Swiss Health Space

An explorative analysis of health perception and its relationship to socio-demographic and geographic characteristics

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Summary

The purpose of this research is to uncover potential relationships that might exist between people's self-reported health, their socio-demographic backgrounds, and the place where they live in Switzerland. Numerous studies have suggested relationships between health and education, socio-economic position and income inequality. There is also increasing evidence that certain locational characteristics (e.g., residential area and neighbourhood) and people's individual characteristics may be independently related to a person's health.

Epidemiological approaches and the use of Geographical Information Systems (GIS) have become popular methods in medical geography. However, explorative (spatial) data analysis to investigate the multidimensional complexity of health has not been fully exploited yet. Applying multivariate exploratory data analysis methods, this thesis aims to reveal latent relationships within health characteristics extracted from the Swiss Health Survey (SHS). In contrast to the deductive, indicator-based health analysis methods commonly used in medical geography, this research employs an empirical and inductive perspective to health, based on health and well-being relationships extracted from individual health surveys. The following research questions are addressed:

- What kinds of health assessment are available to analyse individual health, in particular health perception in Switzerland?
- What kind of conceptual health model can be constructed to explore individual health and health perception?
- What kind of latent structures can be uncovered in Swiss health surveys?
- Do relationships exist between self-reported health characteristics?
- Do relationships exist between self-reported health, socio-demographic backgrounds, cultural differentiation, and geographical locations?

A three-step health data analysis process is proposed to answer the posed research questions:
(1) the feasibility of dimensionality reduction methods is investigated to project multivariate health datasets into a conceptual health space model,
(2) analytical and statistical methods are employed to systematically explore the patterns found in the constructed health space concept, and
(3) uncovered latent structures and relationships are interpreted based on solid theoretical foundations.

A Swiss health space model has been constructed based on a set of 16 health characteristics extracted from the Swiss Health Survey, including self-reported general health, mental health

characteristics, and recent symptoms. Categorical principal component analysis (CatPCA) was employed to systematically explore potential relationships between people's health perception and their socio-demographic backgrounds such as, age, household income, gender, and educational level. Additionally, language area types, municipality types and region types were included in the analysis as supplementary variables. Although health measures are often treated as quantitative (e.g., typically ordinal or metric), they were kept at a nominal level of measurement, in order to be able to uncover potential non-linear relationships within the constructed health space.

The Swiss Health Survey is the largest available health assessment dataset for Switzerland. I discovered two major latent structures in the constructed health space (e.g., health dimensions) in the selected multivariate database. The first dimension represents a continuum of general health and mirrors the distinction between those reporting to have good general health and those reporting having poor general health. The second dimension distinguishes mental and physical health characteristics. This may be interpreted within the scope of the body/mind dualism concept. The constructed health space model externalizes the health perception of survey respondents in Switzerland. The health space is a kind of collective internal health perception. In this two-dimensional space, 'clusters' of mental health and physical health can be detected. Other health characteristics such as health-related well-being and medication show a strong positive association with physical health in the space. Socio-demographic variables and spatial differentiation in Switzerland seem not to have strong explanatory powers.

Knowledge about latent relationships within self-reported health characteristics is relevant for research in medical geography, as well as for epidemiology and public health. Perceived health influences risk behaviour being a part of disease ecology, as well as health care utilisation.

This thesis provides a methodological foundation on how medical geographers could employ exploratory data analysis methods to systematically uncover latent relationships buried in other large self-reported health databases. The developed health space concept provides ample opportunity for further health investigations.

For example, record linkages of SHS or similar databases with general health indicators such as mortality rates or diagnosis-based indicators (e.g., based on the international classification of diseases (ICD10)), could be envisioned to reach a deeper understanding of health. Health space of different cultural backgrounds and geographical locations could be constructed and systematically compared. This could not only provide health researchers with new insights into how people's well-being might relate to their individual characteristics, but also be of

interest to medical geographers who might be interested in how individual differences in health perception might be related to societal and geographical differentiation.

Zusammenfassung

Seit einigen Jahren wird in zahlreichen Studien der Zusammenhang zwischen Gesundheit, Erziehung, sozioökonomischer Position und Einkommen untersucht und die soziale Ungleichheit für eine schlechtere Gesundheit verantwortlich gemacht (Mielck, 1998; Sturm und Gresenz, 2002; Subramanian und Kawachi, 2004; Sundquist und Johansson, 1998). Einige Forscher weisen jedoch darauf hin, dass neben diesen soziodemographischen Faktoren auch vom Individuum nicht direkt beeinflussbare kollektive Faktoren und Rahmenbedingungen eine Rolle für Gesundheit und Wohlbefinden spielen (Hart et al., 1997; Macintyre et al., 1993; Mitchell et al., 2000). Für geographische Ansätze sind gebietsgebundene Faktoren wie Charakteristika des Wohnortes und des sozialen Umfelds in der Nachbarschaft, das Vertrauen und die Interaktion mit der Gemeinschaft sowie die regionale Identität besonders Erfolg versprechend (Lochner et al., 1999; Malmström et al., 2001; Mitchell et al., 2000; Subramanian et al. 2001). Ecob und Macintyre (2000) weisen jedoch darauf hin, dass der Einfluss von gebietsgebundenen Faktoren auf das gesundheitliche Verhalten von der Art und Weise abhängt, wie die Gebiete und die Gesundheit gemessen werden. Im Gegensatz zu den erwähnten Studien folgen Gatrell et al. (2004) dem Ansatz des französischen Soziologen Bourdieu, indem sie soziale Ungleichheiten in einem zweidimensionalen sozialen Raum visualisieren und die Wohnorte sowie Morbiditätsdaten in diesen sozialen Raum projizieren. Auf diese Weise untersuchen sie in einer multiplen Korrespondenzanalyse die Relationen zwischen sozialen Faktoren, Wohnort und Gesundheit.

Das Ziel dieser Arbeit war unter Berücksichtigung soziodemographischer Aspekte und der geographischer Differenzierung die gesundheitliche Wahrnehmung der Schweizer Bevölkerung zu untersuchen. Dazu sollte geeignetes Datenmaterial gesucht und die entsprechende statistische Methodik gewählt werden. Dabei sollte der Komplexität und Relationalität der gesundheitlichen Wahrnehmung besondere Aufmerksamkeit geschenkt werden.

Folgende Forschungsfragen wurden gestellt:

1. Welche Gesundheitsmessungen und gesundheitlichen Charakteristika sind verfügbar, um die Gesundheit, insbesondere die gesundheitliche Wahrnehmung der Schweizer Bevölkerung zu messen?
2. Wie können wir mit explorativen Datenanalysen die gesundheitliche Wahrnehmung analysieren und einen konzeptionellen Gesundheitsraum konstruieren?
3. Existieren verborgene Strukturen und Beziehungen in den Gesundheitsdaten, insbesondere den Selbstangaben zur Gesundheit und wenn ja, welcher Art sind sie.

4. Kann die gesundheitlichen Wahrnehmung der befragten Schweizer Bevölkerung durch sozio-kulturelle Unterschiede und räumliche Variation erklärt werden?

Die Schweizerische Gesundheitsbefragung erschien nach gründlicher Abklärung der „Gesundheitsdatenlandschaft' (Keller-Lengen und Bopp, 2004) die geeignete Datenbasis für unsere Untersuchung zur gesundheitlichen Wahrnehmung der Schweizer Bevölkerung zu sein.

Die Korrespondenzanalyse (CA) und die kategorielle Hauptkomponentenanalyse (CatPCA) boten sich als geeignete explorative Datenanalyse an, um die multivariaten kategoriellen und kontinuierlichen Daten der Schweizerischen Gesundheitsbefragung zu analysieren. In Psychologie und Soziologie sind CA und CatPCA etablierte multivariate Datenanalysemethoden, in der Geographie werden diese Methoden noch nicht so häufig eingesetzt. Wie bei induktiven Ansätzen üblich, werden mit CA und CatPCA Relationen zwischen einzelnen Merkmalen visualisiert und statistisch charakterisiert. Der methodische Ansatz umfasst die geometrische Beschreibung des aus der Schweizerischen Gesundheitsbefragung 1997 ausgewählten Datensatzes, die Visualisierung der Dimensionen und Profile in einer symmetrischen Graphik oder „Karte' und die Interpretation der visualisierten Datenstruktur. Nach mehreren Analysen wurde mit 16 Gesundheitsvariablen, die die generelle Gesundheitswahrnehmung, mentale Charakteristika und Krankheitssymptome umfassen, der Gesundheitsraum kreiert. Die soziodemographischen Variablen (Alter, Geschlecht, Bildung und Einkommen) und gebietsgebundenen Faktoren (Sprachregionen, Gemeindetypen, MS-Regionen u.a.) wurden als passive Variablen in die CatPCA integriert, so dass sie keine Auswirkung auf die Konstruktion des Gesundheitsraumes haben. Obwohl man diese Variabeln oft als ordinal oder metrisch behandelt, wurden sie hier als nominal definiert, um potentiell nicht-lineare Relationen innerhalb des Gesundheitsraumes zu erforschen.

Die vorliegende Studie zeigt, dass der auf 16 Gesundheitsvariabeln basierende und somit eigentlich 16 Dimensionen umfassende Gesundheitsraum hauptsächlich mit zwei Dimensionen beschrieben werden kann. Die erste Dimension repräsentiert ein allgemeines Gesundheitskontinuum und spiegelt die Unterscheidung zwischen guter und schlechter Gesundheit wider. Die zweite Dimension unterscheidet zwischen physischen und mentalen Gesundheitssymptomen und kann als Kartesianischer Körper/Seele-Dualismus interpretiert werden. Es macht jedoch wenig Sinn, diese Multidimensionalität des Gesundheitsraumes auf zwei bis drei Dimensionen zu reduzieren und dieses komplexe gesundheitliche Wahrnehmungskonstrukt zu vereinfachen. Andere Gesundheitsmerkmale, wie gesundheitliches Wohlbefinden und Medikation von verschiedenen Symptomen, weisen eine starke positive Assoziation zur physischen Gesundheit auf. Für die Schweiz scheinen im

Gesundheitsraum die verschiedenen Gesundheitsmerkmale schwach mit individuellen soziodemographischen Aspekten und den gebietsgebundenen Faktoren wie Sprachregionen, Gemeindetypen und MS-Regionen korreliert zu sein.

Der Reichtum an in der Schweizerischen Gesundheitsbefragung umgesetzten Gesundheitskonzepten und die ansehnliche Stichprobengrösse erlauben auch eine künftig erweiterte Erforschung des Schweizerischen Gesundheitsraumes. Ein „Record-Linkage" der Schweizerischen Gesundheitsbefragung mit „objektiveren" Gesundheitsindikatoren wie beispielsweise Mortalitätsraten oder auf ICD10 basierenden ärztlichen Diagnosen könnte zu einem tieferen Gesundheitsverständnis führen, insbesondere auch was die Schere zwischen objektiver Gesundheit und gesundheitlichem Empfinden betrifft. Kulturelle Vergleiche des in dieser Arbeit kreierten Gesundheitsraumes könnten uns aufgrund quantitativer und qualitativer Ansätze auch neue Einsichten in unser Wohlbefinden und unsere psychologische Struktur sowie in das Beziehungskorrelat zwischen individueller und kollektiver Gesundheit ermöglichen.

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Contents

List of Figures

List of Tables

1 Introduction

1.1 Motivation

Changes in the natural and socio-cultural environment represent a challenge to societies. Economic and ecological development, as well as changes in working conditions, social relationships and life-styles affect human health and well-being. In Switzerland, the variety of languages, cultures, identities and social capital, together with their respective attitudes and 'conceptions of the world', may be expected to create regional differences in health-relevant behaviour and in well-being. Switzerland therefore provides a suitable context for analysis of the interaction between individual and collective health-related factors.

Knowledge concerning behavioural risk factors and their effects on health is based on aetiological and pathogenic approaches as well as studies of health outcome inequalities (Mielck, 1998). Recent studies show that in addition to traditional socio-economic inequality factors such as income, education and occupation, collective factors and general conditions also influence health and well-being (Kennedy et al., 1998; Macintyre et al., 1993). Socio-geographical characteristics of residence, neighbourhood, trust and interaction within the social network as well as regional identity are promising possibilities for new socio-environmental approaches in the geography of health (Lochner et al., 1999; Malmström et al., 2001; Mitchell et al., 2000; Subramanian et al., 2001).

The measurement of health is often carried out in a somewhat simplistic manner. This contrasts with a variety of more sophisticated approaches that have been employed to measure socio-economic status, such as absolute income, relative income or the income inequality hypotheses. Frequently, only one or two health-related questions have been used in health surveys to identify a person's perceived health status. A typical question that is commonly employed to assess self-reported health is 'Would you say your health in general is excellent, very good, good, fair, or poor?' (Kennedy et al., 1998; Subramanian and Kawachi, 2003; Sundquist and Johansson, 1997b). Other common quantitative measures are the body mass index (BMI) (Sundquist and Johansson, 1998), or mortality related indicators related to person-years at risk (Sundquist and Johansson, 1997a, 1997b). A consistently found argument for using one single question regarding self-reported general health is that this simple measure has strong predictive validity for mortality, independent of other physiological, behavioural, and psychosocial risk factors (Idler and Benyamini, 1997; Sundquist and Johansson, 1997b). Critics have pointed out that a single variable cannot measure health adequately (Macintyre et al., 2003; Subramanian and Kawachi, 2004).

The World Health Organization conceptualizes the complex phenomenon of health as 'a state of complete physical, mental and social well-being'. This definition has been a guiding theme for subsequent health assessments (Bergner, 1985; Ware, 1995). Several empirical studies have investigated the association between physical and mental health (Cella et al., 2005; Hays & Stewart, 1990; Ware, 1995). Hays and Stewart (1990) concluded that self-reports of physical and mental health not only need to be differentiated, but that both constructs also need to be represented separately for a comprehensive assessment of health status.

Health inequality researchers (e.g., Williams, 1995) have discovered the utility of associating health with the lifestyle choices proposed by (Bourdieu, 1979, 1984). 'It is the [class-related] habitus which, through taste and the bodily dispositions it engenders within particular social fields, together with the volume and composition of capital, determine not only lifestyles and the chances of success in the symbolic struggles for social distinction, but also class-related inequalities in health and illness' (Williams, 1995, p. 579). Similarly, Gatrell et al. (2004) investigated the determinants of health inequalities in social space guided by an Bourdieuan (1984) social space perspective. Inspired by Boudieu's social space concept, Gatrell et al. (2004) associated geographic locations of survey respondents with their location in social space, as a means of visualising the association between socio-demographic space and geographical space. To achieve this they employed correspondence analysis, a multivariate data reduction technique Bourdieu (1979, 1984) had also utilized to analyse 'the structure of the social space'. Bourdieu argued for this form of exploratory analysis technique over multivariate regression, 'because correspondence analysis is a relational technique of data analysis whose philosophy corresponds exactly to what, in my view, the reality of the social world is. It is a technique which thinks in terms of relation, as I try to do precisely with the notion of field' (Bourdieu & Wacquant, 1992, p. 96).

In the last century, numerous epidemiologists and medical geographers investigated the potential relationships between health, the physical environment and the social environment by using aggregated datasets and global health indicators, including individual level datasets. Due to a typically data-poor research environment, medical geographers have typically employed deductive approaches, guided by established theoretical constructs, and testing hypotheses on collected data with inferential statistical methods. On the other hand, exploratory data analysis has become useful in data abundant situations, when testable hypotheses need to be found buried in large databases. Graphical techniques are utilized to gain insights into large data sets such that patterns in the data become apparent. On discovering relationships, the analyst then considers possible hypotheses that may explain such patterns, guided by various theoretical perspectives.

Due to the complexity of the investigated health phenomena, represented in multivariate databases that have been collected in recent years this investigation has adopted an explorative data analysis (EDA) approach. During the past five years the term 'complexity' has emerged in contemporary social science. Urry (2003) refers to complexity as 'a potential new paradigm for the social sciences, having transformed much of the physical and biological sciences' (Urry, 2003, p. 12). In his critical assessment about complexity theory (CT) and geographies of health, Gatrell (2005) considers 'the philosophical underpinnings of CT as an anti-positivist perspective, and its reliance on metaphor' (Gatrell, 2005, p. 2662). Four key aspects of CT are relations and network, non-linearity, emergence and hybrids.

1.2 Objectives

Using a large Swiss health survey (SHS), the principal aim of this study is to systematically investigate, and reveal potential relationships that may exist between people's individual health perception, their socio-demographic backgrounds and their geographic location. Secondly, employing an inductive, exploratory data analysis approach postulated by Tukey (1977) this study aims to provide a new conceptual and methodological perspective for the geography of health field. Based on Bourdieu's social space theory, individual health perception is modelled as a multidimensional health space. In this health space, model health and quality of life related aspects including socio-economic variables and geographical differentiation can be systematically explored with multivariate statistical methods. The space model is constructed with data from the 1997 Swiss Health Survey, employing various data reduction techniques. Special attention is given to potential geographical effects that might influence health perception.

1.2.1 Research questions

The following research questions are guiding the exploratory data analysis endeavour. The first five questions are related to the first objective, the last question to the second objective.

- *What kinds of health assessments are available to analyse individual health, in particular health perception in Switzerland?*
- *What kind of conceptual health model can be constructed to explore individual health and health perception?*
- *What kind of latent structures can be uncovered in Swiss health survey?*
- *Do relationships exist between self-reported health characteristics?*
- *Do relationships exist between self-reported health, socio-demographic backgrounds, cultural differentiation, and geographical locations?*

1.3 Structure of the thesis

Four papers published in peer-reviewed conference proceedings and academic journals form the basis for this paper-based dissertation. The four publications are as follows:

1. Keller-Lengen, Ch. (2005). Regionale Muster im gesundheitlichen Wohlbefinden der Schweizer Bevölkerung. Geographica Helvetica, 60, 97-104.
2. Keller-Lengen, Ch. (2005). Space of health-related well-being. In Fleuret, S.: Espace, Bien-Être et qualité de vie. Actes du Colloque EQBE 'Peut-on prétendre à des Espaces de Qualité et de Bien-Être?' Colloque international, Angers (France) les 23 et 24 septembre 2004. Presses Universitaires d'Angers, 287-296.
3. Keller-Lengen, Ch. and Blasius, J. (submitted). Constructing a space of mental and physical health. Social Science & Medicine.
4. Keller-Lengen, Ch., Blasius, J., Kistemann, Th. (submitted). Visualising areas in the Swiss health space. Health & Place.

The present manuscript is divided into two parts including a synopsis of the thesis and subsequent publications. The synopsis starts with an introductory chapter 1 *'Introduction'* outlining the motivation, objectives and research questions.

Chapter 2 *'Towards geography of health'* summarises briefly the history of medical geography and the state of the art of geography of health, illustrating the diversity of concepts, approaches and methods. Medical geography/geography of health is not well developed in Switzerland. This chapter has been enlarged to give a Swiss research synopsis.

Chapter 3 *'Investigating differences and influences on health'* presents the state of the art for concepts of health and social environment as well as place effects on health.

Chapter 4 '*Concepts of space*' intends to introduce the reader to geographical concepts, which are of increasing importance for psychological and geographical health research. Bourdieu's social space and other space concepts are a basis for this concept of health perception space.

Chapter 5 '*Data*' gives an overview of the Swiss health datasets and a brief description of the creation of record linkage used for answering geographical questions. These findings are published in the first report of the newly established Swiss Network of public health ('network_public_health') and apply to the first research question.

In Chapter 6 *'Methods'* the question of constructing a conceptual health model applying explorative data analysis will be considered. In the introduction, principle considerations are outlined considering conceptual space and explorative data analysis. Correspondence analysis and categorical principal component analysis are demonstrated.

Chapter 7 *'Constructing a health space'* represents a synopsis of the four papers including the various incremental research stages of the thesis. The four papers reply to the questions, 'what kinds of latent structures can be uncovered within Swiss health survey', 'whether relationships exist amongst self-reported health characteristics', and 'whether relationships exist between self-reported health, socio-demographic backgrounds, cultural differentiation, and geographical locations'.

In Chapter 8 '*Discussion*' the findings will be discussed with respect to recent well-established geography of health concepts, methods and findings.

