

Explanatory models concerning the effects of small-area characteristics on individual health

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Abstract

Objectives Material and social living conditions at the small-area level are assumed to have an effect on individual health. We review existing explanatory models concerning the effects of small-area characteristics on health and describe the gaps future research should try to fill.

Methods Systematic literature search for, and analysis of, studies that propose an explanatory model of the relationship between small-area characteristics and health.

Results Fourteen studies met our inclusion criteria. Using various theoretical approaches, almost all of the models are based on a three-tier structure linking social inequalities (posited at the macro-level), small-area characteristics

(posited at the meso-level) and individual health (micro-level). No study explicitly defines the geographical borders of the small-area context. The health impact of the small-area characteristics is explained by specific pathways involving mediating factors (psychological, behavioural, biological). These pathways tend to be seen as uni-directional; often, causality is implied. They may be modified by individual factors.

Conclusions A number of issues need more attention in research on explanatory models concerning small-area effects on health. Among them are the (geographical) definition of the small-area context; the systematic description of pathways comprising small-area contextual as well as compositional factors; questions of direction of association and causality; and the integration of a time dimension.

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Introduction

During the last three decades interest in analysing the relationship between small-area characteristics (e.g. physical features like green space, air quality; institutional environment including health care; social cohesion, social organisations and social capital; reputation of an area) and health has re-emerged. Small-area studies show, for instance, that residents of areas characterised by high poverty rates experience higher age-, race-, and sex-adjusted mortality compared with residents of non-poverty areas (Haan et al. 1987). In addition, living in an area with lower levels of social cohesion is associated with higher all-cause mortality (Martikainen 2003; Marinacci 2004; Jaffe et al. 2005). Living in an area with greater levels of deprivation is associated with an increased risk of coronary heart disease (Diez Roux et al. 2001) and cancer (Kuznetsov et al. 2012), self-rated health (McCulloch 2001; Craig 2005), unhealthy dietary habits, physical activity and physical health (Ecob and Macintyre 2000; Diez Roux et al. 2001; Voigtländer et al. 2010), smoking (Duncan et al. 1999), and obesity (Stafford et al. 2007).

For a long time, the discourse on small-area effects on health has largely been shaped by empirical studies (Macintyre et al. 2002). Earlier empirical studies in particular are characterised by the absence of fully articulated explanatory models (Riva et al. 2007). Such models should summarise the hypothesised pathways that link small-area characteristics and health, based on theoretical approaches. Although empirical studies often report significant associations between small-area characteristics and health outcomes, it remains unclear by which pathways these could impact on individual health. If such pathways are reported it may not be clear whether the association is unidirectional, i.e. only from small-area effects to health and not vice versa (for example, social capital may be increased by health). Even if an association is clearly working in one direction it may not be causal. Moreover, individual characteristics may modify the health impact of the small-area context. Such factors may change over time, as is implied by life-course epidemiology. Compositional effects due to selective population movement may imitate contextual effects. Finally, a sound and generally accepted conceptualisation of “small-area context” is still lacking (Bernard et al. 2007).

In this study we describe existing explanatory models concerning small-area effects on health and compare their properties. Guided by the issues raised above, we point to open questions that should be addressed in future research aimed at advancing the conceptual understanding, as well as empirical studies, of small-area effects on health.

Methods

We conducted a systematic literature search for studies describing an explanatory model of small-area effects on health. We applied the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) (Moher et al. 2009) reporting criteria as far as is possible in a study that is not a systematic review or meta-analysis of empirical studies.

Search strategy and selection criteria

We performed a title word search using the databases Pubmed, Social Sciences Citation Index (SSCI, part of “Web of Science”), PsycINFO, Sozialmedizin (SOMED) and Current Contents Medizin (CCMed) (Table 1).

Additional studies were retrieved from the reference lists of relevant articles. Studies were included if they described an explanatory model of small-area effects on health and if the proposed model comprised at least two different aspects of small-area context potentially relevant for health, e.g. green space and social capital. We excluded studies that (1) do not focus on a health-related outcome; (2) just cite or slightly modify existing explanatory models already published; (3) empirically test hypotheses without describing the underlying explanatory model; or (4) use a spatial scale above the small-area level, i.e. national level, federal states/larger regions. For European countries the latter refers to territorial units NUTS 1 or above according

Table 1 Data bases and search terms used for title word search, English or German publications from 1955 to 2011, all countries

Data bases (in English or German, up to 31 December 2011)	
Pubmed:	since 1965
Social Sciences Citation Index (SSCI, part of Web of Science):	since 1955
PsycINFO:	since 1957
Sozialmedizin (SOMED):	since 1978
Current contents medicine (CCMed):	since 2000
Title word search with the following search terms for: ^a	
Small-area	Small-area, neighbourhood/neighbourhood, place, area, region*, context*, district, quarter, locality, environment
Health	Health, well-being, life expectancy, illness risk, disease, mortality, morbidity, physical condition, health inequalities
Explanatory model	Theory, theoretical model, theor*, explan*, conceptual model, concept*, approach*, pathway*, framework, theoretical conception

^a The search terms within each category have been linked with the operator OR, the search terms of the different categories have been linked with the operator AND

Table 2 Search strategy of literature search for explanatory models concerning the effects of small-area characteristics on individual health, English or German publications from 1955 to 2011, all countries

Number of publications in the selection process				
Data sources	Overall hits ^a	Publications selected because of screening of		
		Title	Abstract	Full text
Pubmed	404	48	18	5
SSCI (Web of Science)	366	25 (7) ^b	4	0
PsycINFO	114	5 (3) ^b	0	0
SOMED	0	0	0	0
Current Contents Medizin	272	0	0	0
Bibliography search and already known	58	53 (5) ^b	21	9
Total	1,214	131	43	14

^a Duplicates not considered

^b Duplicates (number in brackets) have been deleted and assigned to database where they were first found (ordered from top to bottom)

to “Nomenclature of Territorial Units for Statistics” (Nomenclature des Unités Territoriales Statistiques, NUTS) introduced by Eurostat (2012).

