>
<td>50.90</td>
<td>51.08</td>
<td>51.30</td>
</tr>
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<td>Education (%)</td>
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<tr>
<td>Primary or less</td>
<td>7.59</td>
<td>7.56</td>
<td>8.01</td>
<td>7.44</td>
<td>5.79</td>
<td>9.10</td>
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<td>Secondary</td>
<td>57.83</td>
<td>53.73</td>
<td>59.96</td>
<td>59.43</td>
<td>68.59</td>
<td>67.53</td>
</tr>
<tr>
<td>Tertiary</td>
<td>34.58</td>
<td>38.70</td>
<td>32.03</td>
<td>33.13</td>
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<tr>
<td>Currently working</td>
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<td>48.74</td>
<td>52.40</td>
<td>45.79</td>
<td>55.74</td>
<td>44.75</td>
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<tr>
<td>Living together</td>
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<td>48.25</td>
<td>55.82</td>
<td>51.30</td>
<td>55.36</td>
<td>50.75</td>
</tr>
<tr>
<td>with partner</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Having children</td>
<td>61.06</td>
<td>69.39</td>
<td>60.00</td>
<td>72.38</td>
<td>60.94</td>
<td>71.12</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>------</td>
<td>-------</td>
<td>-------</td>
</tr>
</tbody>
</table>

*N and prevalences are calculated using the product of the design weight and the post-stratification weight as weighting factor*
Table 2: Prevalence of good mental wellbeing in men and women by country and OR and 95% CIs for the association of gender and good mental wellbeing

<table>
<thead>
<tr>
<th>Country</th>
<th>Men</th>
<th>Women</th>
<th>Association of gender and good mental wellbeing*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Unadjusted</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>% high mental wellbeing</td>
<td>N</td>
</tr>
<tr>
<td>Scandinavian</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Denmark</td>
<td>494</td>
<td>24.4</td>
<td>524</td>
</tr>
<tr>
<td>Finland</td>
<td>489</td>
<td>10.9</td>
<td>517</td>
</tr>
<tr>
<td>Sweden</td>
<td>491</td>
<td>16.0</td>
<td>499</td>
</tr>
<tr>
<td>Anglo-Saxon</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ireland</td>
<td>506</td>
<td>15.7</td>
<td>530</td>
</tr>
<tr>
<td>UK</td>
<td>1060</td>
<td>12.9</td>
<td>1135</td>
</tr>
<tr>
<td>Bismarckian</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Austria</td>
<td>489</td>
<td>16.8</td>
<td>532</td>
</tr>
<tr>
<td>Belgium</td>
<td>485</td>
<td>15.8</td>
<td>511</td>
</tr>
<tr>
<td>Country</td>
<td>1446</td>
<td>15.3</td>
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<tr>
<td>-------------------</td>
<td>------</td>
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<td>------</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>452</td>
<td>13.0</td>
<td>460</td>
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<tr>
<td>Netherlands</td>
<td>491</td>
<td>16.7</td>
<td>509</td>
</tr>
<tr>
<td>Southern</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Greece</td>
<td>486</td>
<td>12.9</td>
<td>503</td>
</tr>
<tr>
<td>Spain</td>
<td>725</td>
<td>17.6</td>
<td>762</td>
</tr>
<tr>
<td>Italy</td>
<td>1057</td>
<td>11.5</td>
<td>1162</td>
</tr>
<tr>
<td>Portugal</td>
<td>481</td>
<td>17.6</td>
<td>525</td>
</tr>
<tr>
<td>Former Soviet Union (FSU)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Lithuania</td>
<td>501</td>
<td>11.2</td>
<td>604</td>
</tr>
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<td>Latvia</td>
<td>435</td>
<td>6.7</td>
<td>532</td>
</tr>
<tr>
<td>Estonia</td>
<td>428</td>
<td>4.7</td>
<td>535</td>
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<tr>
<td>Central/Eastern European Countries (CEE)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Bulgaria</td>
<td>447</td>
<td>25.0</td>
<td>499</td>
</tr>
<tr>
<td>Country</td>
<td>N</td>
<td>%Yes</td>
<td>NNo</td>
</tr>
<tr>
<td>--------------</td>
<td>-----</td>
<td>------</td>
<td>-----</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>481</td>
<td>12.1</td>
<td>514</td>
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<td>Hungary</td>
<td>472</td>
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<td>542</td>
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<td>Poland</td>
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<td>Romania</td>
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<td>770</td>
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<td>Slovenia</td>
<td>476</td>
<td>5.4</td>
<td>500</td>
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<td>Slovakia</td>
<td>468</td>
<td>9.0</td>
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<tr>
<td>Croatia</td>
<td>470</td>
<td>15.6</td>
<td>508</td>
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</table>

N and prevalences are calculated using the product of the design weight and the post-stratification weight as weighting factor.