Chapter 9 *'Conclusions'* summarizes the main findings of this research. The proposed health space model is set in the context of geography of health. Finally, in an outlook, perspectives towards more holistic research avenues are provided, going beyond current medical geography and health related research approaches. The publication part comprises the four papers mentioned above.

1.4 Relevance of the thesis

Knowledge about latent relationships within self-reported health characteristics is relevant for research in medical geography including disease ecology and geography of medical care (Mayer, 1984), as well as for epidemiology and public health. On the one hand, perceived health influences the risk behaviour of individuals. Risk behaviour, however has a huge impact upon the importance of specific risk factors for the prevalence and ecology of health, health disturbances and diseases. On the other hand, perceived health influences the tendency of individuals to seek health care. Therefore, health perception has to be considered as an important component of the health care system and health system research.

2 Towards a geography of health

2.1 Hygiene, public health, epidemiology and medical geography

Since antiquity, an individual's health has been understood in the context of the environment and environmental influences on health. In curative and preventive medicine we followed the classical tradition of healing, in Greek culture symbolized as 'Ασκλεπιοσ' (Asklepios), God of cure and 'Υγιεια' (Hygieia), goddess of prevention. 'Υγιεια' was determined by an understanding of health care as an individual and collective approach. Over centuries 'public health' has given special attention to the hygiene of the physical environment, e.g. water, soil and air, as well as the fight against infectious diseases. Health problems have rapidly changed in the context of the accelerating epidemiologic transmission since the middle of the 19th century. Nowadays *Public Health* covers the totality of problems and measures concerning the health of a population including all preventive, curative and rehabilitative efforts (Gutzwiller and Jeanneret, 1999). The Oxford Textbook of Public Health (Holland et al., 1991) defined 'Public Health' as being 'is concerned with defining the problems facing communities in the prevention of illness and thus studies of disease aetiology and promotion of health. It covers the investigation, promotion and evaluation of optimal health services to communities and is concerned with the wider aspects of health within the general context of health and the environment' (Gutzwiller and Jeanneret, 1999, p. 25). More briefly: 'Public Health is the process of mobilizing local, state, national and international resources to solve the major health problems affecting communities' (Detels & Breslow, 1991; Gutzwiller and Jeanneret, p. 25). Detels and Breslow's definition emphasizes the process and ecologic thinking in Public Health. Public Health has become oriented towards the important epidemiologic approaches. Corresponding concepts are the potential years of life lost (PYLL), the disability adjusted life years (DALY) and standardized mortality rates (SMR) (Bisig and Paccaud, 1999).

Epidemiology (Greek: 'επι' on, in, at, into, 'δεμοσ' population, and 'λογοσ' reason, theory, teachings) is defined as the investigation of distributions and determinants of health conditions and health incidents in a defined population group and the resulting application for controlling health problems (Last, 2001). For Abelin et al. (1999) this definition shows two methodical functions of epidemiology: investigation of distribution as the descriptive part and the determinants of health as the analytical part of epidemiology. An overview of epidemiologic work content provides the classical scheme of influence factors on health such

as natural environment, behaviour, human biology and health care (Fig. 1). Shortly stated, the epidemiologists ask 'who?', 'what?', 'where?', 'when?'. Descriptive epidemiology focuses on the description of a population's health status. With statistical approaches for collectives (countries, provinces, regions, communities) disease occurrence is analysed in dependence of place and time as well as the characteristics of the persons concerned. Frequencies of new illness cases over time (epidemic curve) and maps of geographic case distributions as well as incidence comparisons by gender, age groups and socio-economic status represent descriptive epidemiologic studies (Abelin et al., 1999).

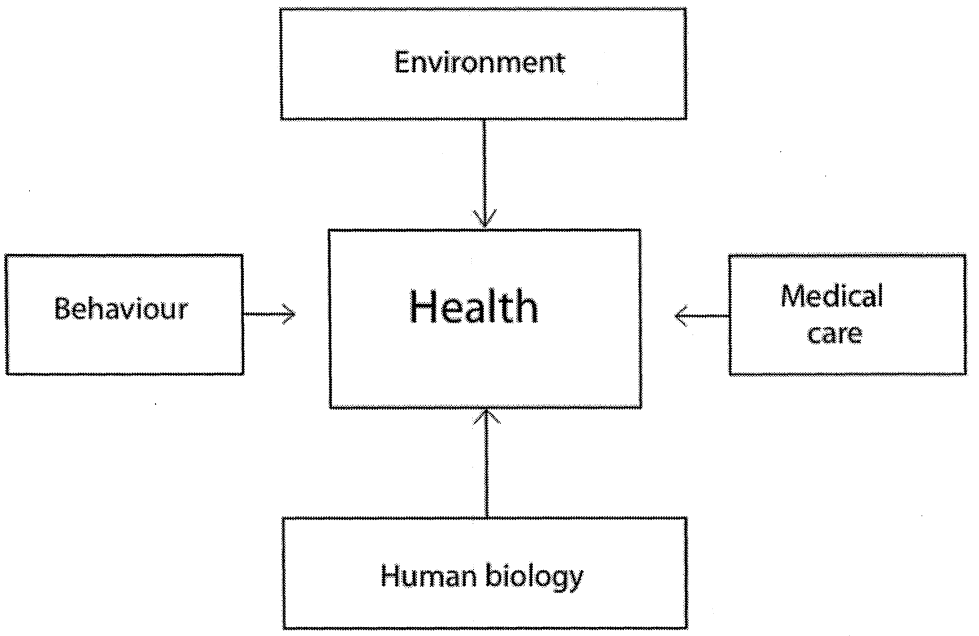

Figure 1: Influences on health, the field of epidemiology

For analytical epidemiology different classical study designs exist. It is necessary to distinguish between experimental studies (e.g. random controlled studies and clinical random double-blind studies) and non-experimental investigations (case-control-studies and cohort studies). Analytical study design deals with causal relationships concerning random, bias, and possible confounding (Abelin et al., 1999). Geographical epidemiology also focused on mortality, or on morbidity and its causes. Adjustments for age structure yielded so-called Standardized Mortality Ratios (SMR), allowing for comparisons between populations that have differing age compositions. Other important indices are the incidence rate; the number of new cases occurring within a given time interval, expressed as a proportion of the number

of people at risk from the disease, as well as the prevalence, the number of people with the disease or illness at any point in time.

In the context of public health and epidemiology, *medical geography* emphasises place and time questions related to health. It describes spatial patterns of health and disease and aims at explaining these spatial patterns by concentrating on the underlying processes that generate identifiable spatial forms (Mayer, 1984). With geographical approaches and methods, it is predominantly geographers who investigate associations between health and place/time and their causal relationships.

2.2 Development and history of medical geography

In classical antiquity, the famous physician Hippocrates (460-377BC) studied medical phenomena and environmental impacts on health. In his work 'On air, waters, and places' he investigated the influence of the environment on health. His empirical approach established one important tradition of medical geography – the 'disease ecology' approach, which is concerned with the myriad of interactions between environment, culture, and disease (Mayer, 1984).

Along with the reintroduction of classical literature into medicine and the 'neo-Hippocratic' refocusing since the 18th century, the notion that place is an important health variable led to the resurgence of geographical concepts in medical thought in Europe, especially in Germany. Ludwig Finke's work and August Hirsch's *Handbook of Historical and Geographical Pathology* (1859-1864) (Barrett, 2000a) are good examples of this. Finke established scientific medical geography as part of regional geography. In his essay on a general medico-practical geography (1792-1795) he outlined the objectives of this discipline as being: to describe the features of a country and the modes of life of its inhabitants as effecting the population's health and diseases as well as prevention and cure. Hirsch's work contained an extensive description of all the diseases then known in the world.

Since 1850 medical geography established also in North America, has remained much more important than that in Continental Europe. A milestone was Drake's (1850) work 'A systematic treatise, historical, etiological, and practical on the principal diseases of the interior valley of North America, as they appear in the Caucasian, African, Indian and Esquimaux varieties of its population' (Barrett, 1996). In contrast to Finke, Drake investigated only one region and travelled extensively in this region to collect his observations. He organized his work in four parts: (i) the topographic and hydrographic aetiology, (ii) the climatic aetiology, (iii) the physiological and social aetiology and (iv) several diseases.

In Germany, after a setback in the second half of the 19th century, medical geography enjoyed a revival when the worsened hygiene conditions of the First World War fuelled numerous epidemics, which were hard to control despite the bacteriological knowledge of the relevant pathogens and routes of infection (Rodenwaldt & Zeiss, 1918). The interdependence of the geographical environment, natural focus and epidemic spread was first realised by Ernst Rodenwaldt while he was doing field research on malaria in Turkey during World War I (Jusatz, 1972). Following on from the politically inspired term of ' geopolicy', in Germany the term 'geomedicine' was created to which medical geography, being a descriptive collection of material, was to be subordinated (Rimpau, 1934). This terminology was maintained in Germany until the 1990s, but was rarely adopted in the international literature (Barrett, 2000a; Kistemann, Leisch, and Schweikart, 1997). German post-war geomedicine was decisively influenced by medical hygienists and was regularly considered in German textbooks of Hygiene (Jusatz, 1964, 1969; Rodenwaldt and Bader, 1951).

Reflecting international developments of medical geography, Learmonth (1978) asked whether there are two medical geographies – disease ecology and health service research. In 1979, Pyle gave an overview about medical geography in his work 'Applied Medical Geography'. He showed the essentials of medical geography, giving an insight into disease classification, measurement systems as well as meaning and method in disease mapping. He discussed elements of disease ecology and geographical applications in planning for improved health care delivery. In studies of disease diffusion he addressed geographic epidemiology, public health and health care planning as well as geographic contributions to the analysis of disease diffusion. Finally, Pyle (1979) gave an introduction to applications of geocoding systems in medical geography.

Mayer (1984) remarked, that 'in the United States, medical geography is one of the least known of the medically related social sciences. Medical geography is concerned with the analysis of spatial patterns of disease and medical care provision' (Mayer, 1984, p. 2680). According to Pyle, Mayer noted that since World War II, medical geography has developed mainly in four areas: first, the analysis of spatial patterns of disease, using techniques and concepts of theoretical geography and geostatistics; second, refinements in disease mapping, including the use of computer-generated maps and automated spatial data representation; third, developments in studying the ecology of disease, using concepts of system analysis to understand the reasons why patterns of disease develop within environmental contexts, and fourth, the application of geographic concepts to health planning and administration.
For Mayer (1990) modern medical geography is an interdisciplinary research branch of geographical science with specifically medical topics. According to Bentham et al. (1991)

medical geography increasingly opens up to the influence of adjacent disciplines. The object of the research is the quality of space as an integral component of processes affecting the health of human beings (Earickson, 2000a). By transferring the extended meaning of landscape from new cultural geography into medical geography, the conception of therapeutic landscapes was established (Gesler, 1992). The model of epidemiological transition (Omran, 1971), describing the correlation between disease patterns and social, economic, ecological and demographic change (Phillips, 1994), was of basic significance to the development of medical geography ten years ago. The same is expected of the concept of political disease ecology being a new focus of medical geography, since it is committed to a more comprehensive and systemic understanding of health and disease (Mayer, 1996). The promotion of more equality in housing and working conditions, health and health care is one of the major tasks of applied medical geography (Earickson, 2000b). Kearns' conception of a post-medical Geography of Health (Kearns, 1993) as a component of social geography, strongly oriented towards social theory was, however, criticised as being narrow and exclusive (Mayer and Meade, 1994). Within the framework of global change research, topics such as climate change, natural disasters, urbanisation, globalisation and armed conflicts are of top priority to medical geography or geography of health (Krafft et al., 2002).

2.3 From 'medical geography' to 'geography of health'

Mayer (1984) defines medical geography as a 'discipline that describes spatial patterns of health and disease and explains those spatial patterns by concentrating on the underlying processes that generate identifiable spatial forms' (Mayer, 1984, p. 2680). Using techniques of simulation and mathematical models of disease spread, geographical patterns of infectious diseases, as well as non-communicable diseases, such as heart disease, cancer and multiple sclerosis, have been analysed. In the last two decades, geographical information systems were established as a major tool in the positivistic approach to medical geography.

Throughout the last five years the term 'medical geography' has gradually been replaced by 'geography of health'. Gatrell (2002) pointed out that for everybody 'health is something we all have, or have had' (Gatrell, 2002, p. 3). The term 'medical' implies a process of diagnosis and therapy. Thinking in this terminology focuses upon pathogenesis, clinical symptoms, diagnosis, health care and to a lesser extent on risk behaviour concerning the aetiology of diseases. Epidemiological studies, mapping of disease distribution and identifying international variations of disease incidence and prevalence, as well as mortality and morbidity reflect the aetiological approach to medical thinking. Geographical patterns of

disease and medical care have been a major focus of medical geography, which has been rapidly developed since World War II. During recent years, medical geography opened up to concepts of sociology and public health. Self-reported health is a very important aspect in current studies of quality of life. Each of us has more or less conscious or unconscious feelings of being well or unwell concerning health. It is possible to describe and estimate individuals' feelings and there are many strategies to deal with health-related well-being. Understanding health as a continuum of health and illness, also postulated by Antonovsky (1997) in his salutogenetic concept, and including various concepts of sociology, psychology, socio-psychology and new public health, the term 'health' much better reflects the work of contemporary 'medical' geography. At the same time, while we have our health feelings and estimations, we exist in homes, schools, workplaces, leisure and other places on the earth's surface and reachable outer space. Moving from place to place gives us our own history of geographies. As Gatrell (2002) remarks, each person has his own geographies as well as his biographies. The individual's health and these personal geographies are deeply linked within us. Geography of health contains this understanding of individual health and geographies. In this thesis, the term 'medical geography' describing historical research of geography concerning medicine and/or health will be used. For current investigations with new concepts, approaches and methods, the term 'geography of health' will be applied.

2.4 Approaches to geography of health

The way in which health varies geographically has often been described by statistical description methods or map visualisation in geographic information systems (GIS). 'None was satisfied with description alone… rather, each was concerned also with explanation of some sort' (Gatrell, 2002, p. 25). Gatrell's (2002) intention to give an overview of explaining geographies of health signals the need for a theoretical framework within geography of health. Gatrell (2002) distinguished between positivist, social interactionist, structuralist, structurationist and post-structuralist approaches.

2.4.1 Positivist approaches

Until quite recently the investigations of medical geographers began with a map of incidence rates. Based on maps as visual representations of medically defined disease characteristics, the following types of questions were asked: 'Are the spatial distribution of rates and variables random or not?'; 'does an explanation exist for apparent clusters in parts of the study area?' Such questions, ultimately of cause and effect (Gould and Wallace, 1994), are tested statistically by setting up a series of formal models designed to test hypotheses and account for variability in incidence (Gatrell, 2002). In health and disease studies as well as in

health care studies, the key geographic variables are location and distance. As in natural science and in analytical epidemiology, such study design represents aspects of positivistic or naturalistic approaches. The search for 'causes' or 'aetiological' factors is mostly utopistic, usually at best only a strong association can be established. Due to the so-called 'ecological fallacy' (Robinson, 1950; Selvin, 1958) the use of a cause related question is not expedient, when investigating for example the association between disease incidence and social variables on an aggregated level. The positivist approach is strongly related to a mechanistic world view. In the reductionist biomedical perspective the body is understood as a machine, which is defined by a set of characteristics. The individual is reduced to a collection of body components, behaviours, lifestyles and social aspects. Health is reduced to rates, incidences and prevalences. In the positivist approach, health is observable, measurable and general conclusions can be drawn relating to it.

2.4.2 Social interactionist or social constructionist approaches

In contrast to the positivists, who investigate recorded individual characteristics, social interactionists consider individual meaning. In contrast to positivist, who ask for example after numbers of beds and numbers of health workers in a health care planning context, other researchers emphasize the subjective experience of health and illness. The social constructionists postulate that 'meanings are constructed out of the interactions' and neglect wider structural influences on health (Gatrell, 2002). By moving away from the dominance of bio-medical based large-scale research' (Sparks et al., 1994), social interactionists focus on qualitative methods and investigate small samples.

2.4.3 Structuralist approaches

In structuralist approaches, the underlying causes of disease are seen to be embedded in political and economic systems. Sickness does not lie in the body, but in the body politic (Turshen, 1984). Rather than at the individual level, it is the broader social context that matters (Gatrell, 2002). Due to the stress on these macro-scale social, political, and economic structures, this style of approach is often referred to as structuralist or political economy perspective. These approaches are influenced by Marxist theories of oppression, domination and class conflict as well as human intention and freewill.

2.4.4 Structurationist approaches

Structuration theory, established by the British social theorist Anthony Giddens, has until now had little impact on the geography of health. However some studies have made use of it – for example a study on the life of women with multiple sclerosis in Vancouver (Dyck, 1995) and thus may be mentioned in this brief review. Structurationism recognizes the duality of structure and agency. Structures shape social practices and actions, but in turn such practices

and actions can create and recreate social structures. Human agency and social structures, both also shape health behaviour.

2.4.5 Post-structuralist approaches

More recently, some geographers, in common with other social scientists and health researchers, have been engaged with other theoretical developments, which may be labelled post-structuralist. They are concerned with the way, that knowledge and experience are constructed in the context of power relation. Work on health risk, on representation of the body and of social groups and on what it means to be a 'healthy citizen', signal post-structionalist impacts on public health and geography of health.

2.5 Methods of geography of health

Gatrell (2002) gives an overview about methods and techniques in the geography of health by specifying two approaches, firstly, 'mapping the geography of health' with quantitative approaches, and secondly, 'interpreting the geography of health' with qualitative approaches. According to Gatrell (2002) quantitative spatial data analysis typically involves one or more of the following three tasks: visualisation, exploratory spatial data analysis and statistical modelling.

2.5.1 Visualisation

Mapping geography of health data helps to see any spatial patterning or visual evidence of associations between health and social or environmental factors. By spatial referencing of health data sets, e.g. postal codes or community identifiers, we can link aggregated individuals to a set of areal units and draw maps concerning comparison of health-related units. Medical geographers 'rarely map observed counts of case by area, since these too would simply reflect population distribution or the age structure of that population' (Gatrell, 2002, p. 51). When mapping crude rates (e.g. number of cases of cancer or heart disease per 10'000 resident people) the age structure of the population has to be considered. Patterns of disease and death are related to the age and gender structure of a population. Mortality rates are standardized by age-group where, for each areal unit, we predict or 'expect' a particular number of deaths, based on the distribution of the population by age in that area and the age-specific rates of death or disease in some wider 'standard' population (Gatrell 2002). Obviously, in medical mapping applications, the basic rules of cartography have to be used (compare Bertin, 1974 and Monmomier, 1991). For medical geography Schweikart and Kistemann (2004) emphasize the importance of using correct colour-pattern variables, which are directly related to the data characteristics. User's spontaneous association of health-related variables with colours, shadow, patterns and forms are discussed in Grosser (2001). In the

adequate numbers of classes and class intervals and of the colour and shading schemes that should be used in choropleth mapping, Cliff and Haggett (1988) and Monmomier (1996) were instrumental in discussing how to read or perceive a map. Area and population size give difficulties due to over-interpretation of large, often less populated rural areas. One solution to symbolize these visually over crowded areas is to use cartograms or isodemographic maps, which transform the areal units according to the population at risk (Dorling, 1995). In his 'Social Atlas of Britain', Dorling (1995) showed numerous maps of health outcomes as cartograms. In the last ten years geographic information systems are increasingly used as visualisation tools. For geographers, public health practitioners, epidemiologists, and community members Cromley and McLafferty (2002) has written the book 'GIS and Public Health'. They give an overview how to applying GIS to the study of human health problems by proposing ideas of representing geographical information such as representing point information with point symbol maps, representing area data with dot density maps and choropleth maps. They discuss also the modifiable area unit problem and give ideas about viewing health attributes in GIS. Viewing and analysing geographical associations by procedures of spatial queries static and dynamic health-related maps are other themes in their publication. The potential of maps for interactive data analysis leads us into data exploration or exploratory visualisation.

2.5.2 Exploratory spatial data analysis

In medical geography exploratory data analysis mainly appears in context of spatial problems. When mapping health data for a set of areal units, Gatrell (2002) points out two important problems - the modifiable areal unit problem (MAUP) and the small number problem. The modifiable areal unit problem, first identified and examined by Openshaw (1984), is of major importance. Analysing how for example health point data are distributed by area, he illustrated that very different results of point distribution and association may be obtained depending upon how the areal units are configured. A configuration based on administrative units, such as the cantons in Switzerland, will give different estimates of disease incidence, e.g. the occurrence of asthma, than one based on different zones or ones that display 'bands' of distance from a possible source of air pollution. In this sense the areal units are 'modifiable' (Gatrell, 2002).