Retrieval and analysis

Our search retrieved 1,214 publications (Table 2). After screening the titles and excluding duplicates ($n = 15$), 131 abstracts were retained. 88 studies had to be excluded after screening the abstract, leaving 43 full texts for subsequent analysis.

Out of these 43 studies, 29 had to be excluded after full text screening (cf. Electronic Supplementary Material). The remaining 14 studies (Robert 1999; Macintyre et al. 2002; Gee and Payne-Sturges 2004; Schulz and Northridge 2004; Galea et al. 2005; Carpiano 2006; Morello-Frosch and Shenassa 2006; Bernard et al. 2007; Kamphuis et al. 2007; Stafford et al. 2007; Daniel et al. 2008; Chaix 2009; WHO 2010; Voigtländer et al. 2012) were summarised by VV and SV along the following criteria: (1) study objective; (2) theoretical approaches used or referred to; (3) type of small area; (4) small-area characteristics and pathways; (5) determinants of residential location.

Results

14 studies met the inclusion criteria (Table 2). A summary of these studies along the above-mentioned criteria is presented in the Table 3.

Study objectives

Most of the studies mention the objective to overcome the lack of a consistent explanatory model of small-area effects on health. Two studies (Schulz and Northridge 2004; Galea et al. 2005) aim to contribute to a better planning of health promotion interventions. In two other studies (Kamphuis et al. 2007; Stafford et al. 2007), the explanatory model serves as a basis for empirical analyses of small-area health effects.

Theoretical approaches

The publications use various theoretical approaches from disciplines such as psychology, urban ecology and sociology. The theoretical approaches refer to (1) psychological aspects of individual experience and behaviour; (2) the interdependency of different small-area characteristics; and (3) the (re-)production of health inequalities through differences in small-area level characteristics and resources.

The “concept of allostasis” (Geronimus 1992; McEwen 1998), for instance, is used by Morello-Frosch and Shenassa (2006) and Daniel et al. (2008) as it helps to describe the ability of a body to respond to psychosocial or physical stressors. Chaix (2009) instead refers to Ajzen’s theory of planned behaviour (Ajzen 1991) to elucidate how the social environment could affect the risk of coronary heart disease (CHD). In addition, Chaix is referencing to the approach of self-efficacy by Bandura (1991) as a psycho-cognitive antecedent of behaviour.

Approaches to explain the interdependency of small-area characteristics are based, for example, on urban ecology and on social disorganisation theories. These theoretical approaches describe how the socioeconomic context is related to residential mobility, ethnic heterogeneity, social organisation, social cohesion and the physical environment (Robert 1999). Stafford et al. (2007) is referring to the “broken windows theory” which describes how physical and social disorder can reinforce each other in a vicious cycle.

Regarding the (re-)production of health inequalities through social differences in small-area context, all publications reviewed here refer to similar theoretical approaches, and often refer to each other. Macintyre et al. (2002), in one of the earliest studies in our review, use the “concept of opportunity structures” which they define as: “socially constructed and socially patterned features of the physical and social environment which may promote or damage health either directly or indirectly through the possibilities they provide for people to live healthy lives” (p. 132). The authors combine this concept with Maslow’s (1968) hierarchy of human needs and urban planning theories to derive a “framework of universal human needs

Table 3 Explanatory models concerning the effects of small-area characteristics on individual health, English or German publications from 1955 to 2011, all countries