*Reference: men

* adjusted for age, education, working status, having children, living together with partner.
Table 3 – Association between gender, welfare regime and good mental wellbeing (dependent variable), (odds ratios and 95% confidence interval)

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2 (individual level variables)*</th>
<th>Model 3 (model 2+ welfare regimes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td>0.75 (0.70- 0.81)</td>
<td>0.76 (0.71- 0.81)</td>
</tr>
<tr>
<td>Welfare Regimes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Scandinavian=ref.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anglo-Saxon</td>
<td></td>
<td></td>
<td>0.66 (0.38- 1.12)</td>
</tr>
<tr>
<td>Bismarckian</td>
<td></td>
<td></td>
<td>0.82 (0.55- 1.22)</td>
</tr>
<tr>
<td>Southern</td>
<td></td>
<td></td>
<td>0.73 (0.48- 1.13)</td>
</tr>
<tr>
<td>Former Soviet Union (FSU)</td>
<td></td>
<td></td>
<td>0.40 (0.25- 0.64)</td>
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<tr>
<td>Central/Eastern European</td>
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<td></td>
<td>0.59 (0.40- 0.87)</td>
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<tr>
<td>Countries (CEE)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Random effects</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between country variance</td>
<td>0.1005</td>
<td>0.09928 (0.03821)</td>
<td>0.04832 (0.02686)</td>
</tr>
<tr>
<td>(SE)</td>
<td>(0.03840)</td>
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<tr>
<td>Median odds ratio (MOR)</td>
<td>1.35</td>
<td>1.35</td>
<td>1.23</td>
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<tr>
<td>Between region variance</td>
<td>0.1629</td>
<td>0.1650 (0.02550)</td>
<td>0.1662 (0.02579)</td>
</tr>
<tr>
<td>(SE)</td>
<td>(0.02518)</td>
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<td></td>
</tr>
</tbody>
</table>

*Control variables not shown: age, education, working status, having children, living together with partner
References


Supplementary Table A – Targeted Sample size, actual sample size, number of regions \(^1\), and response rate \(^2\) in all countries studied

<table>
<thead>
<tr>
<th>Country</th>
<th>Targeted sample Size</th>
<th>Actual sample size</th>
<th>Number of regions</th>
<th>Response rate in %</th>
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<td>1005</td>
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<td>Slovenia</td>
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<td>Slovakia</td>
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<td>Croatia</td>
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<td>1001</td>
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<td>47.3</td>
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</table>

Source:

### Supplementary Table B. Categorization of countries into welfare regimes

<table>
<thead>
<tr>
<th>Scandinavian</th>
<th>Anglo-Saxon</th>
<th>Bismarckian</th>
<th>Southern Europe</th>
<th>Former Soviet Union (FSU)</th>
<th>Central/Eastern European Countries (CEE)</th>
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</thead>
<tbody>
<tr>
<td>Denmark</td>
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<td>Croatia</td>
</tr>
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</table>
### Supplementary Table C – Model 4 Association between gender, welfare regime and good mental wellbeing (dependent variable)*

|                          | Model 4  
|--------------------------|------------------------------
|                          | (model 3+ interactions)      |
|                          | Estimate and (p-value)       |
| **Gender (reference: men)** | -0.16 (0.10)                |
| **Welfare Regimes**     |                              |
| (reference: Scandinavian)||                      |
| Anglo-Saxon              | -0.30 (0.29)                |
| Bismarckian              | -0.13 (0.53)                |
| Southern                 | -0.24 (0.29)                |
| Former Soviet Union (FSU)| -1.02 (0.00)                |
| Central/Eastern European|                              |
| Countries (CEE)          | -0.45 (0.03)                |
| **Interactions (Reference:** | Estimate and (p-value)       |
|  Scandinavian, reference: |                              |
| men)                     |                              |
| Female/Anglo-Saxon       | -0.24 (0.10)                |
| Female/Bismarckian       | -0.14 (0.22)                |
| Female/Southern          | -0.14 (0.29)                |
| Female/ Former Soviet    | 0.15 (0.41)                 |
| Union (FSU)              |                              |
| Female/ Central/Eastern  | -0.15 (0.19)                |
| European Countries (CEE) |                              |

*Control variables not shown: age, education, working status, having children, living together with partner*
Article IV

Environmental noise and incident mental health problems: A prospective cohort study among school children in Germany.

Dreger S, Meyer N, Fromme H, Bolte G; Study Group of the GME cohort.


The full article can be found at:

Environmental noise and incident mental health problems: A prospective cohort study among school children in Germany

Stefanie Dreger¹,²,³, Nicole Meyer³, Hermann Fromm³, Gabriele Bolte¹,²,³, for the Study Group of the GME cohort¹

¹ Department of Social Epidemiology, Institute for Public Health and Nursing Research, University of Bremen, Grazer Straße 4, 28359 Bremen, Germany
² Health Sciences Bremen, University of Bremen, Germany
³ Bavarian Health and Food Safety Authority, Munich, Germany

1. Introduction

Approximately 20% of the EU population are exposed to noise levels that are classified as unacceptable by scientists and health experts (CALM II Network, 2007) and at least 1 million healthy life years (disability adjusted life years) are lost because of environmental noise in western Europe every year (WHO, 2011). For children aged 7–19 years in the same area about 45,000 disability adjusted life years are lost every year, because of cognitive impairment (WHO, 2011). Generally, noise is defined as an unwanted sound or set of sounds (Muzet, 2007). Sources of environmental noise are manifold. The most frequently cited sources of noise are traffic noise, followed by noise from neighbours and then aircraft noise (Muzet, 2007). It can be distinguished between objectively measured noise and subjective noise annoyance. If someone actually feels annoyed by a specific noise source depends on a number of individual and social-cultural aspects (Guski, 1999).