The small number problem is related to scale. As the areal units become larger the number of cases could contribute to a growing number. Mapping and analysing for example standardized mortality ratio (SMR) data for well-populated area units, a considerable degree of confidence can be put at the estimation of the SMR's. This is more than would be the case at a fine spatial scale with very small counts. Possible solutions are (i) to extend the data collection period, (ii) to work at the coarser scale, (iii) to place confidence intervals around the estimate

of the SMR, (iv) to use probability mapping using Poisson distribution or shrinkage (empirical Bayes estimators) of disease risk to calculate the probabilities (Gatrell, 2002; Kistemann, Dangendorf and Schweikart, 2002).

In interpretation of a constructed map, it is of interest whether areas of high incidence 'cluster' together, or whether the spatial patterns of disease rates are randomly distributed. Here, the fundamental geographic concept of spatial autocorrelation is addressed. 'We speak of positive autocorrelation where similar values tend to occupy adjacent locations on the map, and negative autocorrelation where high values tend to be located next to low ones' (Bailey and Gatrell, 1995). Statistical kernel function is used for a spatial point pattern analysis to investigate whether cases are clustered. Population distribution has to be taken into consideration (Bailey and Gatrell, 1995).

2.5.3 Statistical modelling

In medical geography and geographical epidemiology, a standard statistical tool for modelling health and area data is regression analysis. This seeks to account for variation in a dependent variable such as disease incidence in terms of chosen covariates. Most data is aggregated. The need to analyse both places and individuals led Jones and Duncan (1995) to use multi-level modelling for analysing variation in respiratory health. Multi-level modelling is a favoured method to distinguish between compositional and contextual effects (Gatrell, 2002, p. 69) as well as to model simultaneously individuals and their ecologies. Other statistical methods often used in quantitative health research, e.g. epidemiology, are case control methodology, where data for individuals are used to examine the influence of one or more 'risk factors', while adjusting or 'controlling' for the influence of other variables. If data are not spatial auto-correlated, logistic regression is also appropriate. The regression coefficients may be converted into odds ratios that reveal the 'odds' of disease or illness, given the particular value of an explanatory variable or covariate.

2.6 Swiss geography of health

During the last twenty years Anglo-Saxon countries such as the UK, USA, Canada and New Zealand have dominating the international medical geography research. Every two years since 1984 an international medical geography symposium has highlighted recent developments of medical geography presenting the newest ideas and research questions. In recent years European countries such as Portugal, France, Italy, Germany, Belgium, Norway and Sweden, as well as Russia, India and China have increasingly participated in the international discussion and conferences. The medical geography history of these countries will not be

discussed here, but rather the focus will be on developments and current activities in the field of medical geography/geography of health in Switzerland.

While Germany and France have a long and rich research tradition in medical geography, based on the cooperation of geographers and physicians (hygienists, epidemiologists, parasitologists and tropical physicians), Switzerland lacks such a tradition. Selectively some medical geography findings have been published by Swiss departments of geography, e.g. of the universities of Geneva, Berne and Zurich, and of Swiss departments of social and preventive medicine in the universities of Basel and Zurich. The Swiss Health Survey reports of the Swiss Federal Statistical Office also detail some aspects of geography of health. However, an awareness of geography of health hardly exists, and publications in the context of medical geography have been very rare.

In accordance with the publications of Pyle (1979), Mayer (1984) and Gatrell (2002), who discussed the development and research fields of medical geography and showed the important approaches of geographies of health, important Swiss studies in this research field will be reviewed. According to Mayer (1984), 'Swiss medical geography' literature can be divided into two methodical elements, (i) spatial analysis of diseases and (ii) disease mapping, as well as into two subject sections (iii) geography of medical care and (iv) disease ecology.

Ad (i): Spatial analysis of diseases may be identified by the use of formal statistical and mathematical techniques. Describing geographical patterns of disease, Swiss studies addressed the question that concerns the identifiable locational patterns of disease, at different scales. A medico-historical study analysed the spatial and temporal distribution of plague in a region of Switzerland in the years 1628 – 1629 (Eckert, 1982). Bissig and Paccaud (1987) investigated geographical distributions of the most important causes of death. Large studies of mortality changes in Switzerland since 1950 and investigations of regional mortality differences within Switzerland were done by Bopp (1997) and Bopp and Gutzwiller (1999). Cantonal mortality disparities during the period 1978/83 – 1988/93 were analysed by age and cause of death (Wanner et al., 1997). An important work in the mortality research field is Schüler and Bopp's (1997) 'Atlas of cancer mortality in Switzerland from 1970 to 1990'. Regional pattern analysis and inter country comparisons are common. With data from mortality registries linked with population census data, Huisman et al. (2004) investigated socioeconomic inequalities in mortality among elderly people in eleven European populations: Finland, Norway, Denmark, England and Wales, Belgium, France, Austria, Switzerland, Barcelona, Madrid and Turin.

Ad (ii): Disease mapping has been used in Schüler's and Bopp's cancer mortality atlas as well as in a medical care study by Klauss et al. (2005), who created hospital service areas as a new

tool for health care planning in Switzerland. Their results were visualised as maps in a geographical information system. The Swiss Federal Statistical Office frequently reports on regional health differences as derived from the Swiss Health Survey data (Koller, 1998; Koller, 2000) using GIS mapping tools for visualising for example the regional distribution of health-related well-being; alcohol consumption per day and person; percentage of smokers in each region; doctors visits during the last 12 months and hospital days per person during the last 12 months.

Ad (iii): Since 1997, the Swiss Federal Statistical Office has administered and managed statistics of hospitals and since 1998 medical statistics of hospitals aggregated to 605 residential regions, forming a valuable instrument for health planning and administration. Based upon federal hospital discharge data, Klauss et al. (2005) developed 100 hospital service areas, which are intended to study variation phenomena in Swiss health care. Swiss health insurance companies are also very interested in geographical aspects of medical care. However, in Switzerland no research in the geography of medical care has been conducted. This does not mean that the use of geographic information systems (GIS) in medical care does not exist! For emergency services, GIS is well known and often used.

Ad (iv): 'Disease ecology is concerned with the myriad of interactions between environment, culture, and disease' (Mayer, 1984, p. 2682). We do not understand the distribution of a disease without information about its relationship to local and regional ecologies – the interactions between topography, climate, water, soils, plants, and animals and, according to the new public health perception of the environment as social and psychological, the interactions also between physical environment, society and individual psyche. Such approaches also exist in Switzerland. Both large and longitudinal datasets have been used, as well as survey data. Large datasets supported the following studies:

- a study of socioeconomic inequalities measured in terms of education and housing tenure among elderly people in 11 European populations (Huisman et al., 2004) and
- a study of socioeconomic status and ischaemic heart disease mortality in 10 western European populations during the 1990s (Avendano et al., 2005) were based on data from mortality registers linked with population census data of 11 countries and regions of Europe including Switzerland.
- a mortality study, which showed for the first time mortality differentials by level of education for Swiss men and women was based on a longitudinal dataset from the Swiss national Cohort, incorporating a probabilistic record linkage of the 1990 Swiss census, and all subsequent deaths until the end of 1997 (Bopp and Minder, 2003).

In addition to the Swiss Household Panel, which records health datasets (Zimmermann and Burton-Jeangros, 2004), the Swiss Health Survey (SHS) is important in this respect. SHS started in 1992/93 and since then has been carried out every five years. Based on aggregated SHS1992/93, SHS1997, SHS2003 data, the following outputs of the Swiss Health Survey have had a geographical dimension:

- a study of social inequalities and health in the Canton Zurich (Bisig and Gutzwiller, 1999),
- reports of regional health differences for SHS1992/93 and SHS1997 (Koller, 1998; Koller, 2000),
- a study of geographical disparities in self-reported use of mammography and breast self-exanimation according to the Swiss Health Survey (Wanner et al., 2001), and
- a regional pattern study of health-related well-being investigated for the Swiss population (Keller-Lengen, 2005a).

Other studies mainly emphasized quantitative geography of health approaches for health and social environment:

- the Berne-Munich Lifestyle Panel studied health relevant lifestyles among some 2000 adults in Switzerland and Germany based on sociological theory with emphasis on population structures and dynamics of health lifestyles (Abel et al., 1999),
- a comparative European study concerning Belgium, Finland, Germany (eastern and western part separately), Netherlands, Spain and Switzerland, which consider self reported physical activity, public health, and perceived environment (Rütten et al., 2001)
- a study aiming at mapping adolescent health and lifestyles in a multi-state country; Switzerland has been divided into 14 subunits and weighted sub-samples according to age, sex, and professional background (Renaud et al., 2001),
- a study about breast cancer prevention behaviour: a perspective of women from three language regions of Switzerland included 1721 women interviewed by a postal survey questionnaire (Glaus et al., 2004)

The following studies emphasized the physical environment:

- the Swiss Study on Air Pollution and Lung Diseases in Adults (SAPALDIA) (Wüthrich, Schindler, Leuenberger, Ackermann-Liebrich, and SAPALDIA-Team, 1995), investigating, inter alia, the association between lung function and estimated average exposure to NO2, PM10, PM2.5 and Ozone in eight areas of Switzerland (Schindler et al., 1998), and comparing air pollution, climate and pollen in urban, rural and alpine regions in Switzerland, respectively (Monn et al., 1999),

- the multi-centre exposure study in Europe (EXPOLIS), which focused on the European adult urban populations and their exposures to nitrogen dioxide in relation to residential indoor, outdoor and workplace concentrations in Helsinki, Basel and Prague (Kousa et al., 2001),
- the Swiss study on Childhood Allergy and Respiratory symptoms with respect to air Pollution, climate and Pollen (SCARPOL), which investigated the prevalence of hayfever and allergic sensitization in farmers' children and their peers living in the same rural community (Braun-Fahrländer et al., 1995).

A few qualitative approaches exist in the francophone part of Switzerland- represented by the working group of Bailly, at the University of Geneva. This group works with the International Society on System Science in Health Care (ISSSHC) and aims at promoting and developing research in system science with a focus towards improving knowledge and management of health care systems. In this context, Fournand (2005) investigated landscapes of birth and well-being in Geneva on three levels of comprehension: the physical environment which gives women the material reality; the social environment, which gives women the position and relationship within the social network, and the symbolic signification of the environment, which gives women the ideal dimension of reality.

To summarize, in Switzerland medical geography as a part of geography as a whole barely exists in research work and teaching. In Swiss research, methodical elements of medical geography (spatial analysis of diseases and disease mapping), as well as subject sections (geography of medical care and disease ecology) are represented. The mentioned studies mainly use a positivistic approach and are based on epidemiologic study designs. 'Geographical epidemiology' is common and focused on mortality, its causes and morbidity. Most studies are positioned in the research field of social and preventive medicine. However, complex geographical approaches and methods are rarely used. An awareness of medical geography / geography of health unfortunately does not exist.

3 Investigating differences and influences on health

3.1 Health assessments

Since 1948, the World Health Organisation (WHO) has defined health as a 'state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity' (WHO, 1948). Consensus regarding the inclusion of measures of physical, mental, social, role functioning and general health perceptions is noted for comprehensive assessments of health. Today these assessments of health are embedded in a much broader concept than health – the concept of quality of life. This encompasses standard of living, quality of housing and neighbourhood, job satisfaction and health. Health-related quality of life has also been referred to as 'general health status' (Ware, 1995). It includes both physical and mental dimensions of health and refers to the body and bodily needs and emotional and intellectual status. Well-being – including soundness and vitality – is also part of the dictionary definition. Among the attributes of these definitions, the most important in constructing measures are dimensionality, particularly the distinction between physical and mental components, and the full range of health levels implied (Ware, 1995).

The concepts and characteristics of general health surveys have developed historically. Over the past 40 years, numerous „generic', „disease-specific' and „preference-based' measures have been developed that consider diverse aspects of functioning, well-being, symptom states, and subjective perceptions of health. Health status measures have been recommended for increasingly diverse applications such as descriptive research, clinical trials, health policy, health planning and program evaluation, resource allocation, population surveys and clinical practice (McHorney, 1999). McHorney (1999) describes generic measures as 'a broad spectrum of health concepts', which attempt 'to be appropriate for groups differing in disease, severity and co-morbidity.' Generic instruments measure aspects of health that are important to everyone, and thus allow comparisons between different diseases and between healthy and diseased people (Lundberg, 1999). Specific generic tools include both descriptive profiles and preference-based measures (Lundberg, 1999; McHorney, 1999). Disease-specific tools are usually defined by disease pathology and are specifically designed for a particular patient population. For many diseases (e.g. psoriasis, asthma, arthritis, back pain, and cancer), numerous tools exist that differ in conceptual framework, source of items, scaling techniques, and psychometric properties. Preference-based measures are weighted assessments of health state values with life years, which yield a single aggregate score (McHorney, 1999).
McHorney's (1999) 'evolution of the state of the art in health status assessment' presents a historical overview. Before 1960, measurement of patient health status was largely limited to

the activities of daily life or to single item, disease-specific measures of functional ability. In the 1970s the development of generic tools expanded in the UK, partly as a result of extramural support from the UK National Centre for Health Services Research. Definitional expansiveness was the signature of this era, as exemplified by tools consisting of multiple health profiles, each measured by multi-item scales. Development of descriptive generic profiles began in earnest with the Human Population Laboratory, which implemented measurements in physical, mental, and social health. In the mid-1980s the era of psychometric reduction began. There was interest in using generic measures across two different units of analysis – at the individual level in clinical practice and in large scope, group-level studies. Cost and the burden of data collection led to an emphasis on practical efficiency for clinical applications and psychometric efficiency for clinical trials and population-based outcome research (McHorney, 1999). The following surveys resulted during this period:

- the Quality of Well-Being Scale (1973);
- the Sickness Impact Profile (1976);
- the Health Insurance Experiment surveys (1979);
- the Nottingham Health Profile (1980);
- the Quality of Life Index (1981);
- the Dartmouth Function charts (1987);
- the Medical Outcomes Study (MOS) SF-20 Health Survey (1992) which included 20 items distilled from the Health Insurance Experiment's measures;
- the Duke Health Profile (1990), a 17-item survey empirically derived from the Duke-UNC Health Profile;
- the SF-36 Health Survey (1992), measuring eight health concepts and developed as an extension of the SF-20, and
- the 149-item Functioning and Well-Being Profile (FWBP).

The three physical-, social- and- role-functioning concepts are represented in all these surveys. They often measure general health perceptions and energy/fatigue, also referred to as vitality. Psychological well-being, sleep problems, cognitive functioning, quality of life, and self-reported health transitions are less frequently represented. Health Insurance Experiment (HIE) surveys, one of the first compilations of modules developed independently, are focused on five of these modules - physical, mental, social, role-functioning and general health - and constructed from 86 items in a 249-item questionnaire. A wide range of physical functioning items in the same scale, from self-care to strenuous physical activities, and the construction of global mental and general health scales are included in these models.

The Swiss Health Survey (SHS) is a generic instrument based on comprehensive and dynamic approaches. Within the health promotion scope of the Ottawa Charter 1986, the WHO proposed a more open and dynamic definition of health: 'Health promotion is the process of enabling people to increase control over, and to improve, their health. To reach a state of complete physical, mental and social well-being, an individual or group must be able to identify and to realize aspirations, to satisfy needs, and to change or cope with the environment. Health is, therefore, seen as a resource for everyday life and not as the objective of living. Health is a positive concept emphasizing social and personal resources, as well as physical capacities. Therefore, health promotion is not just the responsibility of the health sector, but goes beyond healthy lifestyles to well-being'. The SHS includes individual health, lifestyle and environment data. Health concepts beyond the SHS are as follows: general health perceptions, physical functioning, psychological well-being, psychological distress, bodily pain, energy/fatigue, sleep, cognitive functioning, sense of coherence, social functioning, and use of the health care system. A wide range of physical functioning items in the same scale, from self-care to strenuous physical activities, and the construction of global mental and general health scales are included in these concepts (Calmonte et al., 1998).

3.1.1 Self-reported health, culture and personality

As Subramanian and Kawachi (2004) note, a broad variety of health outcomes are being used. Often investigators use mortality rates or life expectancy or create health indicators based on self-reported health characteristics. In numerous studies, self-rated health factors, e.g. self-rated long-term illness (Malmström et al., 2001), self-reported physical health (Mitchell et al., 2000), self-reported limiting long-term illness (Boyle et al., 2001), reported health status (Sundquist and Johansson, 1997b), health-related behaviours such as smoking, alcohol consumption, diet and exercise (Ecob and Macintyre, 2000), represent the health aspect. Several studies support the choice of self-related health (Carlson, 1998; Kaplan and Camacho, 1983; Sundquist and Johansson, 1997b; Welin, Tibblin, and Svärdsudd, 1985). They correspondingly report that self-perceived health reliably predicts mortality in individual longitudinal follow-up studies. Sundquist and Johansson (1997b) evaluated the health status with one question 'How would you describe your general health?' and gave three response alternatives 'good', 'bad', or 'anywhere between good and bad'. Using such self-reported health characteristics, we have to address the question of which factors may be behind individuals' motivation to choose one of the response alternatives? Additionally it is of interest, in which context of physical and mental health they live.

Personality traits represent an important aspect of health perception and reporting subjective well-being. Ryff (1989) proposed a multidimensional model of psychological well-being

encompassing constructs such as autonomy, environmental mastery, personal growth, positive relations with others, purpose in life and self-acceptance. Six dimensions varied by age, sex and cultural level. The relationship between psychological well-being and personality traits has also been explored by aging process, life changes and stressful life events and resilience (Ryff, 1989; Ryff and Keyes, 1995). Negative correlations within psychological well-being are depression, neuroticism and personality disorders. Positive correlations to psychological well-being show extroversion and openness to experience (Schmutte and Ryff, 1997). The relationship between well-being and personality traits as well as distress is complex.

Siegrist (2003) postulated that subjective well-being refers to people's judgments about their own state. These judgments concern their enduring mood (e.g. happiness) as well as their evaluation of the self (e.g. satisfaction with one's physical and mental health and functioning) and its relationship to the material and psychosocial environment (e.g. life satisfaction, work satisfaction). Moods reflect the perception and evaluation of an individual's affective state, whereas satisfaction with one's life conditions involves cognitive judgments that are based on some standard of comparison. These cognitive judgments point to existing or non-existing discrepancies between expectation and real experience. Scherpenzeel (2004) investigated and discussed three theories of happiness and life satisfaction: social change, comparison and the trait theories. On the individual level, income is strongly related to life satisfaction within poor countries. For affluent countries the relationship is very weak. Sociological theories about inequality postulate that demographic variables are important for satisfaction, because they constitute one's position in society. However, the lack of relationships between demographic variables and satisfaction in affluent countries is evident in contrast to the positive relationship in poor countries. The comparison theories (see Scherpenzeel, 2004, p. 305) allow the suggestion that satisfaction is based on a comparison of one's life with subjective standards of how-life-should-be. This theory implies that satisfaction does not have a relationship with current living conditions, in the sense that people adapt to changing situations and shift their standard of comparison. In contrast to sociology, psychology tends to see satisfaction as a personality trait. This trait is a disposition to or outlook on life, which is either innate or acquired, but is stable and independent of living conditions. Someone having a pessimistic disposition will always take less pleasure from changes in life than someone having an optimistic nature. A variation of the trait theory sees satisfaction rather as a 'national trait': a collective outlook on life based on cultural norms, religion, and history. Both at the individual and the national level, trait theories assume that people stay as happy or unhappy as they are, independent of changes in life circumstances (Scherpenzeel, 2004). There is growing evidence that large increases in wealth in developed nations have not been accompanied by a comparable increase in people's satisfaction and happiness.

Another important aspect of how people answer on a health question relates to the most capacious space within which we think about ourselves – the culture. 'Culture is the way of life of a people. It consists of conventional patterns of thought and behaviour, including values, beliefs, rules of conduct, political organisation, economic activity, and the like, which are passed on from one generation to the next by learning – and not by biological inheritance' (Hatch, 1985, p. 178).