References	Study objective	Theoretical approaches used or referred to	Type of small area	Small-area characteristics and pathways	Determinants of residential location	Strengths and limitations
Robert 1999, USA	To review empirical evidence for the relative impact of community and individual socioeconomic context on health	Urban ecological theory, social disorganisation theory, social capital theory, Wilson's (1987) theory of concentration and social isolation effects in inner cities	Community	2 main pathways connect community socioeconomic context with health: (1) by shaping the socioeconomic position of individuals; (2) by affecting social, service and physical environments of communities which in turn affect individual characteristics that impact health	Individual socioeconomic position may affect the type of community in which one chooses to live	Good empirical basis; weak theoretical background
Macintyre et al. 2002, UK	To disentangle the relationship between place and health	Maslow's (1968) hierarchy of human needs, Urban planning theories (e.g. Brower 1996)	Neighbourhood	There are 2 major categories of neighbourhood effects that include 5 types of local features: opportunity structures (physical features, healthy environments, services) and collective social functioning (socio-cultural features, reputation of the area). Within these domains there are specific aspects by which areas might influence health. List of human needs for a healthy life. Resources for meeting those needs are geographically unequal distributed	Model does not account for individual selection or migration into places	Critical discussion of recent research on place and health; no illustration of pathways
Gee and Payne-Sturges 2004, USA	To explain environmental health disparities based on a framework including community factors (e.g. environmental toxicants, community vulnerability)	Exposure-disease paradigm (Sexton et al. 1993)	Community	There is a difference in the accumulation of neighbourhood resources, community stressors, structural factors and environmental hazards between different ethnic groups. This accumulation process is associated with the degree of community stress at the community level. This is influencing health as a function of individual stressors and coping	Residential segregation is based on ethnicity	Explanation of the vulnerability of ethnic minorities, focussing on environmental health risks; Ethnicity as only socioeconomic indicator
Schulz and Northridge 2004, USA	To understand the relationship between social factors, environmental exposures and health inequalities (to improve environmental health promotion programmes)	Own previous work drawing on the ecosocial perspective, health and human rights, the precautionary principle, and sustainable production (Northridge and Sclar 2003)	Community	Model comprises 4 interrelated levels: (1) fundamental (production of inequalities and creation of spatial concentrations of poverty and wealth); (2) intermediate (built environment and social context); (3) proximal (health stressors, behaviour, social integration and support), and (4) health and well-being	Residential segregation is rooted in the social and cultural institutions and legal codes at the macro-level	Model allows for deduction of intervention strategies; no consideration of the individual socioeconomic position

Table 3 continued

References	Study objective	Theoretical approaches used or referred to	Type of small area	Small-area characteristics and pathways	Determinants of residential location	Strengths and limitations
Galea et al. 2005, USA	To develop a model that can guide interventions aimed at improving health within and across cities	Theoretical frameworks that have considered the social and political determinants of population health (e.g. the DPSEEA framework by the WHO)	Municipality	Health of the urban population is shaped by three levels: (1) global and national trends (e.g. migration, globalisation); (2) municipal level determinants (policies, markets, civil society); (3) urban living conditions (population, physical and social environment, services). Enduring structures like culture and religion are shaping all the components of the model	Model does not account for individual selection or migration into places	Model explains the health of urban populations while considering the larger regional, national and global context; no explicit reference to the individual and neighbourhood level
Carpiano 2006, USA	To address theoretical limitations in research on the relation between neighbourhood factors and health, especially on the conceptualisation of social capital	Social capital theory mainly based on Bourdieu (1986) and Portes (1998)	Neighbourhood	Neighbourhood socioeconomic context impacts on individual health status through social cohesion and social capital which influence neighbourhood attachment as well as health behaviours and other risk factors. Social cohesion is regarded as a precondition of social capital. The proposed pathway is influenced by individual confounders (e.g. length of residency, social position)	Model does not account for determinants of residential location	Model describes the influence of social cohesion and social capital processes at the neighbourhood level on individual outcomes; framework is limited to social capital
Morello-Frosch and Shenassa 2006	To investigate the impact of environmental hazards together with place-based and individual-level psychosocial stressors on maternal and child health	Concept of allostatic load (e.g. Gerominus 1992)	Community	Differentiation between a direct risk chain of hazardous environments to which certain communities are disproportionately exposed and the multilevel interplay of social stressors and buffers at community as well as individual level. These stressors and buffers shape exposure and susceptibility (conceptualised by allostatic load) to environmental hazards	Model does not account for individual selection or migration into places	Integrating the concept of allostatic load and also a temporal dimension; restricted to maternal and child health
Bernard et al. 2007, Canada	To develop a conceptualisation of neighbourhood that accounts for the local production of health	Concept of opportunity structures as proposed by Macintyre and Ellaway (2000, 2003) as well as structuration theory (Giddens 1984) and theory of informal reciprocity (Godbout 2003)	Neighbourhood	Neighbourhoods differ regarding 5 domains of social regulation: (1) physical; (2) economic; (3) institutional; (4) local sociability and (5) community organisations. Distribution of these resources is governed by 4 types of rules: (1) proximity; (2) price; (3) right and (4) informal reciprocity	Residential decisions are shaped by the correspondence between individuals' economic means, lifestyle preferences and neighbourhood characteristics	Holistic, theory-based framework of neighbourhood; no presentation of specific pathways by which neighbourhood resources are transformed into health