Effect of noise can be physiological as well as psychological (Muzet, 2007). Noise leads to annoyance, reduces quality of the

Environmental noise is considered a threat to public health as 20% of the EU population is exposed to health influencing noise levels. An association of noise and mental health problems in children has been suggested by some studies, but results are not consistent and there are no longitudinal studies of this association. Our aim was to investigate the influence of different environmental noise sources at children’s homes on incident mental health problems in school-aged children.

Method: A cohort study of children from first (t0) to fourth grade (t1) of primary school was conducted. Different environmental noise sources (day/night separately) at children’s home were assessed via parental annoyance reports. Increased noise exposure between t0 and t1 was the exposure variable. Incident mental health problems were assessed with the parental version of the Strengths and Difficulties Questionnaire (SDQ). RRs and 95% CIs were analysed to investigate the association between different noise sources and incident mental health problems.

Results: The study population consisted of 583 boys and 602 girls. The most common increase in noise exposure between t0 and t1 was road traffic noise day (26.38%). After adjusting for covariates exposure to road traffic night was significantly associated with the total difficulties score (RR=2.06; 95% CI=1.25–3.40), emotional symptoms (RR=1.69, 95% CI=1.04–2.72), and conduct problems (RR=1.57, 95% CI=1.04–2.38). Noise by neighbours during the day was associated with conduct problems (RR=1.62, 95% CI=1.11–2.40) and hyperactivity (RR=1.69, 95% CI=1.06–2.65). Aircraft noise day and construction work day were not associated with any of the SDQ categories at a significant level.

Conclusion: Environmental noise is an important public health problem. This is the first study to investigate the association of a broad range of noise sources and incident mental health problems in children in a cohort study. Our results suggest that exposure to noise at children’s home is associated with mental health problems such as emotional symptoms, conduct problems and hyperactivity.

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environment and might affect health and cognition (WHO, 2011).

One recent review on the association of noise and mental health in adults generally supported the hypothesis that noise is associated with neurocognitive function, mood disorder and neurodegenerative disease in long-term exposed adults (Tzivian et al., 2015). Earlier research suggests that environmental noise seems to be linked to psychological symptoms (Halpern, 1995; Leslie and Cerin, 2008; Stansfeld et al., 1996, 2000; Stansfeld and Matheson, 2003). So far the results for the association between environmental noise and children's mental health are inconsistent: Some studies report an association of noise with mental health outcomes in children (Crombie et al., 2011; Haines et al., 2001a; Lercher et al., 2002; Stansfeld et al., 2009; Tiesler et al., 2013) others did not find an association (Haines et al., 2001b; Stansfeld et al., 2005, 2010).

Understanding how the environment affects children's health and development is central to sustainable living and the prevention of illness (The Lancet, 2004). It is likely that children present a particularly vulnerable group for non-auditory health effects of noise (Stansfeld and Matheson, 2003), as children are still developing and in addition they have less capacity than adults to anticipate, understand, and cope with stressors (Cohen et al., 1986). There is a possible risk that exposure to noise as an environmental stressor may have irreversible negative effects on their health (Stansfeld and Matheson, 2003).

There are several important gaps in the research on environmental noise and mental health in children concerning study design, exposure and health outcome assessment. Most studies focused on only two noise sources: aircraft noise and road traffic noise; research on other noise sources is lacking in children. Moreover, though the strength and difficulties questionnaire (SDQ) (Goodman, 1997) was used in most studies to assess mental health, many of these studies only investigated the overall SDQ problem score and not the subcategories. In addition, noise exposure was measured mostly at school, where children spent some hours every day, but most of the day, and especially the nights are spent at home. With regard to study design, all studies that we found investigating environmental noise and mental health in children had a cross-sectional design. Thus, causal relationship between exposure and outcome cannot be inferred.

Therefore, the aim of this study was to comprehensively collect data on a broad range of environmental noise sources at home and on several dimensions of mental health in order to investigate the influence of environmental noise on incident mental health problems in a cohort study of school-aged children.

2. Methods

2.1. Sampling and design

The baseline survey was conducted within the health monitoring units in Bavaria (GME, Gesundheits-Monitoring-Einheiten) which are organised by the Bavarian Health and Food Safety Authority. Recruitment for the baseline examination was realized within the compulsory school-entry health examinations (10) when children were 5–6 years old. All parents of children entering school in the city of Ingolstadt and the more rural district of Günzburg, Germany, were invited to participate in the written survey in 2005–2006 and asked for their consent. Response rate of this baseline survey was 84.7%.