Cultural patterns structure both thought and perception. These patterns are conscious or unconscious and reflect peoples' congregation and act in ways associated with particular activities, values and social relations (Young, 1994). The rituals, belief systems and the structures and dynamics of a social system are outcomes of the culture. It is to be expected, that also in self-reported health cultural structures exist which are important for interpreting health perception.

In medicine, many sub-disciplines exist, and people work with and consider a great number of physical and mental health factors. In the investigation of health's association to socio-economic, demographic and geographic factors, we are, however, used to reducing health to two or three variables. This reductionistic health research does not make allowance for the complexity of health, particularly not of the complexity of health-related well-being. However, often the fact is ignored that health perception depends on satisfaction and deep cultural structures and does not relate to current living conditions.

3.1.2 Complexity of health

This section is focused on the complexity theory approach to health perception and the relationship between a systemic approach and analysing similarities. Human's perception based on psychological well-being is complex. The response of an individual regarding health-related well-being or about moods and somatic symptoms as well as about behaviour and lifestyle characteristics are based on individual personality traits as well as collective cultural aspects. These responses can be seen as part of an open, emergent, non-linear system.

Gatrell's (2005) idea of assessing geographies of health and complexity theory and discussing the complexity theory and their key features – relations and networks, non-linearity, emergence, and hybrids in relation to health geographies, can also applied to health perception. Gatrell (2005) compares biological ecosystems and social transport networks with the spread of a virus within a local community and identifies the features of a complex system. We suggest that the perception of lifestyle and health can also be seen as a non-linear, open system with a large number of elements interacting dynamically across networks. The elements are here – thoughts, especially thoughts about health and lifestyles. Interaction within the cognitive space and the social space as well as the physical space is rich. It may

involve both images of human and non-human agents (hybrids) or elements. Networks also exist in the cognitive perception space. A huge number of conscious and unconscious thoughts, which can change suddenly and are always in a dynamic flow, compose a complex universal puzzle. This network is combined with other internal elements and networks, which affect perception and cognition. On the one hand the cognitive network is based on a neurobiological network. On the other hand the complex open emergent cognitive system moods are based on the personality of the individual and collective, cultural structures. The emergence of new structures, here of new thoughts and self-reported health perception, can also be seen as the result of self-organisation. Individual and collective cognition develop in a process of autopoiesis, where each system component aids the transformation of other components and where the network makes itself. As an open system, individual thoughts can develop themselves. Thoughts can be have a strong non-linear effect and transform other thoughts in an unexpected direction. These are known as ideas, and they can have strong nonlinear effects on the collective cognition. A small change in one's individual cognition, e.g. an idea, a thought, does not lead to correspondingly, directly proportional small changes in a collective. One idea can have big effects either for the individual himself or also for the whole social system.

Capra (1996) refers to the 'relations' between system components as pre-eminent, and stresses the 'profound relationality' (Bourdieu, 1979, 1984) of such a system structure. There exist methodological possibilities to analyse and visualise structure patterns and their dimensionality. Psychometric studies consider this profound relationality based on explorative data analysis. Psychometric methodology is well-known and often used (Heiser, 2001; Steyer et al., 1993; Thissen, 2001; Yanai, 2001).

Which structures can we expect in self-reported health-related well-being? Ruini et al. (2003) analysed the psychological well-being of 450 Italian subjects. By exploratory factor analysis they found four main factors or dimensions that accounted for 64% of the variance in the Psychological Well-Being Scales (PWB). The first dimension showed positive correlations with all well-being dimensions and a negative correlation with depression. Dimensions two and three are more related to somatic symptomatology. Dimension four was described as a mixed factor, reflecting characteristics of reliable personality disorder diagnosis, personal growth and positive relations. Hays and Stewart (1990) analysed with confirmatory factor analysis self-reported health status in N = 1,980 patients with one ore more chronic medical conditions. Their findings support the suggestion that health is multidimensional and indicate clearly that self-reports of physical and mental health are distinguishable. The physical and mental health constructs had about 20% of the variance in common. This moderate association indicates that physical and mental health are distinct but correlated components of

overall health status. To identify significant, higher order substructures in the data, Cella et al. (2005) conducted a factor analysis of the data residuals, revealing two definable higher order dimensions: physical well-being and mental well-being.

Based on surveys and mortality registers, we can analyse patterns of relations between, for example, health perception and socio-demographic characteristics. Gatrell's (2005) idea of applying the complexity theory to health is new. System thinking and applying network analysis do not to my knowledge exist in medical sociology and medical geography. The next chapters covering 'social environments and health', 'social capital and health' as well as 'spatial differentiation and health' have to be seen as an analysis of correlations and associations in a multivariate and mostly deductive way.

3.2 Social environments and health

Susser (1994) emphasised that the aggregated socio-economic characteristics of which an individual person is a part may relate to health in other ways than the individual socio-economic part. Thus, ecological research shows that the collective attributes of a population may have an impact on public health (Malmström et al., 2001). Numerous studies indicate that aggregate socio-demographic and socio-economic factors affect human health and well-being. Wagstaff and van Doorslaer (2000) have demonstrated that data from individual-level studies considering the effect of income inequality upon health have the potential to discriminate between most of the advanced hypotheses; in contrast, aggregated-level studies, i.e. studies on population or community (e.g. state) level of aggregation, have not this potential. Therefore, here only individual-level studies are mentioned.

With the use of hierarchical analysis, Malmstöm et al. (2001) have demonstrated that the socio-economic position of a neighbourhood is generally more strongly associated with self-reported long-term illness than with mortality. This effect occurred even after adjusting for marital status, housing tenure and social network. Pocock et al. (1987), Miles (1991) and Bartley (1994) investigated insecurity concerning housing, income and job. Psychosocial effects of hierarchy and social position have also been considered. People in lower social classes, the unemployed and women report and/or experience ill health at higher rates.

Sundquist and Johansson (1997a) estimated the effects of some indicators of socio-economic position such as employment status, education and housing tenure on mortality. Data from 32,853 persons aged 25-64 were collected from seven independent samples of the Swedish population in 1979-1985 and were analysed by a proportional hazard model. The information about mortality was obtained from the Cause of Death Register by the Swedish personal registration number. Being a low educated female or renting a flat (instead of occupying a

house) was associated with increased mortality when tested simultaneously for all independent variables. Being in receipt of a sickness pension, for both sexes, and long-term unemployment, for males, were associated for obvious reasons with high relative risks of mortality. Also single living and working impairment were risk factors for both men and women (Sundquist and Johansson, 1997a). In another study Sundquist and Johansson (1997b) analysed a random sample of 39,156 people, which were interviewed face to face by Statistics Sweden from 1979-85. During follow up 2,656 men and 1,706 women of the sample died. Men and women in both the younger and older age group, who reported poor health status at the interview, had a strongly increased relative risk (RR) of dying during the follow up period (men: RR = 2.05, 95% CI 1.72 - 2.31 / 1.91, 1.74 - 2.10; women RR = 2.34, 95% CI 1.94 - 2.38 / 1.80, 1.61 - 2.02) when simultaneously controlled for age, marital status, education, and housing tenure. Living alone, renting an apartment, and low educational level ($\leq$ 9 years) were also associated with increased mortality risks for men and women in both age groups (Sundquist and Johansson, 1997b). Kennedy et al. (1998) showed in a cross sectional multilevel study for 50 states of the United States (total sample size for the combined 1993-4 datasets was 205,245) that inequalities in the distribution of income were associated with self-rated fair or poor health. The effects of income distribution on self-rated health were not only limited to those in the lowest income groups. The effects of income inequality on self-rated health were demonstrated to be as strong as other individual risk factors. The Gini coefficient was used to measure state wide inequalities in income.

In recent years, criticism and dissatisfaction about the measures of social position has increased. Bartley et al. (1999) examined the relationships of two theoretical measures of social position to cardiovascular risk factors. It could be shown that the strength of the relationships between social position and cardiovascular risk factors varies according to the definition of social position which is used: there is a closer relationship between most health behaviours and the Cambridge scale, an indicator of 'general social advantage and lifestyle', whereas the Erikson-Goldthorpe scheme, which is based on employment relations and conditions, is more strongly related to work control and breathlessness (Bartley et al., 1999). Macintyre et al. (2003) critically reflected different socio-economic classifications by comparing their predictive power for a range of health measures. The investigation of a random sample (N = 2,867) of adults in the West of Scotland showed that associations between social position and health vary by socio-economic classification, health measure and gender (Macintyre et al., 2003). Other studies implied that there is little to no association between complex health variables and socio-economic factors. For 60 metropolitan areas or economic areas of the United States, Sturm and Gresenz (2002) analysed (by use of data of the 1997-8 nationally representative household telephone survey) the relationship between

geographical inequalities in income and the prevalence of common chronic medical conditions and mental health disorders (N = 9,585 adults). A strong continuous association was seen between health, education and family income. No relationship was found between income inequality and the prevalence of chronic medical problems or depressive disorders and anxiety disorders, neither across the whole population nor among poorer people. Only self-reported general health was significantly correlated with inequality at the population level, but this correlation disappeared after adjustment for individual characteristics (Sturm and Gresenz, 2002). The authors concluded that their study does not provide any evidence for the hypothesis that income inequality is a major risk factor for common disorders of physical and mental health.

The most frequently used statistical methods are relatively conventional epidemiological analyses such as linear and logistic regression (Bartley et al., 1999; Kennedy et al., 1998; Macintyre et al., 2003; Sundquist and Johansson, 1998) and proportional hazard models (Sundquist and Johansson, 1997a, 1997b). Gatrell et al. (2004) followed other methods. Following Bourdieu they argued that structures of the social world maybe relevant in different kinds of 'social' space and its possible association with particular health outcomes. By using correspondence analysis they explored the inter-relationships between a number of social survey variables collected in a study of health inequalities and their correlates and linked logistic regression analysis with a graphical exploratory analysis that uncovers inter-relationships between variables.

Increasing interest in studying the effects of the social environment on health, migration and other themes has led researchers to consider the effects of economic, socio-professional, ecological and social characteristics of communities and societies upon populations' migration and health status. As mentioned above, some recent studies could unmask the social environment as a determinant of health.

For migration studies, 'sustainable livelihoods framework' has become an important notion, which has been developed to help understanding and analysis of the livelihoods of the poor. Like all frameworks, it is a simplification, but it could also be useful in assessing the effectiveness of existing efforts to reduce poverty. The important livelihood assets of this framework are human, natural, financial, physical and social capital. One asset that has generated considerable attention, particulary in health studies, is the concept of 'social capital'. The concept of social capital originated in the field of sociology and political science to explain how citizens within certain communities cooperate with each other to overcome the dilemmas of collective action, but recently public health researchers have turned to the notion

of social capital to explain heterogeneities in population health status across geographic areas (Kennedy et al., 1998; Lochner et al., 1999).

3.3 Spatial differentiation of health

Wilkinson (1996) reported that differences in income and health (mortality) within developed countries are very closely related, but differences in income and health between developed countries are very weakly related. Why is life expectancy higher in countries like Greece and Italy than it is in more affluent countries like the United States or Germany? Wilkinson (1996) assumed that countries in which the income differences between rich and poor are larger tend to have worse health than countries in which the differences are smaller. An analysis of the rate of change of life expectancy in twelve European Community countries and the rate of change in the percentage of the population in relative poverty from 1975 to 1985 showed that countries in which the relative poverty diminished such as France and Greece enjoyed faster increases in life expectancy than those in which relative poverty increased as in Ireland and the United Kingdom. What affects health is not the difference in absolute material standards, but social position within societies. On that basis, relative income is important. It does not matter whether one has a larger or smaller house or car in itself, but what these and similar differences mean socially and what they make one feel about oneself and the world around you is significant (Wilkinson, 1996). Boyle et al. (2004) investigated a select group of people from the ONS Longitudinal Study for England and Wales who had not been moved between 1971 and 1991 and who were living in non-deprived households throughout the 20-year period. Their results demonstrated that changes in the relative deprivation of areas are related to morbidity and mortality in a consistent way for both outcomes, although the results were more significant for morbidity. Sundquist et al. (1997c) proved a statistically significant association between the Swedish underprivileged area (UPA) score and the standardized mortality ratio (SMR) in Swedish municipalities; the UPA-score explained 20% of the variation between municipalities in SMR. Mitchell et al. (2000) explored the relationship between individual and area level influences on health and suggested how we might improve research into that relationship. Multilevel analysis demonstrated that the degree of deindustrialisation, which an area experienced in Britain in the 1980s, has an independent association with the health of resident individuals. A significant relationship between individuals' attitude to their community and their health is shown to be independent of individual and area characteristics. Using the data from the Swedish Level of Living Survey, a neighbourhood's low social position and an individual resident's low socio-economic position (i.e., a manual worker, or person renting a flat) were

found to be associated with increased risk of self-reported long-term illness (Malmström et al., 2001). Area of residence and individual characteristics seem to be related to health (Hart et al., 1997; Macintyre et al., 1996). Lochner et al. (1999) premised the importance of trust and interaction with the community for maintaining a high chance of good health.

Sloggett and Joshi (1994, 1998) however, found little or no impact of a ward's deprivation score on an individual's health once the extent of individual disadvantage was accounted for. Likewise Duncan, Jones, and Moon (1995) did not find any area effects on psychological health once individual characteristics were accounted for. In general, weak theoretical accounts exist of how and why the characteristics of an area might exert an influence on the health of its resident population (Macintyre et al. 1993). Lack of theory has often resulted in a choice of variables to characterise an area, which is guided more by what is available 'off-the-shelf' than by careful theoretical consideration. It also sidelines the important question of what is the appropriate spatial scale for analysis. There has, for example, been some use of multivariate classifications to capture the social and economic milieu of an area (Shouls, Congdon, and Curtis, 1996; Wiggins et al., 1998). Whilst this work has successfully identified a health differential by 'area type', it is not clear what these classifications capture, which has the effect. Without an explicit consideration of how the characteristics of an area are expected to influence health, it is not surprising that contrasting results have been obtained in the search for area effects. It is also hard to translate the field's results into a coherent and potent policy message. In particular, little attention has been dedicated to the fact that shared residence in an area does not necessarily mean that individuals will draw the same influences from it. This is because those who are spatial neighbours are not necessarily social neighbours. Area classification cannot take account of the fact that people vary in their interactions with those who live close them.

3.3.1 Critical aspects of health and income inequality studies

Gravelle (1998) argued that the correlation between income inequality and mortality may be a statistical artefact caused by using population data rather than individual data – an example of the 'ecological fallacy'. Ecological fallacy is a widely recognised error in the interpretation of statistical data, whereby inferences about the nature of individuals are based solely upon aggregate statistics collected for the group to which those individuals belong. This fallacy assumes that all members of a group exhibit characteristics of the group at large (Robinson 1950; Selvin, 1958). Gravelle (1998) showed mathematically that the aggregate relationship is consistent with a negative, curvilinear relationship between income and the probability of dying for individuals. Wagstaff and Doorslaer (2000) criticized studies of income inequality and poor health status because of their inability to disentangle the effects of individual income from the contextual effects of income inequality. In other words, an ecologic association

between income inequality (e.g., measured by the Gini coefficient of income distribution for the US state level) and poor health (e.g., measured by age-adjusted mortality rates within each state) may reflect either a contextual effect of income inequality on health, or a compositional effect of income-poor individuals residing in unequal states, or both (Subramanian and Kawachi, 2004). Subramanian and Kawachi (2004) pointed out several critical aspects:

1. The studies that suggest an association between inequality and poor health have so far been conducted within the United States. Several studies outside the United States have not corroborated this association.
2. The absence of an association between income distribution and health may reflect a threshold effect of inequality on poor health. In countries that are relatively more unequal than the United States, e.g. Chile, we find some support for the relationship.
3. The geographic scale and the aggregation level at which income inequality is assessed seem to matter and have been different in each study.
4. In US studies such as the National Health and Nutrition Examination Survey (Fiscella and Franks, 1997); the Panel Study of Income Dynamics (Daly et al., 1998); Behavioural Risk Factor Surveillance System (Kennedy et al., 1998) and eight other studies, were often based on small sample sizes and may have lacked statistical power to detect the effects of income inequality on health.
5. A broad variety of health outcomes, ranging from mortality and self-rated health to depressive symptoms, hypertension, smoking, body mass index, and sedentary behaviour have been linked to the state-level income inequality.
6. The published multilevel studies concern differences in methods of statistical analysis. Only eight studies appropriately recognized the true multilevel structure of the data while modelling the effect of income inequality on health.

In general, these six critical points have also to be applied to studies about area effects and health. In health research we usually have difficulties with the aggregation level due to data protection. Often we can only use macro datasets with different aggregation levels. However, income and health research investigators increasingly also use micro datasets.

3.4 Geographies of health

With his concept of 'geographies and health' – everybody has his own geography and his own health, as well as his biography, Gatrell (2002) contrasts places and locations. Locations are points or areas on the earth's surface, that have coordinates and can be measured with geo-positioning systems or that can have addresses, such as residential homes. Charging locations with meaning, locations become places (Gatrell, 2002). Observing our 'psychology' of places,

for many of us physical and social events happen sometimes in places or locations that are simply dots on a map or only vague areas in our mental map – though for those living there they have always been places. In our life networks we appropriate places, and depending on our mental well-being, we esteem, interpret and symbolise our places in interaction with our psycho-social, social and physical environment. Depending on our social network, our work success, our realities, our age, mental flexibility and mobility we structure a network of places with different priorities. Our place network is the structure of our individual geographies.
In this sense Popay et al. (2003) looked for understanding of the normative contours of 'proper places', which shape the way people respond to the everyday lived reality of places. They saw a profound significance of 'place' in shaping people's lives and identities. In 'The Classical Slum', Roberts (1973) refers to one man's experience of a particular place at a particular time. With another interesting, psychoneuroimmunologic approach he investigated the relationship between cultural values, psychological status and somatic reactions e.g. on stress. Lock and Kaufert (2001) postulated 'local biologies' for culture-caused mental and somatic illness and in this context discussed population and civil illness in developed countries.

3.5 Contextual versus compositional approach

Within the 'health and place' discussions of several medical geographers, numerous investigations of the relative importance of contextual and compositional factors in explaining health, morbidity and mortality variations have been conducted. Macintyre (1993) and Curtis and Jones (1998) distinguished between compositional and contextual explanations for area patterning. According to Macintyre et al. (1993) a contextual explanation would be that some features of the social, economic, cultural or physical environment influence health and behaviour. Contextual effects may either impact on all residents equally, or more on some types of residents than others. 'Such environmental influences might include climate, soil or water conditions, the built environment, publicly or privately provided amenities or facilities, socio-cultural factors such as predominant religion or history, and the reputation of the area' (Ecob and Macintyre, 2000, p. 262). When comparing countries, regions, districts or neighbourhoods, contextual effects are visible in cultural differences of health relevant attitudes such as smoking, drinking alcohol, eating and moving. In contrast to the contextually based area patterns, compositional explanations for area variations in behaviour (e.g. smoking, drinking alcohol, good diet and exercising) would be that the sort of people whose personal and household characteristics (social characteristics and material circumstances) are associated with a special behaviour tend to live in certain types of localities or places (Ecob

and Macintyre, 2000). Duncan et al. (1996) used for compositional the term 'individual' and for contextual the term 'ecological', when they postulated, that 'individuals and their ecologies must be modelled simultaneously'. To tease out the relative importance of contextual and compositional area effects, the quantitative method of multi-level modelling has been the preferred mode of analysis (see Diez-Roux et al., 2000; Duncan et al., 1999). Multi-level modelling offers a means of operationalizing the undoubted connections between individual human behaviour and broader environmental and social contexts (Duncan et al., 1996).

The 'contextual versus compositional' debate could be enriched by the structurationists' explanation, most closely identified by the structuration theory of the British social theorist Anthony Giddens. Structurationism recognizes the duality of structure and agency. In the same sense as structures shape social practices and actions, contextual factors affect individuals and their health. Furthermore, the structurationists' approach that practices and actions can create and recreate social structures may be applied to the compositional framework. According to Giddens' (1984) theory of structuration, individuals, live a routinely day-to-day life in different hierarchical local settings, such as family, work and school. Malmstöm et al. (2001) assumed that neighbourhood is such a local setting for socialisation in the context, with its conflicts, marginalisation or exclusion. Individuals, who live in small, socially deprived, homogenous neighbourhoods, could have an increased risk for self-reported long-term illness and increased mortality.