Table 3 continued

References	Study objective	Theoretical approaches used or referred to	Type of small area	Small-area characteristics and pathways	Determinants of residential location	Strengths and limitations
Kamphuis et al. 2007, Netherlands	To develop a framework for the relationship between neighbourhood and health behaviour that accounts for the perception of neighbourhood factors and to apply it empirically	Theory of planned behaviour (Ajzen 1991)	Neighbourhood (household, work)	Based on their social position individuals are predisposed to neighbourhoods defined by: (1) material conditions; (2) accessibility and availability of facilities; (3) psychosocial conditions and (4) cultural conditions. The effect of these neighbourhood characteristics on health behaviour is mediated by the constructs: (1) attitude; (2) social influences; (3) perceived behavioural control and (4) intention	Model does account for individual selection or migration into places	Framework is based on literature review
Stafford et al. 2007, UK	To develop a theoretical model to explain the association between neighbourhood characteristics and obesity and to apply it empirically	“Broken windows” theory (Wilson and Kelling 1982) together with determinants by a number of empirical studies	Neighbourhood (operationalised as postcode sectors)	Neighbourhood characteristics operationalized by 8 indicators (e.g. crime, leisure centres, fast-food outlets), which impact, partly through social disorder, on physical activity and diet which ultimately influence obesity	Model does not account for individual selection or migration into places	Attempt to formulate a model that can be empirically tested; model does not consider the influence of individual characteristics on the described pathways
Daniel et al. 2008, Canada	To propose a conceptual framework that integrates time and 2 biosocial pathways between place and cardiometabolic disease. Considering epidemiological requirements for causal inference in evaluating this association	Concept of allostatic load and life-course epidemiology as well as previous work on neighbourhood health effects (e.g. Macintyre et al. 2002)	Neighbourhood (constituted by spatial zones in contiguous urban areas)	Structural factors (macro: asymmetry in distribution of resources) and contextual factors (meso: local attributes of place) are linked with the development of cardiometabolic disease through 2 pathways: (1) indirect cognitive path including lifestyle and behaviour and (2) direct-contextual path. The pathways affect biological mediators and moderators such as obesity and allostatic load	Model does not account for individual selection or migration into places	Biosocial model for the relation between place and cardiometabolic disease with a strong focus on biological plausibility; not accounting for bidirectional relationships between, e.g. social position and health
Chaix 2009, France	To review literature on the association between neighbourhood social environments and coronary heart disease (CHD) including methodological advances and to draw a research agenda	Theory of planned behaviour (Ajzen 1991), self-regulation and self-efficacy (Bandura 1991)	Neighbourhood (residential and non-residential)	Model summarises association between: (1) neighbourhood spatial location factors, especially neighbourhood social interactions; (2) neighbourhood experiences and psycho-cognitive antecedents of behaviour (e.g. self-efficacy, locus of control); (3) health behaviour and (4) CHD disease outcomes	CHD outcomes influence the exposure to a certain residential environment	Though model focuses on CHD it is also relevant for other health outcomes

Table 3 continued

References	Study objective	Theoretical approaches used or referred to	Type of small area	Small-area characteristics and pathways	Determinants of residential location	Strengths and limitations
WHO, 2011, Denmark	To understand how environmental risk factors operate between social inequalities and health outcomes for designing effective policies	Framework model developed by the WHO as part of a background document	Environment	Model distinguishes 2 differentials: (1) exposure differential, i.e. variation of exposure for specific individuals or population groups and (2) vulnerability differential, i.e. variability of the exposure-response function between individuals. Model also describes the institutional landscape (environmental actors and health sector) to change environmental conditions and exposure of individuals	Model does not account for individual selection or migration into places	Model presents causes of the unequal distribution of environmental risks as well as ways to tackle environmental inequalities
Voigtländer et al. 2012, Germany	To integrate different explanations for the relationship between small-area context and health and to offer an orientation for future empirical studies	Theories of social inequalities in health (e.g. Steinkamp 1993), previous theoretical approaches of small-area health effects (e.g. Bernard et al. 2007)	Region, neighbourhood	Model comprises 3 levels: (1) macro (system of social structure); (2) meso (small-area context: region and neighbourhood) and (3) micro (health). The small-area context is defined by its social structure and 4 resource domains (physical, economic, institutional, and social) that can impact on health through 3 pathways (direct, distress/behaviour, personal resources)	Residential location is determined by the social position of individuals	Model is not restricted to a specific health outcome and integrates various neighbourhood resource domains based on a social inequalities perspective

CHD coronary heart disease, *DPSEEA* Driving Force-Pressure-State-Exposure-Effect-Action, *WHO* World Health Organization

for a healthy life". They assume that the resources available to meet these needs are geographically unequally distributed and that this unequal distribution may contribute to the production of health inequalities. Bernard et al. (2007) build on this work and argue that the small-area context provides access to health-relevant resources (or fails to do so). Based on Giddens' structuration theory (Giddens 1984), as well as Godbout's theory of informal reciprocity (Godbout 2003), the authors define four rules of access: proximity, right, price and informal reciprocity.

Several studies (Schulz and Northridge 2004; Daniel et al. 2008; Chaix 2009; Voigtländer et al. 2012) include a macro-level perspective, which is already inherent in the model of Macintyre et al. (2002), and argue that the (national) structure of social inequality is linked to a process of spatialisation leading to spatial concentrations of wealth and poverty and thus to spatial differences in type and level of small-area resources. The explanatory model proposed by Gee and Payne-Sturges (2004), for instance, outlines how race/ethnicity is associated with health disparities via residential location. They refer to the "exposure-disease paradigm" of Sexton et al. (1993) which tries to explain disparities in health between different social groups.

Types of small areas

None of the studies reviewed here provides an explicit definition of small-area context including its geographical boundaries. Operationalisation of small-area context is often opportunistic, i.e. based on data availability. For example, three studies use municipalities, defined by administrative boundaries (Galea et al. 2005; Stafford et al. 2007; Daniel et al. 2008). Others refer to communities, neighbourhoods or the environment per se without providing a clear delimitation (Robert 1999; Macintyre et al. 2002; Gee and Payne-Sturges 2004; Schulz and Northridge 2004; Carpiano 2006; Morello-Frosch and Shenassa 2006; Bernard et al. 2007; Kamphuis et al. 2007; WHO 2010). None of the studies explains why the chosen type of area should be more relevant for health than areas delimited in another way. Due to the lack of an explicit definition of small-area context, Voigtländer et al. (2012) propose to distinguish between "neighbourhood" as the (walkable) residential living environment and "region" as the surrounding area that goes beyond the neighbourhood, e.g. comprising the regional labour market and a high level of inner commuter traffic. Chaix (2009) argues that neighbourhood delimitations should capture the environmental conditions to which individuals are exposed to in their local environment. According to him spatial mobility is not constrained to residential neighbourhoods and includes

other local geographic environments such as the work environment and leisure-time environments as well as "large(r) territories within which individuals travel regularly" (p. 88). However, such definitions cannot be generalised as they will also depend on the research question and theoretical approach.