In 2009–2010, a second survey was conducted with children in the fourth grade, aged 9–10 years. Parents were again asked for their consent. Response rate of this second survey was 70.7% (parental questionnaire evaluable) and 64.0% (parental and child's questionnaire evaluable), respectively. At both points of time a whole population survey was conducted. Parents were additionally asked for their consent to retrospectively link these follow-up data at t1 with the baseline data at t0. Thus, the cohort study comprised all children with information at t0 (parental questionnaire) and t1 (parental and child’s questionnaire) and a complete follow-up of 4 years. Altogether 52% of children of the baseline survey could be included in the cohort analysis. Ethical approval was given by the Ethical Committee of the Bavarian Chamber of Physicians. Details of the baseline survey have been published elsewhere (Bolte et al., 2007; Scharte et al., 2013).

2.2. Noise exposure assessment

Annoyance caused by different noise sources was assessed by parental reports for the apartment that the child was living in. The questionnaire on noise annoyance was based on international standardized questions of the International Commission on Biological Effects of Noise (ICBEN) (Fields et al., 2001). Noise sources that were investigated separately for day and night were: road traffic, aircraft, construction work, rail traffic, industry, restaurant, sport facilities, playground, and neighbours. Five alternatives were given regarding the degree of annoyance: ‘not at all’, ‘a bit’, ‘moderately’, ‘strong’, and ‘very strong’. It was shown that annoyance correlates well with objectively measured noise exposure as assessed with a noise map (Kohlhuber et al., 2009). Parental noise annoyance was taken as a proxy variable for children’s noise exposure. For descriptive analyses children were categorized as ‘exposed’ (parents were ‘moderately’, ‘strong’ or ‘very strong’ annoyed), or as ‘not exposed’ (parents were ‘not at all’ or ‘a bit’ annoyed) by a specific noise source. For the analyses of the association with mental health outcomes an exposure variable was coded. Since there is no strict classification of where levels of annoyance start to be harmful, a change in annoyance in negative direction was calculated as main exposure variable (further mentioned as ‘increased-exposure’), indicating an increase of exposure at a fine scaling, of at least one point in negative direction on the 5-point likert scale for each noise source separately between t0 and t1. In additional analyses the group of children that had constant high levels of exposure at t0 and t1 were analysed.

2.3. Mental health assessment

Mental health was assessed by the parental version of the Strengths and Difficulties Questionnaire (SDQ). The SDQ is a brief behavioural screening questionnaire for children and adolescents. It consists of 25 items measuring five dimensions: emotional symptoms, conduct problems, hyperactivity, peer relationship problems, and pro-social behaviour that can be analysed separately or summed to a total difficulties score by summing up the scores in the problem areas without consideration of pro-social behaviour (Goodman, 1997). According to cut-off points, scores of respondents can be classified as normal, borderline, and abnormal (http://www.sdqinfo.com/). To be able to record also slight negative changes in mental health, the SDQ was not dichotomized; instead incident cases were those who moved from ‘normal’ to ‘borderline’ or ‘abnormal’ or from ‘borderline’ to ‘abnormal’ between t0 and t1. The total difficulties score and the four problem areas were analysed in separate models. Children who were classified as ‘abnormal’ in one of the subcategories or the total difficulties score at t0 were excluded for the respective analyses.

2.4. Covariates

Potential confounders were chosen based on previous studies (e.g. Crombie et al., 2011; Tiesler et al., 2013). A $\chi^2$ test was
conducted to investigate associations of variables at t0 (except for migration background, which was only assessed in t1) with the increased-exposure variables. A variable was retained in the analyses if there was a significant association with at least one of the increased-exposure variables \((p < 0.05)\). Factors that were included in the analyses were number of siblings, early biological risk (born premature before week 37 or had a low birth weight \((<2500\, g)\) or both), crowding, second hand smoke at home, physical activity, single parenthood, parental education, parental unemployment, household equivalent income, and migration background. Screen time was not included as covariate, since it was not correlated with any of the increased-exposure variables. Operationalisation of these covariates has already been published elsewhere (Klingshirn et al., 2014; Scharte et al., 2013).

2.5. Statistical analyses

Descriptive analyses were performed to analyse the study sample. For the association of increased noise exposure bivariate and multivariate analyses were conducted applying Poisson Regression Analysis. Separate models were built for all noise sources where at least 10% of children reported increased-exposure during the study period. These were road traffic day and night, aircraft noise day, construction work day and night, neighbours and day and night. Reference was low level of annoyance (‘not at all’ or ‘a bit’) at both times. Two models were run for each of the mental health outcomes (emotional symptoms, conduct problems, hyperactivity, peer relationship problems, and overall problem score). In model 1 we analysed the bivariate association between noise source and the respective mental health outcome, in model 2 covariates were added. Results are presented as relatives risk (RR) with corresponding 95% confidence intervals. Although differences in prevalences of mental health problems between boy and girls exist (Ravens-Sieberer et al., 2007), no differences concerning the exposure were found in our sample. Therefore, no separate analyses for boys and girls were conducted. Although inter-relations between factors were found, no collinearity was detected as the variance inflation factor was never greater than 1.3. All statistical analyses were performed using SAS statistical software V.9.3.

3. Results

3.1. Characteristics of the study population

The cohort consisted of 1185 children. Table 1 shows the characteristics of the study population. Concerning socio-demographic factors the cohort did not change significantly between baseline and follow-up. In total 173 children moved houses during the study period, and analysis showed that they tended to move ‘upwards’ into better houses and to more quiet streets.