4 Concepts of space

In philosophy, mathematics, geography and sociology, the nature of 'space' has been the subject of extensive debate. Since antiquity, concepts of space and time depend on the different philosophical senses. In pre-Euclidian common sense, space was psychological or physiological, which by its own nature was bounded, geocentric (or, rather, 'bodycentric') and heterogeneous. This finite, geocentric and heterogeneous space, hierarchically differentiated into the concentric regions of 'natural places', influenced the cosmology of Plato and Aristotle. The concept of Euclidian – a consequently infinite space arising by extending a straight line in either direction, pervaded the whole of Greek philosophy. This work began in the sixth century by Thales and Pythagoras, the first parents of the two parallel traditions of philosophy. The belief in infinite space as a physical fact can be traced back to the Greek philosophers of the three centuries between Thales and Euclid. The opposition of 'the finite versus infinite space' was closely related to the dispute between the relational and absolutist theories of space. The Cartesian identification of space with matter can be regarded as an instance of the relational theory of space. In a relational sense, Descartes defined motion as concerning neighbouring bodies. The constancy of the quantity of motion, *mv*, is only meaningful within a definite frame of reference. By insisting on the absolute constancy of the total momentum *mv*, Descartes implied an absolute frame of reference indistinguishable from Newtonian space (Capek, 1976).

In the second half of the seventeenth century, all features of the classical concept of space were brought into a clear focus: infinity, infinite divisibility, immutability, causal inefficacy and homogeneity. These were all contained in one feature – homogeneity, depending on relativity of place and relativity of magnitude. Russell postulated in his 'axiom of free mobility'; that neither the size nor the shape of the bodies are affected by their displacement – all regions of space are equivalent, space is causally inert; in this sense space is physically nothing – 'nihil' in the terminology of Gilbert and Otto von Guericke. From this idea, the impossibility of external and internal boundaries of space follows, which means that space must be both infinite and continuous. But while the relativity of space holds in the spaces of constant curvature, that is, besides the space of Euclid also in that of Lobachevsky and Riemann – the relativity of magnitude holds only in Euclidian geometry; *only in it can any geometrical figure be constructed on any scale.* Pascal's Pensées showed the concrete applications of this principle: *'the minute world of micro-cosmos differs from our world only by its dimensions - and so does 'mega-cosmos' from our own world'* (Capek, 1976).

The meanings, which we attribute to space and time, are intimately tied to our understandings of the world in which we live. Space and time are constructs, which help us to understand our existence, to plan our everyday life, to give relationships within the stream of life. Space and time are two important dimensions to analyse our web of life. Space and time were always important features in geography and were influenced by the debate of space and time in philosophy and physics. They are not only central to debates about modernity and postmodernity – modernity can be seen as a certain mode of experience of space and time (Unwin, 2000). Also the history of ideas of space since antiquity shows how central debates over space and time have been. However, postmodernism can be conceived of as an exploration of different spaces and times, and also of different ways of thinking about space and time.

4.1 Conceptual space

In this thesis, space is a conceptual space, which enables us to 'order the immense mass of experience' (Kutschera, 1972). This conceptual space is built upon geometrical structures based on a number of quality dimensions, which represent various qualities of objects. Judgements of similarity and difference generate an ordering relationship of characteristics. The dimensions assign properties to objects and specify relationships among them. In this thesis, the objects are our experiences and perceptions related to health. The similarity of the health perception profiles specifies the relationships among them. The coordinates of a point within a conceptual space represent particular instances of each dimension. The structure of many quality dimensions of a conceptual space will make it possible to talk about distances along the dimension (Gärdenfors, 2000). An axiomatic system for geometry can be constructed from two terms, 'betweenness' and 'equidistance', which are defined over a space of points, lines or planes. Based on these elements, a metric space is defined that has a distant function D. This metric space will be explained later in the methodological chapter.

Conceptual spaces are static and describe only the structure of representations. The assumption to describe processes is a description of the dynamics of the representations. Gärdenfors interprets 'conceptual spaces as theoretical entities that can be used to explain and predict various empirical phenomena concerning concept formation. In particular, the distances associated with metric space should be seen as theoretical terms. And if similarity is defined by distances via equation..., similarity will be a theoretical term, too...' (Gärdenfors, 2000), p. 31). In a scientific manner, for Gärdenfors (2000) the dimensions of conceptual

spaces are instruments for predictive and constructive purposes. However, he distinguishes between a phenomenological and a scientific interpretation of conceptual spaces.

4.2 Scientific and phenomenological interpretations

The conceptual space and its quality dimensions can be interpreted scientifically or phenomenalogically. Since the last century, as a result of relativity theory, western culture has faced a huge challenge to surmount a Newtonian mechanistic world-view and traditional Cartesian dualism – the mental and physical realms. The static view, leads to a dualism of two realms – the 'subjective' one, to which becoming because of its 'mind-dependence' is confined, and the 'objective' world of physics. This dualism still affects all our thoughts, also in 'natural' and 'social' science. Is space an external fact given by 'objective' nature outside of the human brain? Or is space a construction of the human brain and only one of many possible alternatives, all equally agreeable to nature, when and by whom it was constructed? If we follow the history of the concepts of space, we will find both.

As Werlen (1993) showed 'objective' positivistic standpoints supported by the philosophy of Popper, influenced geo-determinist, behaviourist and structuralist concepts in geography as well as the opposite, subjective point of view of e.g. Schutz (1972, 1974), Husserl (1965) and Luckmann (1983). Werlen (1993) discussed spatial concepts comparing the Popperian critical rationalism with the phenomenological ideas of Schutz (1962) and linked this epistemiological debate with the sociological action theories of Pareto (1975), Weber (1968) and Parsons (1952). Lagopoulos and Boklund-Lagopoulou (1992) also described objectivism and subjectivism, considering spatial studies in positivism, behaviouralism structuralism, environmental psychology and architectural psychology.

Based on such scientific theories, the dimensions of conceptual space are seen as instruments for predictions, the benefit of theoretical concepts. In this thesis, scaling methods, correspondence analysis and categorical principal analysis, are used to generate new dimensions that organize apparent unstructured data. These procedures can be seen as a form of induction. 'Within the philosophy of science, it has in general been thought to be futile to construct a mechanistic procedure for generating scientific discoveries of this kind' (Gärdenfors, 2000, p. 217). In this context, Gärdenfors (2000) demonstrates how the conceptual space of Newtonian particle mechanics is based on scientific quality dimensions, which 'are ordinary space (3-D Euclidian), time (isomorphic to the real numbers), mass (isomorphic to the nonnegative real numbers), and force (3-D Euclidian space). An object can

be seen as a point representation in this eight-dimensional space (Gärdenfors, 2000). Such theoretical concepts in scientific theories generate a number of new dimensions.

The phenomenalogical approach is aimed at describing the psychological structure of the perceptions and memories of humans (Gärdenfors, 2000). According to humanistic and behavioural geographers as well as environmental psychology, the mind through its psychological process realizes a subjective representation of the external world. This representation is achieved by observing the world and selecting and structuring incoming information. These processes are inseparable from attitudes, values, emotions, desires, and motives, as well as perception, sensations, cognition, and learning. However, these psychological factors should not be seen as features on their own, but they play a role in the stream of consciousness of each individual as well as in the interaction with other actors. If subjects have different experiences in the same culture and society, the consciousness of each individual in that community will attain an inter-subjectively consistent structure. During the course of the knowing subject's life, a certain structure of consciousness is build up, which Schutz analyses in detail in his work on 'relevance structure and ideal types'. Although the world with its 'things' enters the consciousness of every knowing subject in various ways, it can nevertheless be experienced inter-subjectively as a world common to all, by means of acts of cognition and appearance (Brauner, 1978). Schutz (1962) postulated that structuring the sphere of subjective experience in the social world should be done according to Sorokin's economic and political or similar dimensions. Bourdieu's (1979, 1984) social space is an example of interpreting conceptual space in a phenomenological manner.

4.3 Bourdieu's social space

In the following, consideration will be given to some ideas and concepts of human geography and psychology, which may make health space comprehensible. This thesis was strongly influenced by sociologists such as Bourdieu, Giddens and Schutz. The term 'social space' in particular occurred in Bourdieu's work (1979, 1984). Parsons et al. (1952) indicated 'the need for a representational model more in the nature of a 'space' in terms of which all the relations can be represented simultaneously' (Parsons et al., 1952, p. 200). However, Werlen's (1993) theory, that a specific scheme of reference is necessary for every ontologically different area of human action, does not cover the idea and the need for a relational model, which could be interpreted as a space. Bourdieu (1979, 1984) developed a well-known spatial frame of reference for the social world. He observed, 'that the Marxist conceptualization of the social world is based on an economical one-dimensional form of space' (Werlen, 1993, p. 152).

Bourdieu (1979, 1984) understood the Marxist theory of classes to be the result of the reduction of the social world only to the one-dimensional field of economics. Instead of this one-dimensional concept, Bourdieu (1979, 1984) developed, on a theoretical and empirical basis, a multi-dimensional social space. With correspondence analysis he created this social space by representing different characteristics of the social world. He discovered different principles of distribution, meaning that the positions of agents are defined by their relative position to each other and in reality every agent occupies only one position in social space. Bourdieu (1979, 1984) constructed his social space mainly based on four dimensions, which he called economical, cultural, social and symbolic capital (Fig. 2, Bourdieu, 1983). The coordinates of the multi-dimensional social space define every agent's position. His or her position depends on the total amount of capital at his or her disposal and the composition of this capital as well as the proportional importance of each of the four capitals to the total amount of capital.

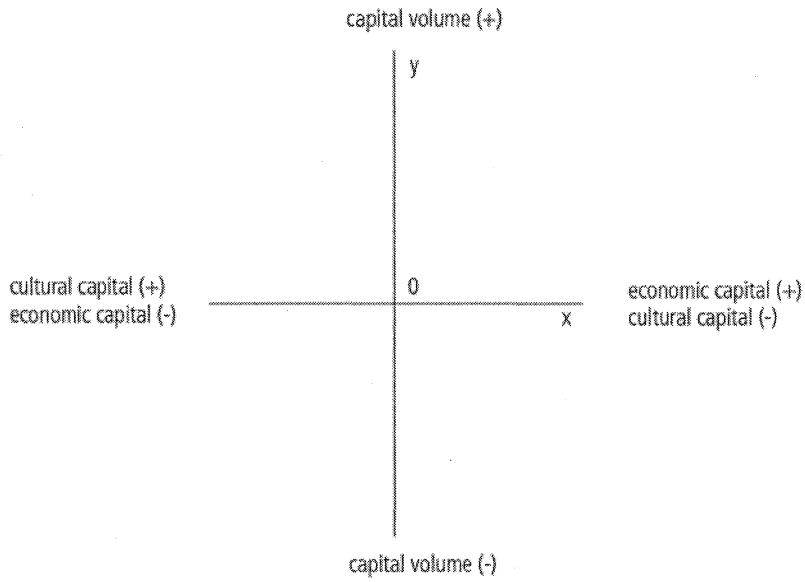

Figure 2: Social space constructed on the characteristics of economic and cultural capital represented on the x-axis and the capital volume represented on the y-axis (Source: Bourdieu, 1983)

For Bourdieu (1979, 1984) the social space mirrors an ensemble of relations of force, which is characterized by the field of force and the underling field characteristics. Each individual lives in these fields of force and underlies more or less these tensions of force in social space.

Bourdieu's theory of 'habitus' attempts to join such individual aspects of social space. Bourdieu localized agents in the social space. In contrast Werlen (1993) point out that 'instead of agents Bourdieu should try to localize meanings of action in the social space' (Werlen, 1993, p. 1555). Werlen's (1993) critic comments of actors and meanings of actions are comprehensible, due to correspondence analysis is arranged on a contingency table or Burt table and each row and column, which appear later in the map of space, represents a profile of the reported meanings and perceptions of agent's lifestyle and not an agent himself. These profiles of meanings are the basis of the conceptual, multidimensional, social space. However, it is possible to project residential addresses of subjects in the constructed social space (see Gatrell et al. 2004). This provides a static geographical representation of an agent in the social space.

5 Data

5.1 Swiss health datasets

The absence of medical geography in Switzerland may be one cause for a missing awareness of the importance of geographically relevant health datasets as well as health datasets with a longitudinal design. In recent years the need for health datasets has increased as a result of the demands of public health research. An ideal conception could be a linkage between health surveys, social insurance data and socio-demographic Census data according to the Nordic heritage of public health. In this context, the newly established Swiss 'network_public_health' is endeavouring to achieve an anonymous record linkage of individual health data and to merge it with the Swiss National Cohort, which represents the Swiss Census 1970-2000. In the study 'Health relevant individual data in Switzerland', Keller-Lengen and Bopp (2004) investigated a dataset of 50 health surveys concerning amount, kind and quality of potential characteristics. Population based health surveys are proved regarding their sufficiency, data quality and availability, but not concerning data protection. The investigated datasets can be grouped into five categories: official surveys, register data, insurance data, health and quality of life surveys, and specific collective studies. Assessing the content, formal and technical potential of a record linkage concerning the characteristics 'health information', 'complete inventory count versus sample', 'geographical representativeness' and 'availability for scientific application', the following datasets are recommended for a record linkage with the Swiss National Cohort: statistics of mortality cases and mortality causes, statistics of live births, statistics of still births and causes of still births, the hospital statistics of VESKA ('Vereinigung Schweizerischer Krankenhäuser'), the obligatory registration of the Federal Office of Health, the Swiss Health Survey and the Swiss Household Panel, the Socio-Medical Indicator System of Swiss Population and the dataset of cardiovascular risks. This analysis pointed out interesting new perspectives for public health research in Switzerland. However, the Nordic heritage of public health remains unrivalled (Keller-Lengen and Bopp, 2004).

5.2 Swiss health survey

The health data used in the four papers is drawn from the Swiss Health Survey collected in 1997 (SHS97) by the Swiss Federal Statistical Office. The dataset contains a random sample of 13,004 interviews collected mainly by a telephone survey representing all cantons of Switzerland; the response rate (69 percent) is relatively high. The sample was taken in a two-step procedure: first, a random sample was drawn representing all Swiss geographic areas

whereby areas with a low population density are over-sampled to make firm analyses of them. Second, within the areas households were randomly selected and within the households the target persons. For more details on field characteristics, (see Calmonte et al., 2000).

5.2.1 Health characteristics

In accordance with the WHO definition of health as being a state of complete physical, psychological and social well-being, a complex and dynamic concept of measuring health is included in the SHS97. For the first paper 'Regionale Muster im Wohlbefinden der Schweizer Bevölkerung' the self-rated health-related well-being (hrwb) variable was chosen based on the question: 'How healthy do you feel today?' There existed five response alternatives: very good, good, average, poor and very poor. Several studies support the choice of such self-rated health parameters as a valid measure of health (Idler and Benyamini, 1997), as self-rated general health was highly correlated with 'objective' health outcome measures such as mortality rate (Sundquist, 1997b).

In addition to health-related well-being, in the second paper 'space of health-related well-being' the following psychological variables are used:

1. Loneliness – It was possible to answer with 'I very often feel alone / I quite often feel alone / I sometimes feel alone / I never feel alone',
2. Fear of becoming ill – 'I fear very strongly / quite strongly / a little / hardly / not at all getting ill',
3. Depressed and moody – 'If you think about the last week, on how many days were you depressed and moody: nearly every day / on three or four days / on one or two days / never?
4. Being calm and well-balanced – ' In the last week, on how many days were you calm and well-balanced: nearly every day / on three or four days / on one or two days / never?
5. Irritated and nervous – 'In the last week, on how many days were you irritated and nervous: nearly every day / on three or four days / on one or two days / never?
6. Optimism, full of power and energy – 'In the last week, on how many days were you full of energy, power and optimism: nearly every day / on three or four days / on one or two days / never?
7. Satisfaction with childhood – 'Are you very / just / not satisfied with your childhood?'

For the last two papers 'Constructing a space of physical and mental health' and 'Visualising areas in the Swiss health space' a set of 16 health characteristics depicting self-reported

mental and physical health data, recent symptoms and medication has been selected. For mental health the same six items as mentioned above are chosen: feeling lonely; depressed and moody; calm and well-balanced; irritated and nervous; optimistic and powerful, and fear of becoming ill; with categories 'nearly every day', 'on three or four days of the last week', 'on one or two days of the last week' and 'not during the last week'. As physical symptoms, ten items are included: weak, tired and lacking energy; headache and face-ache; sleep disorders; abdominal pain and pressure; backache; fever; cardiac dysrhythmia such as cardiac palpitation and tachycardia; thoracic pain and pressure; articular pain as well as diarrhoea or constipation or both. All questions referred to the last four weeks, giving the categories 'not at all', 'a little bit' and 'strongly' (see Table 5, Appendix A). Since we are interested in the structure of mental and physical symptoms and want to consider areas with low population densities, the weighting factors included in the dataset are not used.

Considering medication in the paper 'Constructing space of mental and physical health', the following items are included: sedative agent, vitamin preparation, analgesic agent, reconstituent agent, somnifacient agent, anti-asthmatic agent, anti-rheumatic agent, medication for constipation, cardiac agent and hypotensive agent (see Table 5, Appendix A).

5.2.2 Socio-demographic variables

To test the association of socio-demographic variables with mental and physical health, differentiated by age groups (15-21, 22-28, ..., 85-91, 92+ years), household income (0-3,000 Swiss Francs (SFR), 3,001-6,000 SFR, 6,001-9,000 SFR, 9,000+ SFR), gender and educational level (in education, primary school, vocational school, secondary school, high school, university, no education) are included. Although these variables were often treated as ordinal or even metric, they were kept as nominal to check for non-linear relationships within the space of physical and mental health. In the first paper, socio-professional categories, which are created on basis of work position, amount of employment and last achieved occupation, are added as socio-economic variables.

5.2.3 Geographical data

To study area effects on the perception of health, the following Swiss classifications of regions and areas were used: the three Swiss language areas - German, French and Italian, seven statistical regions following the European Nomenclature of Territorial Units (NUTS-2), eight classes of municipalities by population size, 22 municipality types, and 106 Mobilité spatial (MS) regions (see Table 6, Appendix A).

Municipality typology was developed to classify the approximately 3,000 Swiss municipalities following the centre-periphery model for describing the spatial organisation of Switzerland. The classification was based on the 1980 Swiss Census (and updated in 1990),

and differentiated large centres, middle-sized centres, and small centres as well as centres of peripheral regions (cf. Joye et al., 1988). Characteristics for the suburban municipalities were defined with the regard to the density of jobs, the number of commuters, the housing structure and the income of the inhabitants. Characteristics for the municipalities outside the suburban area were based on the dominant economic structure of the inhabitants as well as on the migration rate (Joye et al., 1988).

The 106 'mobilité spatial' (MS) regions have been used as an important regional analysis level. They differentiate mountain, urban and regional planning regions. This classification reflects spatial mobility patterns and small labour market areas with functional orientation towards centres, and depicts regions of homogeneous socioeconomic conditions and commuter coherences (Schuler et al., 1997).

6 Method

„It's difficult to understand why statisticians commonly limit their inquiries to Averages, and do not revel in more comprehensive views. Their souls seem as dull to the charm of variety as that of the native of one of our own flat English countries, whose retrospect of Switzerland was that, if its mountains could be thrown into its lakes, two nuisances would be got rid of at once. An average is but a solitary fact, whereas if a single other fact be added to it, an entire Normal Scheme, which nearly corresponds to the observed one, starts potentially into existence...
Some people hate the very name of statistics, but I find them full of beauty and interest. Whenever they are not brutalised, but delicately handled by the higher methods, and are warily interpreted, their power of dealing with complicated phenomena is extraordinary. They are the only tools by which an opening can be cut through the formidable thicket of difficulties that bare the path of those who pursue the Science of man.'

Francis Galton (1889), *Natural Inheritance*, London: Macmillan (from D.W. Forrest (1974), *Francis Galton: The Life and Work of a Victorian Genius,* New York: Taplinger Publishing Co.; in Gifi (1990).

6.1 Introduction

This thesis takes an inductive exploratory data analysis (EDA) approach. 'Exploratory data analysis is detective work – numerical detective work – or counting detective work – or graphical detective work.' (Tukey, 1977, p. 1). Like a detective investigating a crime, we use tools and our understanding in explorative data analysis. Pictures based on EDA force their messages upon us. The greatest value of such a picture is when it forces us to notice what we never expected to see (Tukey, 1977, p. vi). By analysing relationships with EDA it is possible to receive new insights into an impressive multidimensional space.