Small-area characteristics

Most of the studies reviewed here group small-area characteristics into distinct aspects of the small-area context. Few authors concentrate on just a small number of small-area characteristics which they describe in detail. Carpiano (2006), for example, focuses on characteristics related to the social environment.

The two main categories distinguished in almost all explanatory models are the social and the physical environment. Many authors further differentiate: Robert (1999), for instance, adds the category "services". Macintyre et al. (2002) mention five categories: physical features, availability of healthy environments, the quality of services, socio-cultural features, and features relating to the reputation of an area. The first three categories describe the opportunity structure for people to live healthy lives. The remaining two categories refer to "collective social functioning and practices". The reputation of an area describes the wider social environment going beyond the small-area context; it may instigate processes of stigmatisation and exclusion. Based on the work by Macintyre et al. (2002), Bernard et al. (2007) define five so-called "resource domains" through which residents of neighbourhoods can acquire health-relevant resources: the physical, institutional, economic, community organisations, and local sociability domains. Voigtländer et al. (2012) build on this work and collapse the two domains community organisations and local sociability under the category "social capital and organisations", while additionally including the category "neighbourhood social structure". Changes in the neighbourhood social structure could lead to changes in the resources locally available, and vice versa. Focussing on neighbourhood identities, Chaix (2009) also proposes the category "socio-interactional environment".

Other models which concentrate on specific small-area aspects or a particular health outcome often provide a more detailed description. Carpiano (2006), for instance, focuses on the social environment, considering only characteristics related to social cohesion and social capital. Two studies concentrate on health behaviour in general (Kamphuis et al. 2007) resp. obesity-related behaviour (Stafford et al. 2007), i.e. physical activity and diet. While the latter does not mention specific categories apart from "social disorder", the first describes the following four categories of the neighbourhood: material conditions, accessibility and

availability, psychosocial conditions, and cultural conditions.

Pathways

All pathways in the models start with a differential exposure to small-area resources that ultimately leads to differential health outcomes, thus implying a uni-directional causal association. Furthermore, most of the models describe individual or contextual factors which could mediate as well as modify the health impact of small-area characteristics.

The studies reviewed here envisage several pathways. Kamphuis et al. (2007), for example, propose a pathway based on the constructs of Ajzen's theory of planned behaviour (Ajzen 1991), which mediates the health impact of small-area characteristics. The model of Daniel et al. (2008) includes two pathways for cardiometabolic disease: an indirect cognitive pathway including lifestyle and behaviour, and a direct-contextual pathway. Both pathways comprise biological mediators such as obesity and allostatic load. Morello-Frosch and Shenassa (2006) differentiate between a direct risk of hazardous environments, and the interplay of social stressors and buffers at the community and individual level. At the individual level, they also refer to the concept of allostatic load as a mediating pathway between small-area characteristics and health. Focussing on CHD outcomes, Chaix (2009) describes a pathway based on small-area experiential factors, i.e. neighbourhood experiences and psycho-cognitive antecedents of behaviour such as self-efficacy and locus of control. Carpiano (2006) describes social cohesion and social capital as mediating pathways between socioeconomic small-area characteristics and health. Voigtländer et al. (2012) propose an integrated model by stating three pathways for the internalisation of small-area resources and stressors: a direct pathway, a distress/behaviour-related pathway, and a personal-resources pathway. Some studies, however, do not outline the potential pathways in detail (Macintyre et al. 2002; Bernard et al. 2007).

Individual and contextual factors which modify the health effects of small-area characteristics are part of the proposed pathways. Such factors are important because they can influence the susceptibility of some (but not all) individuals towards potentially health-damaging small-area effects. Effect modification is explicitly considered by five models (Robert 1999; Morello-Frosch and Shenassa 2006; Daniel et al. 2008; WHO 2010; Voigtländer et al. 2012). For instance, the indirect cognitive pathway in the model of Daniel et al. (2008) can be modified by individual socioeconomic status (SES) and other individual resources, as is the case for the models of the WHO (2010), Robert (1999), and Voigtländer et al. (2012). For example, a higher SES

can lower individuals' dependence from locally available resources. Morello-Frosch and Shenassa (2006) view environmental hazards as the result of interplay between community and individual stressors/resources. Amongst others, poverty (resp. SES), social support, working conditions and health behaviours are individual-level factors that are related to community-level stressors and resources.

Determinants of residential location

All explanatory models acknowledge that exposure to health-damaging as well as health-promoting small-area characteristics is not based on chance. Rather, individuals have preferences (Bernard et al. 2007), and they may, or may not, have opportunities to choose between a number of possible residential locations (Robert 1999; Macintyre et al. 2002; Gee and Payne-Sturges 2004; Bernard et al. 2007; Chaix 2009; Voigtländer et al. 2012). For example, persons with low income tend to end up with higher exposures to health-damaging characteristics than the well-off. According to Gee and Payne-Sturges (2004), in the United States, race (resp. ethnicity) largely determines the residential location and thus the amount of an individual's exposure to environmental hazards and pollutants as well as community stress.