The noise source that most children were exposed to at t0 and t1 was road traffic day (11.39% and 17.72% resp.). The lowest exposure prevalence was reported for playgrounds night at t0 (0.08%) and sport/leisure time facilities night at t1 (0.59%) (see online supplement Table A). In Table 2 the frequency of increased-exposure by different noise sources are displayed. The most common increased-exposure between t0 and t1 was road traffic day (26.38%). The noise source with the lowest percentage of reported increased-exposure was sport/leisure time facilities night and playground night (both 2.29%). Concerning mental health problems, lowest prevalence of abnormal problem scores in the subcategories was reported for the total difficulties score \((t0 = 3.57\%\); \(t1 = 6.29\%\)) at both times, and highest for conduct problems at t0 (9.81%) and peer relationship problems at t1 (10.07%) (see online supplement Table B).

Table 1

| Characteristics of the study population at baseline (t0) and follow-up (t1) (N=1185)*. |
|-----------------------------------|--------|--------|--------|--------|
| Gender                           | t0     | %      | t1     | %      |
| Male                             | 583    | 49.2   | 583    | 49.2   |
| Female                           | 602    | 50.8   | 602    | 50.8   |
| Number of siblings               |        |        |        |        |
| 0                                | 203    | 17.2   | 167    | 14.1   |
| 1                                | 658    | 55.7   | 634    | 53.7   |
| 2                                | 239    | 20.2   | 269    | 22.8   |
| ≥3                               | 81     | 6.9    | 111    | 9.4    |
| Parental education               |        |        |        |        |
| High                             | 430    | 38.3   | 426    | 38.0   |
| Middle                           | 428    | 38.1   | 471    | 41.9   |
| Low                              | 265    | 23.6   | 226    | 20.1   |
| Parental employment status       |        |        |        |        |
| Unemployed                       | 33     | 2.9    | 18     | 1.6    |
| Employed                         | 1113   | 96.0   | 1119   | 96.6   |
| Only working partly              | 13     | 1.1    | 22     | 1.9    |
| Crowding                         |        |        |        |        |
| Not crowded                      | 956    | 84.8   | 994    | 88.2   |
| Crowded                          | 171    | 15.2   | 113    | 11.8   |
| Second hand smoke at home        |        |        |        |        |
| Yes                              | 354    | 30.0   | n.a.   | n.a.   |
| No                               | 826    | 70.0   | n.a.   | n.a.   |
| Child’s physical activity        |        |        |        |        |
| High                             | 461    | 39.3   | 418    | 35.7   |
| Low                              | 711    | 60.7   | 754    | 64.3   |
| Single parent                    |        |        |        |        |
| Yes                              | 94     | 8.2    | 121    | 10.5   |
| No                               | 1057   | 91.8   | 1030   | 89.5   |
| Household equivalent income      |        |        |        |        |
| < 60% of median income           | 173    | 14.6   | 221    | 18.7   |
| 60% until median income          | 305    | 25.7   | 461    | 38.9   |
| > 60% of median income           | 158    | 13.3   | 304    | 25.7   |
| Not indicated                    | 549    | 46.3   | 199    | 16.8   |
| Migration background             |        |        |        |        |
| Yes                              | 309    | 26.2   | 309    | 26.2   |
| No                               | 872    | 73.8   | 872    | 73.8   |

n.a. not analysed (data not collected at t1).

* Number of children in each category \((n)\) for whom information on the variable is available may be different due to missing data.

Table 2

<table>
<thead>
<tr>
<th>Increased-exposure by different noise sources between t0 and t1.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise sources</td>
</tr>
<tr>
<td>---------------------------------------------------------------</td>
</tr>
<tr>
<td>Road traffic</td>
</tr>
<tr>
<td>Day</td>
</tr>
<tr>
<td>Night</td>
</tr>
<tr>
<td>Aircraft</td>
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<td>Day</td>
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<tr>
<td>Night</td>
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<tr>
<td>Construction work</td>
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<td>Day</td>
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<td>Night</td>
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<tr>
<td>Rail traffic</td>
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<td>Day</td>
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<td>Night</td>
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<td>Industry</td>
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<td>Night</td>
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<td>Restaurant</td>
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<td>Day</td>
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<td>Night</td>
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<td>Sport facilities</td>
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<td>Playground</td>
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<tr>
<td>Neighbours</td>
</tr>
<tr>
<td>Day</td>
</tr>
<tr>
<td>Night</td>
</tr>
</tbody>
</table>

Table 3 shows incident mental health problems between t0 and t1. Highest percentage of incident cases was reported for conduct problems (12.77%), lowest for total difficulties score (8.92%).
3.2. Increased-exposure and children’s incident mental health problems