In a Cartesian coordinate system, space has two or more dimensions. Space can be based on simple Euclidian distances or on different systems with different relativity in space and time. However, each system can be described with abstract spaces in many dimensions. 'Systems of axes are linked unalterably to our bodies, and carried about with us wherever we go', as Poincaré (1854-1912) puts it. This structures practical space into right and left, up and down, in front and behind (Bourdieu, 1977). The idea of the 1980s and 1990s, that space is socially 'produced' or 'constructed', is also worth noting (Lagopoulos, 1993; Sywyngedouw, 1992).

Analysing patterns and structures of our self, this thesis seeks to find a fictional health perception space according to Bourdieu's social space. Bourdieu (1979, 1984) argued that

structures of the social world can be visualised within a social space. Following Bourdieu's work, Gatrell et al., (2004) constructed a social space with correspondence analysis to explore the inter-relationships between a number of socio-demographic characteristics such as sex, age and work status. They also included several items measuring economic, cultural and social capital in the same sense as Bourdieu such as PC and car ownership, and neighbour contacts. In a subsequent step, they introduced health characteristics into their social space. Taking the idea of constructing a latent space, this thesis aims to construct a health space on the basis of health characteristics. For deeper interpretation of this space, a system of axes is proposed that is linked unalterably to our mind and perception as Poincaré postulated for our bodies. As the primary characteristics are ordinally scaled and to keep the information about the categories' order, scaling methods such as correspondence analysis and categorical principal component analysis (CatPCA) as an inductive statistical approach are used.

In this methodological part of the thesis, I shall provide some general mathematical notions of a conceptual space. An axiomatic system for geometry can be constructed from two relationships, the betweenness and the equidistance defined over a space of points, lines or planes. Based on ordinary Euclidian geometry, the basic axioms for betweenness can be supplemented with an axiom for density. Equidistance is a four-place relation $E(a,b,c,d)$, which is read as 'point a is as far from point b as point c is from point d' (Gärdenfors, 2000), p. 17). Based on equidistance and betweenness, we can construct a metric space with a distant function D for the space H (H means 'health'). In the two-dimensional space R^2 Euclidian distance

$$d_E(x,y) = \sqrt{((x_1 - y_1)^2 + (x_2 - y_2)^2)}$$

satisfies the following conditions for all points a, b and c in H (Gärdenfors, 2000, p. 18):

$D1: d(a,b) \geq 0$ and $d(a,b) = 0$ only if $a = b$ (minimality)
$D2: d(a,b) = d(b,a)$ (symmetry)
$D3: d(a,b) + d(b,c) \geq d(a,c)$ (triangle inequality)

In a metric space a betweenness relation B and an equidistance relation E can be defined in the following way:

Definition of Betweenness: $B(a,b,c)$ if and only if $d(a,b) + d(b,c) = d(a,c)$

Definition of Equidistance: $E(a,b,c,d)$ if and only if $d(a,b) = d(c,d)$

For the Euclidian distance function, the definition of the betweenness relation has the effect that all points between a and b are the ones on the straight line between a and b.
Additionally, other metrics exist to define a metric space on R^2 such as city-block metric. In CA and CatPCA the Euclidian distance define the metric space.

This methodical section will give a brief introduction to correspondence analysis (CA) and categorical principal component analysis (CatPCA). Both methods are explorative multivariate analysis techniques which are associated with different aspects of correlation matrices. In confirmatory statistical methods, for example multiple regression, we try to predict one variable from the other variables. The aspect, in which we are interested, is the multiple correlation coefficient. In contrast, in principal component analysis we are interested in one or several of the eigenvalues of the correlation matrix; in canonical correlation analysis we look at the canonical correlations, and in many multi-nominal likelihood procedures we study the determinant of the correlation matrix (de Leeuw, 1990).

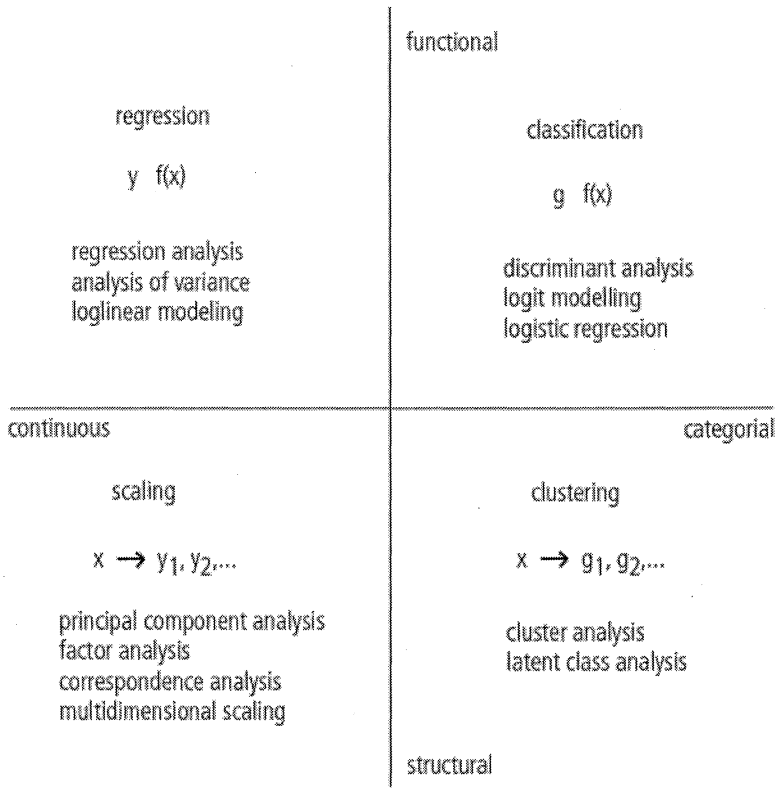

Figure 3: Outline of multivariate analysis methods (Source: Blasius, 2001)

Blasius (2001) illustrated the placement of the statistical methods in a coordinate system with a function–structure axis and a continuous-categorical axis (Fig. 3). In contrast to regression, classification and clustering, the scaling methods CA and CatPCA are to apply for the analysis of the structure of continuous data.

In physics and chemistry, scaling methods are preferred for continuous variables and for analysing structures. More recently in sociology and psychology, nonlinear categorical principal component analysis has been implemented, especially for categorical variables. Two quite different forms of nonlinear principal component analysis have been proposed. The first – so-called multiple correspondence analysis (MCA) and the second – non-metric or categorical principle component analysis or categorical principle component analysis (Cat PCA). Gifi (1990) has related and combined the two forms geometrically and computationally.

6.2 Correspondence analysis (CA)

Benzécri (1973) presented correspondence analysis as a model-free inductive exploratory approach. CA is seen to be helpful when we want 'to let the data speak for itself'. Van der Heijden & de Leeuw (1989) and de Leeuw (1982) adopted another definition of a model for CA, namely that a model is a non-linear projection of the data on a usually low-dimensional parameter space. The term 'model-free' suggests that no explicit decisions are to be taken in studying the data. The primary goal of CA is to transform a table of numerical information about relationships in a n-dimensional space into a lower dimensional graphical space. Graphical techniques such as histograms, box-plots and various types of scattergrams are common, especially in descriptive statistics. As example of CA, Table 1 shows a contingency table (health-related well-being and municipality types) and Fig. 4 the corresponding output of correspondence analysis, which is called a 'map'. The three primary concepts of CA are 'profiles', 'masses' and 'chi-squared distances' (Greenacre and Blasius, 1994).

Conventionally, a single χ^2 statistic is used to summarise the information of such a contingency table. This collapses by introduction of a considerable volume of data and it is of interest to explore relationships between particular categories of the variables. Correspondence analysis permits us to visualise these inter-relationships (Gatrell et al., 2004).

Table 1: 4 x 22 table of frequencies from health-related well-being and municipality types (see Paper 1)

22 Municipality types Chi-Square p = <0,0001, Cramer's V = 0,05	Health-related well-being				
	Very good	Good	Moderate	Poor/very poor	Total
MUT1 Large centres	488	1040	251	91	1870
MUT2 Middle-sized centres	374	874	227	80	1555
MUT3 Small centres	251	543	108	37	939
MUT4 Centres of peripheral regions	109	215	54	17	395
MUT5 Affluent municipalities	169	341	75	19	604
MUT6 Touristy municipalities	185	349	77	22	633
MUT7 Semi-touristy municipalities	82	155	25	7	269
MUT8 Municipalities with homes and institutions	63	160	37	6	266
MUT9 Employment municipalities in metropolitan regions	174	337	86	23	620
MUT10 Suburban municipalities in metropolitan regions	216	469	123	35	843
MUT11 Periurban municipalities in metropolitan regions	105	183	33	11	332
MUT12 Employment m. in non-metropolitan regions	208	502	117	30	857
MUT13 Suburban m. in non-metropolitan regions	144	314	56	31	545
MUT14 Periurban m. in non-metropolitan regions	254	544	113	40	951
MUT15 Allochthonous commuter municipalities	118	220	45	17	400
MUT16 Autochthonous commuter municipalities	63	121	26	7	217
MUT17 M. with industrial-tertiary working population	126	362	85	22	595
MUT18 Municipalities with industrial working population	102	193	37	12	344
MUT19 M. with agrarian-industrial working population	81	192	50	10	333
MUT20 M. with agrarian-tertiary working population	82	162	36	11	291
MUT21 Municipalities with agrarian working population	13	65	11	4	93
MUT22 Municipalities with huge population decline	11	22	11	4	48
Total	3418	7363	1683	536	13000

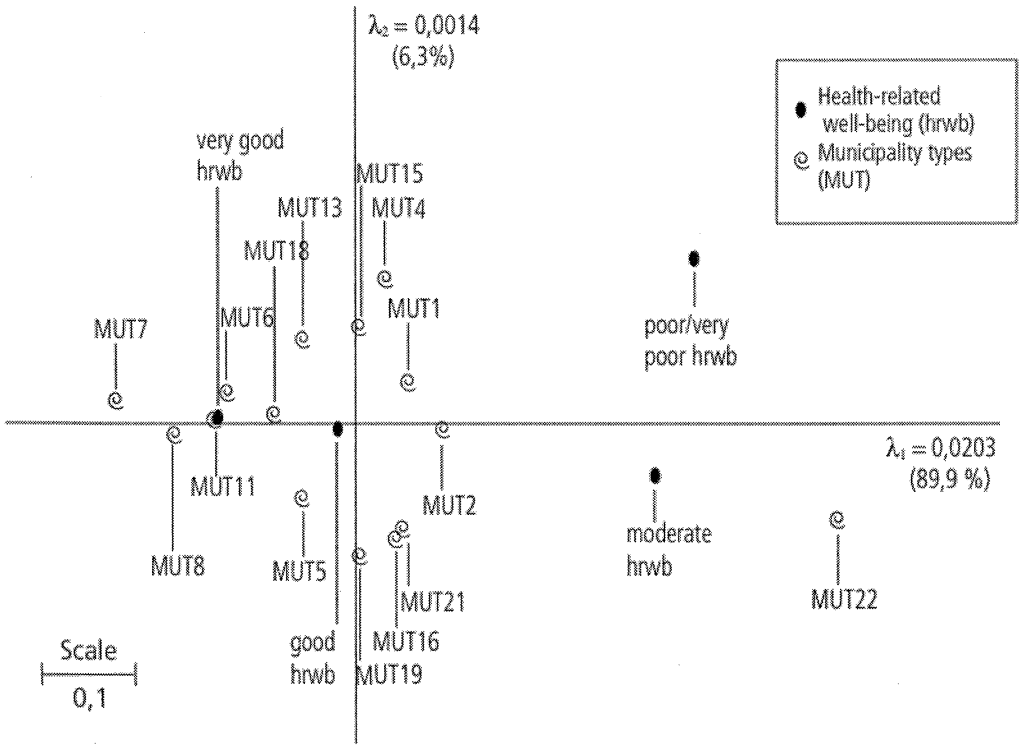

Figure 4: Two-dimensional symmetric CA map of health-related well-being and 22 municipality types (see Paper 1)

There follows a short introduction to these concepts and in the computation of CA. We start with the contingency table (e.g. Table 1) of

$$T_H(I \times J) \tag{1}$$

where I is number of rows and J the number of columns in the given health table T_H (Fig. 4). Each row and each column have a different number of respondents, called the base of respondents. For comparison we bring rows and columns of table T_H more in line with their common base of 100% by computing percentages relative to the row or column totals. The decision how to choose to compute percentages, either row-wise or column-wise, depends on the predominant interest either in the describing (independent) variables, or in the (dependent) variables that have to be described. Such a set of percentages, calculated for a row or a column of frequencies, is called a *profile*. The last row is the profile of the column totals of the health table T_H and is called the *average profile* (Table 1).

If the row sums are $n_{1+}, n_{2+}, \ldots, n_{I+}$ of T_H, where e.g. $n_{1+} = \sum_j n_{1j}$ and (2)

the column sums are $n_{+1}, n_{+2}, \ldots, n_{+I}$ of T_H, where e.g. $n_{+2} = \sum_i n_{i2}$ then (3)

the grand total of the health table T_H is $\sum_i \sum_j n_{ij}$ (4)

(Blasius and Greenacre, 1994).

6.2.1 Profiles

The profiles are mathematical 'vectors' which can be interpreted geometrically because they define points in a multidimensional space. They are also called 'objects' (xxx). Each profile is defined by a certain number of cases or respondents (relative frequency), who constitute the profile. Elements in a row profile or a column profile can be used as coordinates to locate the vectors in a multi-dimensional space. Each profile is thus condensed into a unique point in this space. The multidimensionality of the profiles can be reduced for visualising the profiles in a two-dimensional plane (Greenacre and Blasius, 1994).

6.2.2 Masses

As fundamental as the first concept in CA, the second is that of a *mass* associated with each profile. Each profile is assigned a weight proportional to the whole respondents. The marginal frequencies are then divided by the grand total of the table, to obtain quantities, which are called *row masses* and which are used to weight each row profile differently in the analysis (Greenacre and Blasius, 1994).

The row masses $r_1, r_2, \ldots, r_I$ are the row sums divided by the grand total

$$r_i = \frac{n_{i+}}{n} \tag{5}$$

The vector of row masses will be denoted by **r**.

The column masses $c_1, c_2, \ldots, c_I$ are the column totals divided by the grand total

$$c_j = \frac{n_{+j}}{n} \tag{6}$$

The vector of column masses will be denoted by **c** (Greenacre and Blasius, 1994).

The average profile (e.g. over the rows), which is the profile of the column totals of the data, represents the weighted average of the individual row profiles, where the weights are the corresponding masses. In this sense, the average profile can be thought of as lying in an average, or central, position in the cloud of profile points, but tends to lie more towards the profiles which have higher mass (Blasius, 2001).

6.2.3 Distances

Situating the profile vectors in the multi-dimensional space, an intuitive idea of the position of a profile in this space and of distances between profile points is possible (see also the betweenness and equidistance concepts of Gärdenfors, 2000). The similarity of the profiles can be seen as a function of distance. In CA the concept of *Euclidian distance*, also known as *Pythagorean distance*, is used to construct a metric space. Considering the general case of a set of I points in J-dimensional space, coordinates are defined through the rows of the matrix Y, with masses $w_1, w_2, \ldots, w_I$ assigned to the respective points and the space is structured by the weighted Euclidian with dimension weights $q_1, q_2, \ldots, q_J$ associated with the respective dimensions. The distance between any two points, say **x** and **y**, is equal to

$$\sqrt{(\mathbf{x}-\mathbf{y})^{\mathrm{T}}\mathbf{D}_{\mathbf{q}}(\mathbf{x}-\mathbf{y})} \tag{7}$$

where $\mathbf{D}_{\mathbf{q}}$ is a diagonal matrix of point masses and dimension weights respectively.

In CA, the use of a variation of Euclidian distance called a *weighted Euclidian distance* to measure is accepted and depicts distances between profile points. Because of the analogy with the chi-squared concept of calculating squared differences between proportions relative to their expected, or mean, values, this distance is known as the *chi-square distance* (Greenacre and Blasius, 1994, Blasius, 2001).

6.2.4 Mathematical notions of creating a metric health space

How is it now possible to bring the row and column profiles and masses together and create a space based on a correspondence matrix **H**?

The correspondence matrix **H** is defined as the original health table T_H divided by the grand total n,

$$\mathbf{H} = (\frac{1}{n})T_H \tag{8}$$

where the row and column sums of **H** are the row and column masses respectively.

The row profiles are the rows of the original table T_H divided by their respective row totals. The matrix of row profiles can therefore be defined as the rows of the correspondence matrix **H**, divided by their respective row sums (i.e. row masses), which can be written as

$$\mathbf{D_r^{-1}H} \tag{9}$$

where $\mathbf{D_r}$ is the diagonal matrix of row masses.

The column profiles are the columns of the original table T_H divided by their respective totals. The matrix of column profiles therefore consists of the columns of the correspondence matrix **H** divided by their respective column sums

$$\mathbf{HD_c^{-1}} \tag{10}$$

where $\mathbf{D}_c$ is the diagonal matrix of column masses.

After assembling all entities, the equivalence of row and column problems is considered. The row problem, for example, consists of a set of I profiles in the rows of $\mathbf{D_r^{-1}H}$, with masses **r**

in the diagonal matrix $\mathbf{D}_r$ and in a space with distances defined by the diagonal matrix $\mathbf{D}_c$. It is necessary to derive the centroid of the row profiles, which is:

$$\mathbf{r}^T\mathbf{D}_r^{-1}\mathbf{H} = \mathbf{1}^T\mathbf{H} = \mathbf{c}^T \tag{11}$$

In order to compute the solution to CA, the singular value decomposition (SVD) is used, which is a generalization of the well-known eigenvalue decomposition (EVD). Whereas the eigenvalue-eigenvector decomposition applies to square matrices, which are usually symmetric in statistical applications e.g. decomposition of the correlation matrix in principle components analysis (PCA), the singular-value decomposition applies to rectangular matrices. The SVD is defined as the decomposition of an I x J matrix **A** as the product of three matrices (Greenacre and Blasius, 1994):

$$\mathbf{A} = \mathbf{U}\Gamma\mathbf{V}^T \tag{12}$$

where the matrix $\mathbf{\Gamma}$ is a diagonal matrix of positive numbers in descending order: $\gamma_1 \geq \gamma_2 \geq \ldots \gamma_K > 0$, K is the rank of **A**, and the columns of the matrices **U** and **V** are orthogonal, that is $\mathbf{U}^T\mathbf{U} = \mathbf{V}^T\mathbf{V} = \mathbf{I}$, whereas **I** is the identity matrix (diagonal matrix). The K numbers $\gamma_1, \gamma_2, \ldots$ are called 'singular values', the K columns of **U** are called 'left singular vectors' and the K columns of **V** are called 'right singular vectors'. The close connection between the SVD and the EVD is embodied in the following two results which are obtainable directly from the definition, that a n x m matrix can be written as $\mathbf{Z} = \mathbf{SL}$, where **Z** is the case x variables matrix of mean-centered data (when the covariance matrix is analysed) or both mean-centred and normalized (e.g. 'z-transformed') data (when the correlation matrix is analyzed), the matrix **L** contains the factor loadings and **S** the factor scores (Greenacre and Blasius, 1994):

$$\mathbf{A}^T\mathbf{A} = \mathbf{V}\Gamma^2\mathbf{V}^T \tag{13}$$

$$\mathbf{A}\mathbf{A}^T = \mathbf{U}\Gamma^2\mathbf{U}^T \tag{14}$$

Equation (13) shows that the right singular vectors of **A** are identical to the eigenvectors of $\mathbf{A}^T\mathbf{A}$ and the singular values of **A**, $\gamma_1^2, \gamma_2^2, \ldots \gamma_K^2$, are the square roots of the eigenvalues of $\mathbf{A}^T\mathbf{A}$. Equation (14) shows the similar connection to the eigenvalues and eigenvectors of $\mathbf{A}\mathbf{A}^T$.