In addition to focussing on specific determinants of residential location, five models integrate a macro-level perspective, i.e. they link the small-area context and its resources to the societal structure of inequality as a whole and its (re-)production (Schulz and Northridge 2004; Kamphuis et al. 2007; Chaix 2009; WHO 2010; Voigtländer et al. 2012). Schulz and Northridge (2004), for example, specify macro-social factors such as historical condition, legal codes and ideologies, which shape social inequalities. These inequalities produce spatial variations of wealth and poverty with different qualities regarding the physical and social environment. Galea et al. (2005) refer to enduring structures as well as major global and national trends that cause differences in urban living conditions. The model of WHO (2010) includes the macroeconomic context at the highest level, which is driving social inequalities and as such environmental disparities.

Discussion

We were able to retrieve only few studies aiming to develop explanatory models concerning small-area effects on health (Table 3). As we also screened their reference sections, it is unlikely that this dearth is a consequence of an imperfect search strategy. Additionally, we repeated the search and added "community" as search term. We found 654 additional articles using this search strategy. After

screening the titles 14 abstracts were retained. However, none of these studies describe an explanatory model concerning small-area effects on health. We cannot rule out that we have missed a relevant publication, of course, but the low number more likely reflects that the theoretical aspects of this popular research area remain underdeveloped.

Differences and similarities of the reviewed explanatory models

The explanatory models proposed in the 14 publications included here have much in common, but they differ regarding their specific objective. Whereas some models aim to provide a basis for empirical research on the influence of small-area characteristics on obesity (Stafford et al. 2007) or health-related behaviour (Kamphuis et al. 2007), other models explicitly aim to conceptualise neighbourhood (Bernard et al. 2007) or a framework for reducing environmental health inequalities (Schulz and Northridge 2004). Most of the models work with “black boxes”. Some models, for instance, describe how inequalities in health are generated at the national or macro-level, thus also shaping the small-area level, but do not explain how these inequalities are related to characteristics at the individual level such as health behaviour and SES (Schulz and Northridge 2004; Galea et al. 2005). In contrast, other models describe how individual SES is linked to small-area characteristics, but fail to outline by which pathways these characteristics could affect individual health (Robert 1999). Some models differentiate categories of small-area characteristics without providing a conceptual or graphical description of the pathways leading to differences in, for example, health behaviour and SES, and ultimately to health disparities (Macintyre et al. 2002).

Certain elements, however, seem to be common ground for most of the explanatory models, whether described in a graphical form or in the text:

- (a) Small-area disparities in health are to a substantial extent due to differences in individual exposure to small-area resources and stressors (and partly also due to individual preferences). The notion of “opportunity structures” as proposed by Macintyre et al. (2002) has a substantial influence in this context. Furthermore, most models integrate psychological theories on stress and health behaviour, e.g. the “concept of allostasis” and the theory of planned behaviour, to explain the internalisation of small-area-resources.
- (b) None of the retrieved studies explicitly defines small-area context (including synonyms like neighbourhood and community); only two studies (Chaix 2009; Voigtländer et al. 2012) clearly propose to

differentiate between small-area context and larger territories such as the regional employment market. As the appropriate definition of the small-area ought to arise out of the underlying theoretical approach and hypothesised pathway(s) of the small-area characteristic(s) under study and its health effect(s), simply using available administrative boundaries or egocentric neighbourhoods will be scientifically unproductive (cf. Vallée and Shareck 2014).

- (c) The small-area context is frequently conceptualised in terms of the physical and the social environment. A number of studies differentiate the social environment further into services (Robert 1999; Macintyre et al. 2002; Galea et al. 2005; Bernard et al. 2007; Chaix 2009; Voigtländer et al. 2012) and social relations (Chaix 2009) including socio-cultural features (Macintyre et al. 2002), social cohesion (Carpiano 2006; Stafford et al. 2007) social capital (Galea et al. 2005; Carpiano 2006; Voigtländer et al. 2012) and community organisations (Bernard et al. 2007). Apart from this, Macintyre et al. (2002) mention the reputation of an area as an additional feature, which is a characteristic at least partly created outside the small-area context influencing opportunities rather than being a local exposure.
- (d) A number of pathways mediate between disparities in small-area context and individual health. These are: a cognitive pathway by which the experience of small-area characteristics influences allostatic load (resp. distress) and behaviour, a direct pathway comprising health effects of environmental hazards, as well as an indirect pathway of small-area effects on individual SES and individual personal resources such as self-efficacy. Furthermore, the health impact of small-area-characteristics is described as being dependent on the susceptibility of individuals and families. The use of pathways in the explanatory models also points out that compositional and contextual explanations for small-area health effects are not mutually exclusive; also compositional characteristics may themselves depend on small-area characteristics and act as intermediary or effect modifying factor (Macintyre et al. 2002).
- (e) Almost all of the explanatory models regard differences in small-area context as a result of social inequalities, because social inequalities do not only influence an individual’s choice of residential locations, but also create spatial concentrations of wealth and poverty, leading to spatial concentrations of (un)favourable small-area characteristics. Thus, the essential structure of the explanatory models reviewed here is a three-tier structure linking social inequalities (posited at the macro-level), small-area

context (posited at the meso-level) and individual health (micro-level).