Table 4 displays crude and adjusted RRs and 95% CIs for incident mental health problems for different noise sources. We observed that increased-exposure to road traffic day and night were the most prominent risk factors for incident mental health problems. Road traffic day was associated with incident cases of the total SDQ difficulties score, emotional problems, and peer relationship problems in bivariate analysis. For road traffic night the association was even more profound, as RRs also stayed significant in most multivariate analysis: For the total SDQ difficulties score the RR, adjusted for all covariates, was 2.06 (95% CI 1.32–3.21). For emotional problems an RR of 1.67 (95% CI 1.12–2.48), and for conduct problems an RR of 1.57 (95% CI 1.04–2.33) was found in the multivariate analysis. For peer relationship problems the RR in the bivariate analyses was 1.67 (1.12–2.48), which did not stay significant when adjusting for covariates. Neither road traffic noise night nor day was a risk factor for hyperactivity. After adjustment neighbours day was a risk factor for conduct problems (RR 1.62; 95% CI 1.16–2.27), which did not stay significant when adjusting for covariates. Neighbours night was a risk factor for emotional symptoms (RR 1.66; 95% CI 1.02–2.61) and peer relation problems (RR 1.55; 95% CI 1.02–2.36) in bivariate analysis, which did not stay significant when adjusting for covariates. Aircraft noise day and construction work day showed no significant association with any of the SDQ outcome variables. In sensitivity analyses we assessed the association with incident mental health problems in children who had constant high levels of exposure at t0 and t1. The results showed the same pattern as reported above, and the associations were even more distinct as RRs were higher; however CIs were wider as this group of children was smaller (see online supplement Table C).

4. Discussion

4.1. Key results

In the present paper we investigated the association between exposure to different environmental noise sources at children’s home and incident mental health problems among 1185 school-aged children. Three main findings result from our analysis. First, exposure to road traffic noise at day or at night was the main risk factor for incident mental health problems as measured with the SDQ in children aged 9–10 years. Second, exposure to noise by neighbours night and day also seemed to be a risk factor for some subcategories of the SDQ. Third, noise by construction work day and aircraft noise day were not associated with incident mental health problems. Thus, increased exposure to noise does not necessarily result in mental health problems; the source of noise seems to play a major role.
4.2. Comparison with previous studies and interpretation of findings

Previous studies have considered some of the noise sources and mental health outcomes in a cross-sectional design. Comparisons of results have to be interpreted with caution due to methodological differences.

In our study exposure to road traffic noise day or night was related to SDQ total difficulties score, emotional problems, conduct problems and peer relationship problems. The relationship was more distinct for nighttime road traffic noise. Previous studies investigating the association between road traffic noise and mental health in children found mixed results. A recent study that also investigated noise exposure at children’s homes and its association with mental health outcomes in Germany found that higher noise levels day and night at the most exposed façade were associated with increased hyperactivity symptoms, and higher noise levels at the least exposed façade were associated with increased emotional symptoms; no significant association was found between noise and overall SDQ problem score (Tiesler et al., 2013).

Lercher et al. (2002) who investigated the effects of residential noise levels at the least exposed façade were associated with in-sociation with mental health outcomes in Germany found that also investigated noise exposure at children’s homes and its mental health in children found mixed results. A recent study that two subscales of the KINDL (Bullinger et al., 1994), but only in slightly lower values for children’s mental health, assessed with exposure to overall ambient daytime and nighttime noise reported difficulties score, emotional problems, and conduct problems with increased road traffic noise at school has been linked with higher hyperactivity at school was associated with decreased conduct problems; again no association was found between road traffic noise and overall SDQ, emotional problems, and hyperactivity (Crombie et al., 2011). The finding of reduced conduct problems with increased road traffic noise was unexpected for the authors and they reported that it was not consistent with theory. They argue that this finding could be due to chance or due to difficulties in accurately measuring road traffic noise (Crombie et al., 2011; Stansfeld et al., 2009). Another publication of this study contradicted our results in parts as they reported that road traffic noise at school was associated with decreased conduct problems; again no association was found between road traffic noise and overall SDQ, emotional problems, and hyperactivity (Crombie et al., 2011). The finding of reduced conduct problems with increased road traffic noise was unexpected for the authors and they reported that it was not consistent with theory. They argue that this finding could be due to chance or due to difficulties in accurately measuring road traffic noise (Crombie et al., 2011; Stansfeld et al., 2009). The fact that our results were more distinct for road traffic noise at night than during the day might be explained by the fact that children are more disturbed during the day by e.g. playing and do not pay attention to noise. Moreover, parents may not be at home during the day, which could have led to underreporting of the true burden of noise during the day.

We observed that aircraft noise during the day at children’s homes was not related to mental health problems. In other studies the results have been mixed. In the RANCH study, which deliberately chose regions that were exposed to high aircraft noise, aircraft noise at school has been linked with higher hyperactivity (Crombie et al., 2011; Haines et al., 2001a; Stansfeld et al., 2009) score and higher total SDQ difficulties score (Haines et al., 2001a). Whereas in other analyses of this study aircraft noise was found to be not associated with the SDQ total difficulties score (Stansfeld et al., 2005) or subcategories of the SDQ. In the London subgroup of the RANCH study, neither nocturnal exposure to aircraft noise at home nor exposure to aircraft noise at schools affected children’s mental health, neither on the total difficulties score of the SDQ nor on any of its subscales (Haines et al., 2001b; Stansfeld et al., 2010). Our study area consisted of regions that were not exposed to high levels of aircraft noise. Therefore, the degree of objective exposure was presumably lower than in the RANCH study.