Recalling the third concept of CA the *Euclidian distances* (see equation (7)) SVD is useful. For the matrix **Y** (described above) let $\mathbf{D}_w$ and $\mathbf{D}_q$ be the diagonal matrices of point masses and dimension weights respectively, and let w be the vector of point masses, assuming the

point masses add up to 1: $\sum_i w_i = 1$, or in matrix notation: $\mathbf{1}^{\mathbf{T}}\mathbf{w} = 1$, where $\mathbf{1}$ is the vector of ones. The general result is that any low-dimensional map of the points can be derived directly from the SVD of the following matrix:

$$\mathbf{A} = \mathbf{D}_{\mathbf{w}}^{1/2}(\mathbf{Y} - \mathbf{1}\mathbf{y}^{\mathbf{T}})\mathbf{D}_{\mathbf{q}}^{1/2} \tag{15}$$

where $\mathbf{y}^{\mathbf{T}}$ is the centroid of the rows of $\mathbf{Y}$.

Inserting for the centroid equation (11) the matrix $\mathbf{A}$ is thus:

$$\mathbf{A} = \mathbf{D}_{\mathbf{r}}^{1/2}(\mathbf{D}_{\mathbf{r}}^{-1}\mathbf{H} - \mathbf{1}\mathbf{c}^{\mathbf{T}})\mathbf{D}_{\mathbf{c}}^{-1/2} = \mathbf{D}_{\mathbf{r}}^{1/2}(\mathbf{H} - \mathbf{r}\mathbf{c}^{\mathbf{T}})\mathbf{D}_{\mathbf{c}}^{-1/2} \tag{16}$$

Remembering the equivalence of row and column problems, the column problem consists of a set of J profiles in the columns of $\mathbf{H}\mathbf{D}_{\mathbf{c}}^{-1}$, which masses $\mathbf{c}$ in the diagonal $\mathbf{D}_{\mathbf{c}}$, in a space with distance defined by the diagonal matrix $\mathbf{D}_{\mathbf{r}}^{-1}$. Analogous to the row profiles we transpose the matrix $\mathbf{H}\mathbf{D}_{\mathbf{c}}^{-1}$ of column profiles to obtain $\mathbf{D}_{\mathbf{c}}^{-1}\mathbf{H}^{\mathbf{T}}$. The centroid of these profiles is $\mathbf{c}^{\mathbf{T}}\mathbf{D}_{\mathbf{c}}^{-1}\mathbf{H}^{\mathbf{T}} = \mathbf{1}^{\mathbf{T}}\mathbf{H}^{\mathbf{T}} = \mathbf{r}^{\mathbf{T}}$, the row vector of row masses. The matrix in (11) is:

$$\mathbf{A} = \mathbf{D}_{\mathbf{c}}^{1/2}(\mathbf{D}_{\mathbf{c}}^{-1}\mathbf{H}^{\mathbf{T}} - \mathbf{1}\mathbf{r}^{\mathbf{T}})\mathbf{D}_{\mathbf{r}}^{-1/2} = \mathbf{D}_{\mathbf{c}}^{1/2}(\mathbf{H}^{\mathbf{T}} - \mathbf{c}\mathbf{r}^{\mathbf{T}})\mathbf{D}_{\mathbf{r}}^{-1/2} \tag{17}$$

which is just the transpose of the matrix derived for the row problem above. Both the row and column problems are solved by computing the SVD of the same matrix, called the matrix of standardized residuals:

$$\mathbf{A} = \mathbf{D}_{\mathbf{r}}^{1/2}(\mathbf{H} - \mathbf{r}\mathbf{c}^{\mathbf{T}})\mathbf{D}_{\mathbf{c}}^{-1/2} \tag{18}$$

i.e. the I x J matrix with elements

$$a_{ij} = \frac{(p_{ij} - r_i c_j)}{\sqrt{r_i c_j}}, \tag{19}$$

where p_{ij} is the observed proportion in the (ij)th cell and $r_i c_j$ the expected proportion calculated from the product of the corresponding marginal proportions. Multiplying this

expression by the sample size n, we would obtain the observed frequency n_{ij} and the expected frequency $\frac{n_{i+}n_{+j}}{n}$.

Squaring the standardized residuals (19), then summing them over the I x J cells of the table and multiplying the result by the total n, the chi-square statistic for the contingency table is obtained:

$$\chi^2 = n\sum_i\sum_j \frac{(p_{ij} - r_i c_j)^2}{r_i c_j} \tag{20}$$

The decomposition of the matrix **A** of standardized residuals implicitly involves de decomposition of the chi-square statistic, which is proportional to the sum of squares of the elements of **A**.

From (20) follows that the chi-square statistic can be decomposed into I x J components of the form:

$$n \times \frac{(p_{ij} - r_i c_j)^2}{r_i c_j} \tag{21}$$

which is identical to the usual terms in the chi-square calculation of the form:

$$\frac{\left(\frac{n_{ij} - n_{i+}n_{+j}}{n}\right)^2}{\frac{n_{i+}n_{+j}}{n}} \tag{22}$$

where $\frac{n_{i+}n_{+j}}{n}$ is the well-known 'expected frequency' (Greenacre and Blasius, 1994).

6.2.5 Inertia

The sum of the squares of the elements of **A** is the 'total inertia (λ)' of the contingency table:

$$\lambda = \sum_i\sum_j \frac{(p_{ij} - r_i c_j)^2}{r_i c_j} \tag{23}$$

which from (20) is the chi-square statistic divided by n:

$$\text{total inertia } \lambda = \frac{\chi^2}{n} \tag{24}$$

The term *inertia* or moment of inertia (Drehmoment) is borrowed from mechanics. Every physical object has a centre of gravity, or centroid. Every particle constructing that object has a certain mass (r) and a certain distance (d) from the centroid. The (moment of) inertia of the object is defined as the sum of the quantities rd^2 for the whole object. In CA a set of profile point with masses adding up to 1 exist, these points have a centroid (the average profile) and there is a measure of distance (the chi-square distance) between profiles. Each profile points contributes a certain amount towards this inertia (Blasius, 2001, Greenacre and Blasius, 1994).

There exist $K = \min\{I-1, J-1\}$ dimensions in the solution. The squares of the singular values $\mathbf{A}$ in (16), i.e. the eigenvalues of $\mathbf{A}^{\mathbf{T}}\mathbf{A}$ or $\mathbf{A}\mathbf{A}^{\mathbf{T}}$, also decompose the total inertia. These are denoted by $\lambda_1, \lambda_2, \ldots, \lambda_K$ and are called the principal inertias. As in PCA, the principal inertias are often expressed as percentages of the total inertia.

6.2.6 Principal coordinates

To go back to (15) and write the SVD as

$$\mathbf{A} = \mathbf{U}\Gamma\mathbf{V}^{\mathbf{T}} \tag{25}$$

then the principal coordinates of the row points, i.e. the projections of the row profiles onto principal axes, are contained in the following matrix:

$$\mathbf{F} = \mathbf{D}_{\mathbf{w}}^{-1/2}\mathbf{U}\Gamma \tag{26}$$

for example, the coordinates of the points in an optimal two-dimensional display are contained in the first two columns of **F**, The principal axes of the display are contained in the matrix:

$$\mathbf{A} = \mathbf{D}_{\mathbf{q}}^{-1/2}\mathbf{V} \tag{27}$$

where for example, the first two principal axes are the first two column vectors of **A**.

In CA, the principal coordinates of the rows are obtained using (26), for the row problem, i.e.:

$$\mathbf{F} = \mathbf{D}_r^{-1/2}\mathbf{U}\Gamma \tag{28}$$

or in scalar notation:

$$f_{ik} = \frac{u_{ik}\gamma_k}{\sqrt{r_i}}$$

The principal coordinates of the columns are obtained using (26), for the column problem, i.e.:

$$\mathbf{G} = \mathbf{D}_c^{-1/2}\mathbf{V}\Gamma \tag{29}$$

or

$$g_{ik} = \frac{v_{ik}\gamma_k}{\sqrt{c_i}}$$

The standard coordinates of the rows are the principal coordinates divided by their respective singular values:

$$\mathbf{X} = \mathbf{F}\Gamma^{-1} = \mathbf{D}_r^{-1/2}\mathbf{U} \tag{30}$$

or

$$x_{ik} = \frac{f_{ik}}{\gamma_k}$$

The standard coordinates of the columns are the principal coordinates divided by their respective singular values, in other words the standard coordinates are

$$\mathbf{Y} = \mathbf{G}\Gamma^{-1} = \mathbf{D}_c^{-1/2}\mathbf{V} \tag{31}$$

or

$$y_{ik} = \frac{g_{ik}}{\gamma_k}$$

Each principal inertia λ_K is decomposed into components $r_i f_{ik}^2$ for each row i:

$$\lambda_K = \sum_I r_i f_{ik}^2$$

or

$$\mathbf{D}_\lambda = \mathbf{F}^{\mathrm{T}}\mathbf{D}_{\mathrm{r}}\mathbf{F} \tag{32}$$

The contributions of the rows to the principal inertia are conventionally defined as the inertia components relative to their total (the principal inertia λ_K):

$$\frac{r_i f_{ik}^2}{\lambda_K} \tag{33}$$

The interpretation of the row contributions is opposite to that of the squared factor loadings. Whereas the squared factor loadings tell to what extent each row category and each column category is described by the axes, the contributions of inertia show to what extent the geometric orientation of an axis is determined by the single variable categories (Greenacre and Blasius, 1994).

For the *i*th row the inertia components for all K axes sum up to the 'row inertia' of the *i*th row, which is defined as the mass x squared distance of the row profile to the centroid:

$$\sum_j \frac{(\frac{p_{ij}}{r_i - c_j})^2}{c_j} = \sum_k r_i f_{ik}^2 \tag{34}$$

The row inertia on the left-hand side is identical to the sum of squared elements in the *i*th row of **A**:

$$\sum_j s_{ij}^2 = \sum_j \frac{(p_{ij} - r_i c_j)^2}{r_i c_j} \tag{35}$$

The squared correlations of the rows with the principal axes are the inertia components

$$\frac{r_i f_{ik}^2}{\sum_j s_{ij}^2} \tag{36}$$

These can be interpreted geometrically as the squared cosines of the angles between each row profile and each principal axis.

In the reduced K^* -dimensional space, the explained inertia can be summed over the K^* axes to obtain a measure of quality of display for each row:

$$\text{Quality of } i\text{th row} = \frac{\sum_{k=1}^{K*} r_i f_{ik}^2}{\sum_j s_{ij}^2} \tag{37}$$

Geometrically, the qualities can also be interpreted as the squared cosines of the angle between each row profile and the subspace defined by the first K^* axes. The qualities are equivalent to the communalities in PCA.

The square root of the quantities is correlated between each row profile and each principal axis. By attaching the sign of the corresponding coordinate to each correlation, we obtain the equivalent of the factor loadings in PCA (Greenacre and Blasius, 1994).

Each principal inertia λ_K is decomposed into components $c_j g_{ik}^2$ for each row j:

$$\lambda_K = \sum_j c_j g_{jk}^2 \tag{38}$$

or

$$\mathbf{D}_\lambda = \mathbf{G}^{\mathrm{T}}\mathbf{D}_{\mathrm{r}}\mathbf{G}$$

Similarly to the rows we can transform principal inertia to the quality jth column:

$$\text{Quality of } j\text{th column} = \frac{\sum_{k=1}^{K*} c_j g_{jk}^2}{\sum_j s_{ij}^2} \tag{39}$$

The row profiles are situated in a K-dimensional space. The chi-square distances between the row points can be calculated exactly in this full space. For the ith and I'th rows, the distance between them is:

$$\sqrt{\sum_j \frac{\left(\frac{p_{ij}}{r_i} - \frac{p_{i'j}}{r_{i'}}\right)^2}{c_j}} \tag{40}$$

These distances are also the usual Euclidian distances between the principal coordinates in all K dimensions:

$$\sqrt{\sum_{k=1}^{K} (f_{ik} - f_{i'k})^2} \tag{41}$$

In the low-dimensional map, or reduced space, of dimensionality K^*, the distances between row points can be calculated as the usual Euclidian distance between their principal coordinated:

$$\sqrt{\sum_{k=1}^{K^*}(f_{ik} - f_{i'k})^2} \tag{42}$$

Being partial sums of the distances, these distances in the reduced space are all less than or equal to the distances in the full space.

The same can be computed for the column profiles situated in a K-dimensional space or in a reduced K^*-dimensional space.

The original correspondence matrix can be reconstructed from the row and column masses, the principal inertias and the row and column coordinates in either the principal or standard form. This 'reconstitution formula' is derived from the SVD of the matrix of standardized residuals given by formula and the definitions of the principal and standard coordinates in terms of the singular vectors and singular values. Depending on whether the principal or standard coordinates are used, this formula can be expressed in four equivalent ways:

$$\mathbf{H} = \mathbf{r}\mathbf{c}^{\mathbf{T}} + \mathbf{D}_{\mathbf{r}}\mathbf{F}\boldsymbol{\Gamma}^{-1}\mathbf{G}^{\mathbf{T}}\mathbf{D}_{\mathbf{c}}$$

$$\mathbf{H} = \mathbf{r}\mathbf{c}^{\mathbf{T}} + \mathbf{D}_{\mathbf{r}}\mathbf{F}\mathbf{Y}^{\mathbf{T}}\mathbf{D}_{\mathbf{c}}$$

$$\mathbf{H} = \mathbf{r}\mathbf{c}^{\mathbf{T}} + \mathbf{D}_{\mathbf{r}}\mathbf{X}\mathbf{G}^{\mathbf{T}}\mathbf{D}_{\mathbf{c}}$$

$$\mathbf{H} = \mathbf{r}\mathbf{c}^{\mathbf{T}} + \mathbf{D}_{\mathbf{r}}\mathbf{X}\boldsymbol{\Gamma}^{-1}\mathbf{Y}^{\mathbf{T}}\mathbf{D}_{\mathbf{c}}$$

The essential numerical results of CA are the table of eigenvalues (principal inertias) and percentage of inertia, given in Table 2, Table 3 and Table 4.

Table 2: Summary of CA outputs for health-related well-being and MUT (computation in SPSS®)

Dimension	Singular Value	Inertia	Chi Square	Sig.	Proportion of Inertia		Confidence Singular Value	
					Accounted for	Cumulative	Standard Deviation	Correlation
1	.048	.002			.512	.512	.009	.008
2	.034	.001			.265	.777	.009	
3	.032	.001			.223	1.000		
Total		.004	58.305	.644[a]	1.000	1.000		

[a] 63 degrees of freedom

Table 3: Overview of row points for health-related well-being and MUT (computation in SPSS®)

MUT	Mass	Score in Dimension		Inertia	Contribution				
					Of Point to Inertia of Dimension		Of Dimension to Inertia of Point		
		1	2		1	2	1	2	Total
1	.133	-.102	.132	.000	.029	.067	.405	.491	.895
2	.116	.073	-.076	.000	.013	.020	.143	.112	.255
3	.080	.070	-.325	.000	.008	.245	.055	.860	.914
4	.017	.209	.073	.000	.015	.003	.906	.079	.984
5	.041	.500	-.123	.001	.213	.018	.917	.040	.957
6	.026	.218	-.359	.000	.026	.096	.332	.648	.980
7	.013	.118	-.188	.000	.004	.013	.059	.108	.167
8	.005	.104	.595	.000	.001	.050	.020	.470	.490
9	.059	.158	.360	.000	.031	.221	.201	.748	.949
10	.069	-.333	-.098	.000	.160	.019	.941	.058	1.000
11	.028	-.032	-.151	.000	.001	.018	.036	.575	.612
12	.073	.000	.061	.000	.000	.008	.000	.631	.631
13	.045	.020	-.071	.000	.000	.007	.022	.198	.220
14	.086	-.259	-.025	.000	.120	.002	.993	.006	.999
15	.035	-.024	-.010	.000	.000	.000	.170	.021	.191
16	.019	-.146	-.067	.000	.009	.003	.059	.009	.068
17	.052	.307	.204	.000	.103	.063	.750	.238	.988
18	.033	-.095	.369	.000	.006	.132	.083	.913	.996
19	.032	-.153	.085	.000	.015	.007	.814	.182	.996
20	.026	.282	-.073	.000	.043	.004	.608	.029	.637
21	.008	-1.059	-.119	.000	.196	.003	.953	.009	.962
22	.004	.295	-.136	.000	.007	.002	.120	.018	.138
Active Total	1.000			0.004	1.000	1.000			

Table 4: Overview of column points for health-related well-being and MUT (computation in SPSS®)

Health-related well-being	Mass	Score in Dimension		Inertia	Contribution				
					Of Point to Inertia of Dimension		Of Dimension to Inertia of Point		
		1	2		1	2	1	2	Total
1	.263	.178	-.132	.001	.175	.134	.406	.161	.566
2	.566	-.044	.154	.001	.022	.390	.096	.865	.961
3	.129	.128	-.284	.001	.044	.303	.103	.366	.469
4	.041	-.939	-.380	.002	.759	.173	.882	.104	.986
Active Total	1.000			.004	1.000	1.000			

6.3 Categorical principal component analysis (CatPCA)

Principal Component Analysis (PCA) is a well-known technique of displaying relationships between cases associated by several variables. With (ordered and unordered) categorical variables, PCA is not immediately available, although these variables are often treated as if they were numerical. The more appropriate technique is to use Categorical Principal Component Analysis (CatPCA, also known as non-linear principal components analysis) in which the category values (for example, '1' to '4'; in the given example 'very often', 'relatively often', 'sometimes', 'never') are replaced by optimal scores in each dimension (for details, see Gifi, 1990; Heiser & Meulman, 1994). The optimal scoring process allows order-

constraints to be imposed so that ordered categorical variables receive increasing, or at least non-decreasing, quantifications (as well as 'optimal scores' to the single dimensions) as the category-levels become increasingly severe within the r-dimensional space (with $r = 1, 2, ...$; usually $r = 2$).

If the responses are not consistent with the implied ordering in r dimensions, this manifests itself by giving tied optimal quantifications for two or more subsequent categories. Unlike classical PCA, the number r of dimensions required in the fit must be specified in advance and the solutions for r and $r + 1$ dimensions are not nested. Once the quantifications and the object scores in the r-dimensional space have been found, the quantifications may replace the category codes of the indicators and the remainder of the analysis may be regarded as a classical PCA. In addition to the object scores of the variable categories, scores for the respondents (subject or respondent scores) are available in each dimension. The mean values of these subject scores are standardized to zero, the variances to one.

In addition to the optimal scores for the variables on each axis, to the quantifications in the r-dimensional space, and to the object scores for the respondents on each axis – as classical PCA – CatPCA provides factor loadings for the variables. Furthermore, CatPCA allows the inclusion of supplementary variables into a given space. Supplementary variables have no influence on the geometric orientation of the axes, but they can be interpreted together with the active variables. These types of variables are often used for including information from a different substantive background, for example, socio-demographic variables.

CatPCA also provides quantifications of the variable categories within r dimensions. The process of finding co-ordinates of points in a lower-dimensional space is the concern of biplots. For quantitative variables and in linear cases biplots are expressed as vectors, therefore the approximation is often interpreted through singular value decomposition (Gabriel, 1971, 1981). By contrast, Gower and Hand (1996) stressed that biplot axes may be interpreted just like other co-ordinate axes, e. g. by projection and reading off a scale. The biplots can be drawn using the information of the variable quantifications in the r-dimensional space (in SPSS®: 'vector coordinates'). Comparing the biplot-axes provides the response structure. In the present study, the biplot will show which characteristics of well-being are performed by the same respondents and which by different, and how the different characteristics are associated with each other.

CatPCA also allows the inclusion of nominal variables; in this case, there are no constraints in the categories' order within the space. Defining all variables as nominal is the object of

homogeneity analysis (Gifi, 1990; Heiser & Meulman, 1994), also known as multiple correspondence analysis (MCA). The calculations are done with the use of standard software (SPSS®).

7 Constructing a health space

The main components of this thesis are four publications, which demonstrate the research development of three years (2003-2006). This chapter summarises the goal of the four studies, the research questions, methods, results and the conclusions of each study.

7.1 Regional patterns of health-related well-being in the Swiss population

Keller-Lengen, Ch. (2005). Regionale Muster im gesundheitlichen Wohlbefinden der Schweizer Bevölkerung. Geographica Helvetica, 60, 97-104.