- (f) Explanatory models propose associations, but these are not necessarily causal. Thus, care is needed not to over-interpret them. Several sources of bias need to be considered. Of particular importance is the question whether effects that appear to be contextual are due to selective population movement.

Explanatory models for different purposes

Explanatory models can serve different purposes. Basically, they can be used to guide empirical research, to inform (public health) policy interventions and programmes (e.g. Borrell et al. 2013), and to advance theory of small-area effects on health. The more comprehensive models for empirical research (e.g. Daniel et al. 2008; Voigtländer et al. 2012) comprise social inequalities posited at the macro-level which shape the small-area context, as well as specific pathways by which small-area characteristics affect individual health including the issue of susceptibility. The model proposed by Carpiano (2006) is limited to small-area social capital, but describes this in detail, i.e. its links to social cohesion and neighbourhood attachment. Thus, it is especially helpful for empirical researchers who are specifically interested in the role of small-area social relations and health.

In terms of policy interventions and programmes, the models of Schulz and Northridge (2004) and of WHO (2010) may be most useful. Both describe the origins of environmental and health disparities at the global and national level while at the same time integrating an intervention perspective. The WHO model, for instance, includes political actors, which may intervene in specific steps of the pathways from social inequalities via small-area context to health, e.g. environmental protection, health education and health service provision.

Regarding further theoretical advancements of these explanatory models, the models by Macintyre et al. (2002), Bernard et al. (2007) and Carpiano (2006) seem to offer the best starting point, as they comprise sound theoretical descriptions of small-area health effects including opportunity structures, rules of access to small-area resources as well as social capital. So far, the model by Daniel et al. (2008), who partly served as co-authors for the model by Bernard et al. (2007), is the only model that explicitly takes the role of time into consideration. Time here refers to the evolution of person-place interactions as well as small-area effects across the life course, including cumulative exposures, induction periods and outcomes with a long lag-time period. Clearly, this is an approach which warrants further development.

Conclusion

Existing explanatory models concerning small-area effects on health show a number of limitations that require more research. Among them are the (geographical) definition of the small-area context; the systematic description of pathways comprising small-area contextual as well as compositional factors; questions of direction of association and causality; and the integration of a time dimension. It is important to continuously compare the strengths and weaknesses of different explanatory models and to develop specific models for specific purposes. Empirical studies should always explicitly state the explanatory model on which they are based.

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References

- Ajzen I (1991) The theory of planned behavior. *Organ Behav Hum Decis Process* 50(2):179–211
- Bandura A (1991) Social cognitive theory of self-regulation. *Organ Behav Hum Decis Process* 50(2):248–287
- Bernard P, Charafeddine R, Frohlich KL, Daniel M, Kestens Y, Potvin L (2007) Health inequalities and place: a theoretical conception of neighbourhood. *Soc Sci Med* 65(9):1839–1852
- Borrell C, Pons-Vigues M, Morrison J, Diez E (2013) Factors and processes influencing health inequalities in urban areas. *J Epidemiol Community Health* 67(5):389–391
- Brower S (1996) *Good neighborhoods: a study of in-town and suburban residential environments*. Praeger Publishers, Westport (CT)
- Bourdieu P (1986) The forms of capital. In: Richardson JG (ed) *Handbook of theory and research for the sociology of education*. Greenwood, New York, pp 241–258
- Carpiano RM (2006) Toward a neighborhood resource-based theory of social capital for health: can Bourdieu and sociology help? *Soc Sci Med* 62(1):165–175
- Chaix B (2009) Geographic life environments and coronary heart disease: a literature review, theoretical contributions, methodological updates, and a research agenda. *Annu Rev Public Health* 30(1):81–105
- Craig N (2005) Exploring the generalisability of the association between income inequality and self-assessed health. *Soc Sci Med* 60(11):2477–2488
- Daniel M, Moore S, Kestens Y (2008) Framing the biosocial pathways underlying associations between place and cardiometabolic disease. *Health Place* 14(2):117–132
- Diez Roux AV, Merkin Stein S, Arnett D, Chambless L, Massing M, Nieto F, Sorlie P, Szklo M, Tyroler H, Watson R (2001) Neighbourhood of residence and incidence of coronary heart disease. *N Engl J Med* 345(2):99–107
- Duncan C, Jones K, Moon G (1999) Smoking and deprivation: are there neighborhood effects? *Soc Sci Med* 48(4):497–505
- Ecob R, Macintyre S (2000) Small area variations in health related behaviours; do these depend on the behaviour itself, its