To the best of our knowledge no study so far has investigated the relationship between noise by neighbours and mental health in children, therefore the results can only be linked to findings in adults. In a study among adults aged 18 years or over in London Guite et al. (2006) found that noise from neighbours was independently associated with mental health and vitality. A study by Grimwood (1993) among adults found that concerning neighbourhood noise people mostly objected noise from radio, barking dogs human voices, banging doors, television, or hi-fi. In this survey, two types of emotional response to noise were observed: outwardly directed aggression, as for example feelings of bitterness, annoyance, aggravation, and anger towards the source of the noise, and a more emotional response of anxiety, tension, and feelings of pressure. The fact that we found an association between noise and hyperactivity is supported by theory, as it is thought that noise affects hyperactivity through arousal (Crombie et al., 2011). The arousal theory states that noise exposure changes arousal levels, which may lead to raised physiological activity levels, which might become manifest as psychological difficulties (Cohen et al., 1986).

Our data did not show an association of noise by construction work and any of the SDQ subcategories. To the best of our knowledge annoyance by construction work as a potential risk for mental health problems has not been studied in previous studies. Although almost 20% of respondents reported an increase of annoyance by construction work, only 7% felt annoyed at an at least moderate rate. It could be argued that although an increase of noise annoyance can be observed, this probably took place on low levels (e.g. from ‘not at all’ to ‘a bit’), which might not be enough to actually affect mental health.

4.3. Strengths and limitations

We need to state several limitations concerning our study. Our first limitation refers to the fact that we only have subjective assessment of noise exposure reported by parents. In an ideal situation we would have objective and subjective assessments, as they complement each other. For objective noise assessment noise maps have been developed for some cities. However, for small towns such as Günsburg and for more rural areas included in our study noise maps do not exist. Therefore, objective assessment of noise was not possible in this study. However, annoyance by noise has been shown to be a good proxy for the extent of the exposure to noise (Kohlhuber et al., 2009). Moreover, parental reports of the SDQ may underestimate internalising disorders, as they are less visible and children may not always disclose their feelings to their parents (Goodman et al., 2000). However, a self-reported version is not available for this age group and might be less reliable (Marris et al., 2004). Also, it seems unlikely that underreporting would have varied by noise exposure. Another limitation concerns a possible selection bias as the follow-up was only conducted among those school children who attended the fourth grade at the time they should. Children who repeated a school year were not assessed in the follow-up. One reason why children repeat a class could be mental health problems. In addition, although we carefully adjusted our analyses for socio-demographic variables as well as possible biological and environmental risk factors, we cannot completely rule out potential bias.

The strengths of this study mainly relate to the longitudinal design. Our study setting provided access to a large unselected cohort of children using baseline data from a whole population survey with a high response rate of 85%. Noise data for a variety of different noise sources and separately for day and night allowed us to investigate whether the source of the noise and the time of exposure mattered for the development of mental health problems. Another strength is that the exposure variable was operationalized as children’s increase in exposure between t0 and t1, instead of grouping them in high and low exposure groups. Additionally, we analysed the risk for children that had constant high
levels of noise exposure, as it has been proposed that prolonged noise exposure impairs health via increased annoyance and/or directly via chronically augmented arousal levels (Babisch, 2002). In our data we found that children who were in the group of constant high exposure, and therefore were continuously exposed for a long time, had higher risk for mental health problems, than children who experienced an increase of noise during the study period. The outcome incident mental health problems was assessed with a validated questionnaire. We included a comprehensive set of socio-demographic confounders as well as other potential biological and environmental risks from the literature to control for their influence on the association of exposure to environmental noise and children’s mental health problems.

5. Conclusion

In conclusion our data suggest an association between noise and incident mental health problems in children. Moreover, increase of noise does not automatically result in mental health problems; the source of noise matters. More cohort studies are needed to confirm our results in children. Ideally, these should complement objectively assessed noise exposure with additional data on annoyance and noise insulation of the apartment. Our results further strengthen the need to prevent environmental noise exposure as noise and noise annoyance in the population is an important issue for public health.

Funding

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Ethical approval

Ethical approval was given by the Ethical Committee of the Bavarian Chamber of Physicians.

Acknowledgements

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Appendix A. Supplementary materials

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.envres.2015.08.003.

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(http://www.sdqinfo.com/). Youn thinner.


WHO, 2011. Burden of Disease from Environmental Noise. World Health Organiza-
### Online Supplement

**Table A** Exposure to different noise sources at baseline and follow-up *

<table>
<thead>
<tr>
<th>Noise Sources</th>
<th>Exposure at baseline (t0)**</th>
<th>Exposure at follow-up (t1)**</th>
<th>Children with constant high levels of noise exposure at t0 and t1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
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</tr>
<tr>
<td>Road traffic</td>
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</tr>
<tr>
<td>day</td>
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<tr>
<td>night</td>
<td>44</td>
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<td>74</td>
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<tr>
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<td></td>
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<td>Neighbours</td>
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<tr>
<td>night</td>
<td>29</td>
<td>2.5</td>
<td>56</td>
</tr>
</tbody>
</table>

* Numbers were calculated without missings

** Children were exposed to a specific noise source ‘moderately’, ‘strong’ or ‘very strong’ in comparison to ‘not at all’ and ‘a bit’
Table B Characteristics of mental health as assessed by the Strengths and Difficulties Questionnaire (SDQ) at baseline and follow-up*

<table>
<thead>
<tr>
<th></th>
<th>baseline (t0)</th>
<th>follow-up (t1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td><strong>Total difficulties score</strong></td>
<td></td>
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<tr>
<td>Normal</td>
<td>1083</td>
<td>92.0</td>
</tr>
<tr>
<td>Borderline</td>
<td>52</td>
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<tr>
<td>Abnormal</td>
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<tr>
<td><strong>Emotional symptoms</strong></td>
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<tr>
<td>Normal</td>
<td>1053</td>
<td>88.9</td>
</tr>
<tr>
<td>Borderline</td>
<td>68</td>
<td>5.7</td>
</tr>
<tr>
<td>Abnormal</td>
<td>64</td>
<td>5.4</td>
</tr>
<tr>
<td><strong>Conduct problems</strong></td>
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<td></td>
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<tr>
<td>Normal</td>
<td>910</td>
<td>77.0</td>
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<tr>
<td>Borderline</td>
<td>156</td>
<td>13.2</td>
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<tr>
<td>Abnormal</td>
<td>116</td>
<td>9.8</td>
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<tr>
<td><strong>Hyperactivity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>1087</td>
<td>92.0</td>
</tr>
<tr>
<td>Borderline</td>
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<td>3.0</td>
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<tr>
<td>Abnormal</td>
<td>59</td>
<td>5.0</td>
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<tr>
<td><strong>Peer relationship problems</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>990</td>
<td>83.8</td>
</tr>
<tr>
<td>Borderline</td>
<td>94</td>
<td>8.0</td>
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<tr>
<td>Abnormal</td>
<td>98</td>
<td>8.3</td>
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</table>

* Numbers were calculated without missings
Table C: Association between constant high levels of noise exposure by different noise sources and incident mental health problems between t0 and t1 assessed by the Strengths and Difficulties Questionnaire (SDQ) using Poisson Regression Analysis

<table>
<thead>
<tr>
<th></th>
<th>Total difficulties score</th>
<th>Emotional symptoms</th>
<th>Conduct problems</th>
<th>Hyperactivity</th>
<th>Peer relationship problems</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>RR (95% CI)</td>
<td>RR (95% CI)</td>
<td>RR (95% CI)</td>
<td>RR (95% CI)</td>
<td>RR (95% CI)</td>
</tr>
<tr>
<td></td>
<td>crude</td>
<td>adjusted*</td>
<td>crude</td>
<td>adjusted*</td>
<td>crude</td>
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<tr>
<td><strong>Road traffic day</strong></td>
<td>2.21 (1.79-2.75)</td>
<td>2.30 (1.35-3.93)</td>
<td>2.30 (1.35-3.93)</td>
<td>2.30 (1.35-3.93)</td>
<td>2.30 (1.35-3.93)</td>
</tr>
<tr>
<td><strong>Road traffic night</strong></td>
<td>2.4 (1.95-2.86)</td>
<td>2.4 (1.95-2.86)</td>
<td>2.4 (1.95-2.86)</td>
<td>2.4 (1.95-2.86)</td>
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<td><strong>Aircraft noise day</strong></td>
<td>1.08 (0.92-1.26)</td>
<td>1.08 (0.92-1.26)</td>
<td>1.08 (0.92-1.26)</td>
<td>1.08 (0.92-1.26)</td>
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<tr>
<td><strong>Construction work day</strong></td>
<td>2.42 (1.86-3.14)</td>
<td>2.42 (1.86-3.14)</td>
<td>2.42 (1.86-3.14)</td>
<td>2.42 (1.86-3.14)</td>
<td>2.42 (1.86-3.14)</td>
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<tr>
<td><strong>Neighbours day</strong></td>
<td>2.13 (1.53-2.97)</td>
<td>2.13 (1.53-2.97)</td>
<td>2.13 (1.53-2.97)</td>
<td>2.13 (1.53-2.97)</td>
<td>2.13 (1.53-2.97)</td>
</tr>
<tr>
<td><strong>Neighbours night</strong></td>
<td>2.15 (1.47-3.13)</td>
<td>2.15 (1.47-3.13)</td>
<td>2.15 (1.47-3.13)</td>
<td>2.15 (1.47-3.13)</td>
<td>2.15 (1.47-3.13)</td>
</tr>
</tbody>
</table>

* Adjusted for number of siblings, early biological risk, crowding, second hand smoke at home, physical activity, single parenthood, parental education, parental unemployment, household equivalent income, and migration background.
Versicherung der eigenständigen Verfassung

Hiermit versichere ich, dass ich die vorliegende Dissertation selbständig verfasst und keine weiteren als die angegebenen Quellen und Hilfsmittel verwendet habe. Alle Stellen, die ich wörtlich oder sinngemäß aus anderen Werken entnommen habe, sind unter Angabe der Quellen als solche kenntlich gemacht.

Diese Arbeit hat in gleicher oder ähnlicher Form noch keiner anderen Prüfungsbehörde vorgelegen.

Bremen, 12. Dezember 2016

Stefanie Dreger