- measurement, or on personal characteristics? *Health Place* 6(4):261–274
- Eurostat (2012) NUTS—nomenclature of territorial units for statistics. http://epp.eurostat.ec.europa.eu/portal/page/portal/nuts_nomenclature/introduction. Accessed 18 Feb 2014
- Galea S, Freudenberg N, Vlahov D (2005) Cities and population health. *Soc Sci Med* 60(5):1017–1033
- Gee GC, Payne-Sturges DC (2004) Environmental health disparities: a framework integrating psychosocial and environmental concepts. *Environ Health Perspect* 112(17):1645–1653
- Geronimus AT (1992) The weathering hypothesis and the health of African-American women and infants: evidence and speculations. *Ethn Dis* 2:207–221
- Giddens A (1984) *The constitution of society*. University of California Press, Berkeley
- Godbout J (2003) *The world of the gift*. McGill-Queen's University Press, Montreal
- Haan M, Kaplan GA, Camacho T (1987) Poverty and health. Prospective evidence from the Alameda County study. *Am J Epidemiol* 6(125):989–998
- Jaffe DH, Eisenbach Z, Neumark YD, Manor O (2005) Individual, household and neighborhood socioeconomic status and mortality: a study of absolute and relative deprivation. *Soc Sci Med* 60(5):989–997
- Kamphuis CB, van Lenthe FJ, Giskes K, Brug J, Mackenbach JP (2007) Perceived environmental determinants of physical activity and fruit and vegetable consumption among high and low socioeconomic groups in the Netherlands. *Health Place* 13(2):493–503
- Kuznetsov L, Maier W, Hunger M, Meyer M, Mielck A (2012) Regional deprivation in Bavaria, Germany: linking a new deprivation score with registry data for lung and colorectal cancer. *Int J Public Health* 57(5):827–835
- Macintyre S, Ellaway A (2000) Ecological approaches: rediscovering the role of the physical and social environment. In: Berkman LF, Kawachi I (eds) *Social epidemiology*. Oxford University Press, Oxford, pp 332–348
- Macintyre S, Ellaway A, Cummins S (2002) Place effects on health: how can we conceptualise, operationalise and measure them? *Soc Sci Med* 55(1):125–139
- Macintyre S, Ellaway A (2003) Neighbourhoods and health: An overview. In: Kawachi I, Berkman LF (eds) *Neighbourhoods and health*. Oxford University Press, New York, pp 20–42
- Marinacci C (2004) The role of individual and contextual socioeconomic circumstances on mortality: analysis of time variations in a city of north west Italy. *J Epidemiol Community Health* 58(3):199–207
- Martikainen P (2003) Effects of the characteristics of neighbourhoods and the characteristics of people on cause specific mortality: a register based follow up study of 252,000 men. *J Epidemiol Community Health* 57(3):210–217
- Maslow A (1968) *Toward a psychology of being*, 2nd edn. Van Nostrand, New York
- McCulloch A (2001) Ward-level deprivation and individual social and economic outcomes in the British Household Panel Study. *Environ Plann A* 33(4):667–684
- McEwen BS (1998) Stress, adaptation, and disease: allostasis and allostatic load. *Ann N Y Acad Sci* 840(1):33–44
- Moher D, Liberati A, Tetzlaff J, Altman DG (2009) Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med* 6(7):e1000097
- Morello-Frosch R, Shenassa ED (2006) The environmental “risk-scapes” and social inequality: implications for explaining maternal and child health disparities. *Environ Health Perspect* 114(8):1150–1153
- Northridge ME, Sclar E (2003) A joint urban planning and public health framework: contributions to health impact assessment. *Am J Public Health* 93(1):118–121
- Portes A (1998) Social capital: its origins and applications in modern sociology. *Annu Rev Sociol* 24:1–24
- Riva M, Gauvin L, Barnett TA (2007) Toward the next generation of research into small area effects on health: a synthesis of multilevel investigations published since July 1998. *J Epidemiol Community Health* 61(10):853–861
- Robert SA (1999) Socioeconomic position and health: the independent contribution of community socioeconomic context 1. *Annu Rev Sociol* 25:489–516
- Schulz A, Northridge ME (2004) Social determinants of health: implications for environmental health promotion. *Health Educ Behav* 31(4):455–471
- Sexton K, Olden K, Johnson BL (1993) “Environmental justice”: the central role of research in establishing a credible scientific foundation for informed decision making. *Toxicol Ind Health* 9(5):685–727
- Stafford M, Cummins S, Ellaway A, Sacker A, Wiggins RD, Macintyre S (2007) Pathways to obesity: identifying local, modifiable determinants of physical activity and diet. *Soc Sci Med* 65(9):1882–1897
- Steinkamp G (1993) Soziale Ungleichheit, Erkrankungsrisiko und Lebenserwartung: Kritik der sozialepidemiologischen Ungleichheitsforschung [Social inequality, illness risk and life expectancy: criticism of social epidemiological injustice research]. *Soz Präventivmed* 38:111–122
- Vallée J, Shareck M (2014) Re: “Examination of how neighborhood definition influences measurements of youths’ access to tobacco retailers: a methodological note on spatial misclassification”. *Am J Epidemiol* 179(5):660–661
- Voigtländer S, Berger U, Razum O (2010) The impact of regional and neighbourhood deprivation on physical health in Germany: a multilevel study. *BMC Public Health* 10:403–415
- Voigtländer S, Mielck A, Razum O (2012) Die Bedeutung des kleinräumigen Kontexts für Gesundheit: Entwurf eines Erklärungsmodells [Impact of small-area context on health: proposing a conceptual model]. *Gesundheitswesen* 74(11):702–709
- WHO (2010) Environment and health risks: a review of the influence and effects of social inequalities. http://www.euro.who.int/_data/assets/pdf_file/0003/78069/E93670.pdf. Accessed 18 Feb 2014
- Wilson JQ, Kelling GL (1982) Broken windows. *Atl Mon* 249(3):29–38
- Wilson WJ (1987) *The truly disadvantaged: The inner city, the underclass, and public policy*. University Chicago Press, Chicago