7.1.1 Introduction and objectives

Since the 1990s, discussions on the state of health considered general and regional characteristics such as statistical areas, cultural and regional characteristics, as well as place of residence or neighbourhoods. For Switzerland, Bopp and Gutzwiller (1999) investigated regional distinctions in mortality ratios. Schüler and Bopp (1997) expressed their research in a cancer atlas comprising several volumes. Koller (2000) showed that in Switzerland, culture and geography are important for health-related well-being. Differences in health-related well-being seem to depend on altitude, hospitalisation periods as well as being concerned with the prevalence of individual risk factors (Koller, 2000). The association of health-related well-being with 22 municipality typologies (Joye et al., 1988) was investigated considering age, gender, level of education and socio-professional characteristics.

7.1.2 Data and methods

In the present study the Swiss Health Survey 1997 (SHS97) is used. Based on the Horwitz-Thompson estimator, SHS97 data have been weighted with consideration for gender, age, place of residence and nationality. Health-related well-being is used as a general health characteristic, whereby the respondents were asked how healthy they felt at the time of asking: excellent, good, moderate, poor or very poor. Several studies support the choice of such self-rated health parameters as a valid measure of health, as self-perceived health is seen to reliably predict 'objective' health outcome measures such as mortality (Carlson, 1998; Sundquist and Johansson, 1997b). Based on the centre-periphery model the 22 municipality types (MT) are created as area classifications, which represented the regional socio-demographic and centre-periphery structure of Switzerland. With simple correspondence analysis multivariate testing is performed.

7.1.3 Results

Based on the contingency table constituted by a matrix of 38 rows and 4 columns a projection space with 37 dimensions was created. The inertia of the first axis is $\lambda_1 = 0.0203$, and for the second axis the inertia is $\lambda_2 = 0.0014$. The first dimension explains 90% of the total variance, the second 6% and a third dimension 4% of the total variance. In ordinal order from left to right the first axis represents a very good health-related well-being (GW1 profile on the left side of the Fig. 5 (enhanced version)) to a poor health-related well-being (GW4 profile on the left side of the Fig. 5). Similarly, the profiles of age as well as socio-economic and socio-professional indicators are ordinally ordered and located along the first axis. Profiles of excellent and good health-related well-being are associated with the profiles of young and well-educated people representing a high socio-professional status. In contrast, the profiles of the elderly and of people with low education and low socio-professional status are associated with the poor health-related well-being profiles.

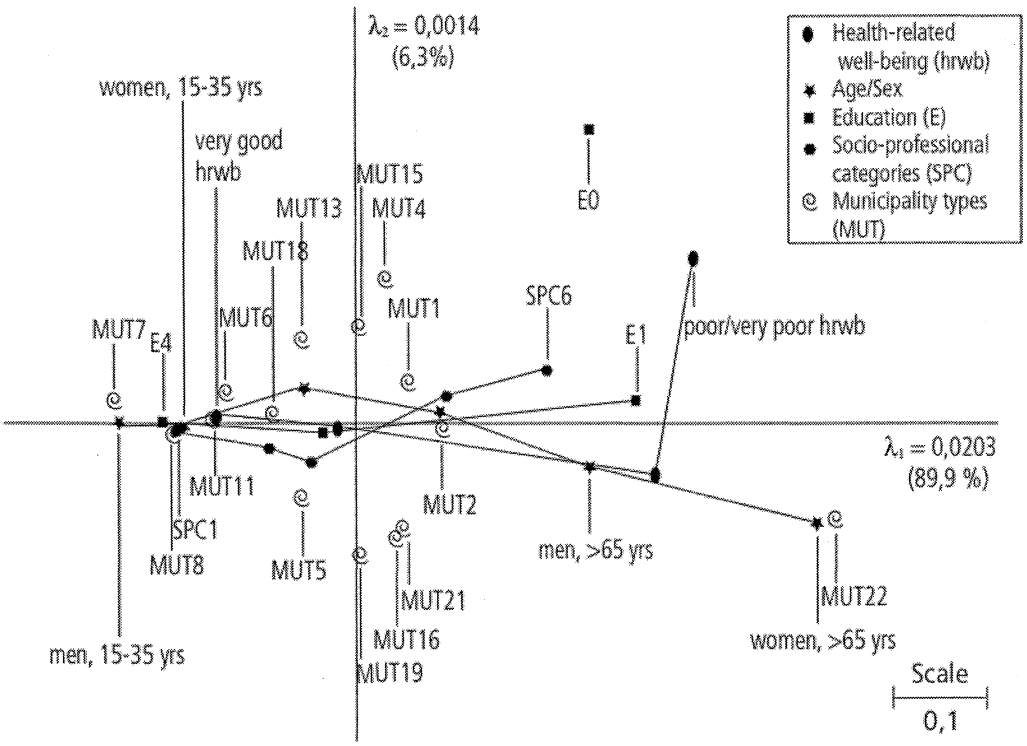

Figure 5: Two-dimensional map of health-related well-being, socio-demographic factors and 22 municipality types

Profiles of tourist and semi-tourist MT's are associated with excellent health-related well-being. Semi-tourist destinations are defined as smaller sized tourist destinations mostly situated in the periphery of the large tourist destination, and dominated by agriculture. The profiles of industrial working population MT's, suburban living municipalities of non-

metropolitan area MT's and affluent MT's are associated with good health-related well-being. In contrast, the MT profiles of large urban centres and middle-sized urban centres and the agrarian working population MT are associated with moderate health-related well-being and the declining population MT profile with poor health-related well-being.

7.1.4 General conclusions

In Switzerland, 83% of the population indicate their general health as good or very good. In particular, age seems to have a stronger influence on health-related well-being than socio-economic and locational characteristics. In urban centres and the rural periphery, health-related well-being is often below the national average. In peri-urban and affluent areas, both representing a higher income area with many single-family homes, as well as tourist and semi-tourist destinations, people consider their general health to be good or very good.

7.2 Space of health-related well-being

Keller-Lengen, Ch. (2005). Space of health-related well-being. In: Fleuret, S. (Ed.): Espace, Bien-Être et qualité de vie. Actes du Colloque EQBE 'Peut-on prétendre à des Espaces de Qualité et de Bien-Être?' Colloque international, Angers (France) les 23 et 24 septembre 2004. Presses Universitaires d'Angers, 287-296.

7.2.1 Introduction

For the Swiss Health Survey 1997 (SHS97), the first study showed weak associations between health-related well-being and socio-demographic as well as spatial differentiation. In a follow-up study, the health-related well-being phenomenon is investigated in more detail. More specifically, we aim to identify which psychological factors may be relevant for respondents to answer as having good general health. This question is considered. Siegrist (2003) postulated that subjective well-being refers to people's judgments about their own state concerning their enduring mood as well as their evaluation of the self and its relation to the material and psychosocial environment. Ryan and Deci (2000) emphasised three psychological needs – competence, autonomy and relatedness, which affect self-motivation and well-being. Additionally, subjective vitality, a positive feeling of aliveness and energy has to be considered as a dynamic reflection of well-being. In this sense, health-related well-being is a construct of psychological, social and physical aspects.

Based on these assumptions this study investigates the relationship between health-related well-being and states of mind such as depression and moodiness, irritation and nervousness, optimism, feelings of power and energy, being calm and well-balanced as well as loneliness, satisfaction with childhood and fear of becoming ill. These psychological characteristics are a part of SHS97. In a first step they are analysed with MCA in an explorative data analysis

approach. In a second step, individual socio-demographic factors and collective Swiss area typologies are integrated in an extended health-related well-being model. In contrast to the use of simple correspondence analysis in the first paper, in this follow-up study multiple correspondence analysis (MCA) was applied. This research work is to be understood as a preliminary stage to the following construction of health space.

7.2.2 Data and methods

The psychological variables of SHS97 differentiated a minimum of three to five Likert scale categories. For the question on loneliness, the four response choices are for instance 'I very often feel alone'; 'I quite often feel alone'; 'I sometimes feel alone' and 'I never feel alone.' The socio-demographic factors include age, gender, education, income and work situation. A variety of spatial classifications across different spatial scales were considered for the analysis. Urban and rural areas are distinguished, as well as three language areas. Municipalities are also classed by population size into eight classes. Finally, twenty-two socio-demographic municipality types are distinguished as well as 106 MS regions.

7.2.3 Results and conclusions

Results suggest a strong and possibly linear ('Horseshoe effect' on the second dimension) association between health-related well-being, moods, loneliness, satisfaction with childhood and fear of becoming ill in the first dimension. A strong effect between age and health-related well-being as well as age and psychological factors could be found in the second dimension. The profiles 'school not completed' or 'no education after school' are associated with poor health-related well-being, moodiness, poor satisfaction of childhood, and fear of becoming ill. The other socio-economic profiles as well as all area typologies are located too close to the centroid to be interpreted in more detail.

As the results show, internal psychological factors have a strong effect on health-related well-being. Socio-demographic aspects and spatial effects turned out to play a less important role for health perception.

7.3 Constructing a health space of self-perceived health

Keller-Lengen, Ch. and Blasius, J. (submitted). Constructing a space of mental and physical health. Social Science & Medicine.

7.3.1 Introduction

Ware (1995) noticed that factor analytic studies confirmed the hypothesized physical and mental components of health. The generally applied health characteristics of the 'Psychological General Well-Being Index' (PGWB), e.g. general health and vitality, do not

discriminate mental from physical health components (Ware, 1995). Hays and Stewart (1990) applied confirmatory factor analysis to distinguish between physical and mental health as well as to relate health factors to socio-demographic variables such as age and income. Motivated by the results of the paper 'Space of health-related well-being' discussed earlier and according to Ware (1995), Hays and Stewart (1990), a health space was constructed with characteristics of health perception. This conceptual space may help us to understand the complexity of health perception and to relate health characteristics to socio-demographic factors. First, on the basis of characteristics of mental and physical symptoms from the SHS97 (sample size: 13,004) a latent space is constructed. Since the variables to be included in the model are ordinal (for example, ranging from 'never' to 'nearly every day') categorical principal component analysis (CatPCA) instead of MCA is applied. Using CatPCA also helps to avoid trivial solutions on the first or second dimension as they can appear when applying MCA (see Gifi, 1990; Van Rijckevorsel, 1987). Second, the structure of this 'health space' is described and the inter-relationships between the selected variables are portrayed using biplot methodology (Gower and Hand, 1996). Finally, with the help of supplementary variables (Gifi, 1990), the interpretation of the constructed health space is extended by additional characteristics, in this example: medication, socio-demographic characteristics and 'health-related well-being' (hrwb).

7.3.2 Methods

From SHS97, we analysed a set of health characteristics such as self-reported general health and mental health, recent symptoms and medication with CatPCA. A detailed list of health variables can be seen in the Appendix A. To test the association of socio-demographic variables with mental and physical health, we include age, household income, gender and educational level. Although these variables are often treated as ordinal or even metric, they are kept as nominal to uncover potential non-linear relationships within the space of physical and mental health.

7.3.3 Results

Fig. 6 presents an earlier version of the health space computed with CatPCA, which has not been published yet. A set of health characteristics (N = 31) such as health-related well-being, satisfaction with body weight, mood variables (N = 6), body symptoms (N = 10) as well as ten medication (N = 10) and three handicap variables are used to construct a health space. Due to missing data, health behaviour characteristics of SHS97 such as drinking alcohol, smoking, wholesome nutrition and movement could not be included. Fig. 6 shows the 31 health characteristics projected into two dimensions. The first dimension has an eigenvalue of $\lambda_1 = 4.912$ and explains 16% of the variation, the second dimension represents an eigenvalue of $\lambda_2 = 2.519$ and explains 1% of the variation, which is negligible. In Fig. 6 we can detect a

cumulation of poor *physical* health profiles in the right bottom quadrant of the coordinate system as well as a cumulation of poor *mental* health profiles in the right upper quadrant of the coordinate system. The distribution of medication profiles correlates with the mood and symptom profiles, in that a daily applied cardiac agent and hypotensive agent, anti-rheumatic agent and medication against constipation correlate with poor physical symptoms. Interestingly, the infrequently applied medication profiles for sedative agent, vitamin preparation, analgesic, reconstituent, and anti-asthmatic agents correlate more strongly with a 'few days of moodiness', in contrast to frequently applied medication which is mostly associated with poor physical symptoms. Age is noticeably correlated with mental and physical health.

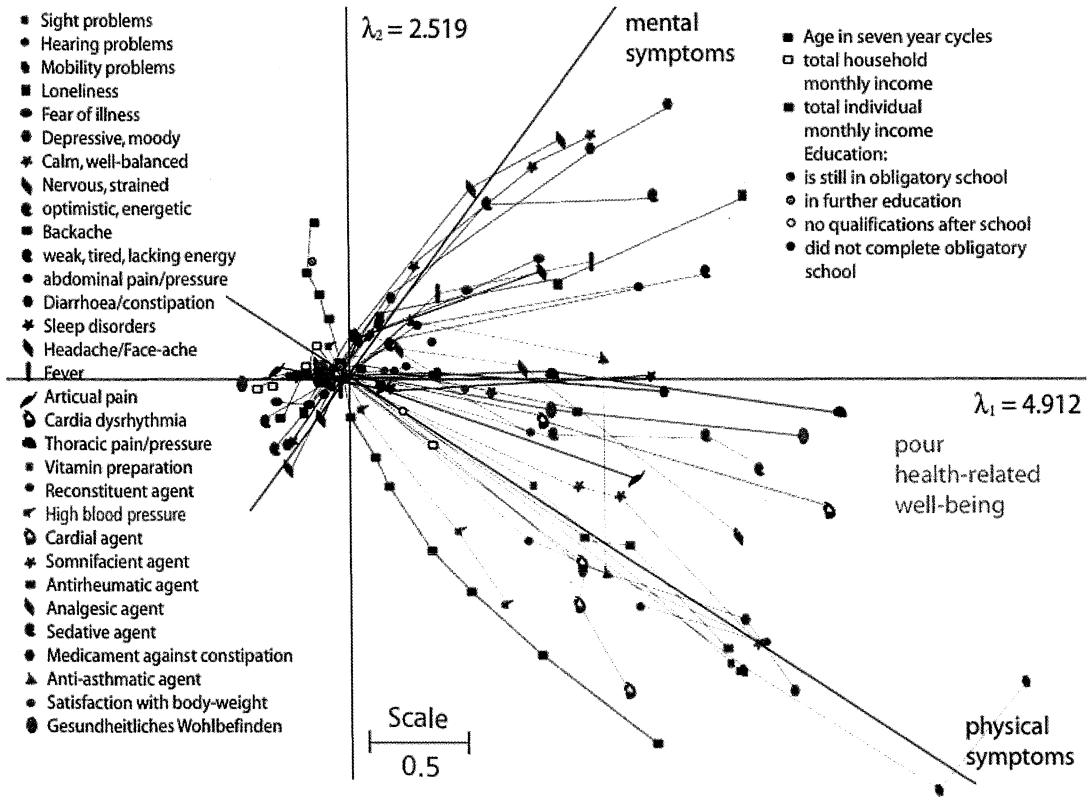

Figure 6: Two-dimensional map of preliminary CatPCA results based on 31 health characteristics, age, income and education presented by principal coordinates

Due to the relatively low level of explained variance and missing data in some health variables, we investigated a more strongly validated set of 16 health variables with CatPCA. In contrast to Fig. 6, where the health space with principal coordinates was mapped, here we depict the vector coordinates of the object points represented in the health space. With CatPCA and MCA an n-dimensional space can be calculated. In this case the maximum

dimension is 16. We fit the data into five dimensions and show the goodness of fit in the Shepard plot (Fig. 7).

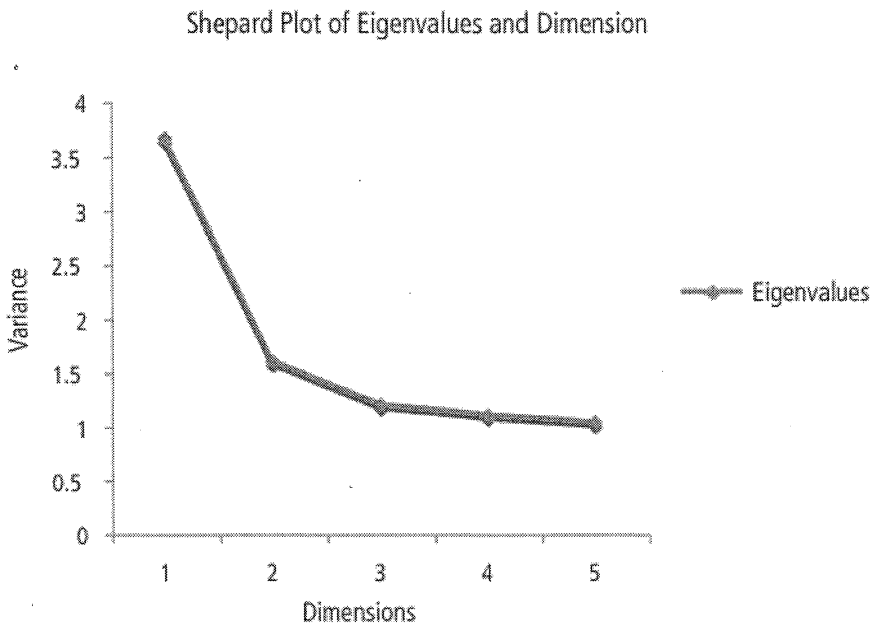

Figure 7: Shepard plot for goodness of fit of the eigenvalues and the five dimensions

The first dimension explains 23.0% of the variation in the data ($\lambda_1 = 3.686$, Fig. 1 in Paper 3), and fits the data best in comparison to the other dimensions (Shepard plot, Fig. 7). The mental symptoms have the strongest component loadings on the first axis (see Table 1 in Paper 3). The first dimension mirrors the distinction between those having good general health and those having poor general health. The second dimension explains an additional 10% of the total variation ($\lambda_2 = 1.598$), and represents the distinction between two kinds of health characteristics: mental and physical symptoms. The third dimension with an eigenvalue of $\lambda_3 = 1.200$ mainly represents the component of 'diarrhoea or constipation, or both' and 'abdominal pain and pressure'. The fourth dimension distinguishes 'fever', 'articular pain' and 'no cardiac dysrhythmia' from the remaining physical health symptoms, the fifth dimension 'cardiac dysrhythmia such as cardiac palpitation and tachycardia' and 'thoracic pain and pressure' as well as 'no sleep disorders', 'no backache' and 'no articular pain'. Dimensions three, four and five represent special physical symptoms, which can be interpreted as symptoms of an illness. Dimension three could be seen as a representation of

intestinal problems, dimension four as a representation of influenza and the fifth dimension as a representation of heart problems. Based on the eigenvalues of the dimensions, depicted in the Shepard plot, we decided on a two-dimensional solution, because the first two dimensions explain most of the variance and adding more dimensions does not provide much more useful information. Dimensions three, four, five and so on do not change the interpretation of the first two dimensions.

By interpreting the 'poor general health' area in the two dimensional solution (Fig. 1 in Paper 3) we can identify three health characteristic clusters. The first cluster reflects poor mental health, indicated by the categories 'not calm and not well-balanced', 'nervous and strained', 'depressive and moody', 'not optimistic and not powerful' as well as 'loneliness'. This cluster is contrasted by a second cluster consisting of the characteristics 'abdominal pain and pressure', 'backache', 'fever', 'cardiac dysrhythmia', 'thoracic pain and pressure', 'articular pain' and 'diarrhoea or constipation or both'. A subdivision of health factors has been uncovered in many other studies investigating the structure of health (for example Cella et al., 2005; Hays and Stewart, 1990). All active health variables are most strongly correlated with the first dimension (which we call general health). All variables have positive factor loadings. This means people's responses in general reflect well-being with respect to the mental and physical symptom questions (see Table 1, Paper 3). The second dimension may be interpreted to reflect the distinction between characteristics of mental and physical health.
However, we can identify four of the variables, which form their own, intermediate cluster, and fall somewhat between mental and physical health. This clusters include 'fear of becoming ill', 'weak, tired and lacking of energy', 'headache and facial pain', and 'sleep disorders' as shown in Fig. 1 in Paper 3. These four characteristics are not properly explained in the two-dimensional solution indicated by their low factor loadings (see Table 2, in Paper 3).

Health-related well-being (hrwb), which is frequently used to assess general health, is mainly correlated with the first dimension of the constructed health space (see factor loadings in Table 2 in Paper 3). It is also correlated with the physical symptoms captured in the second dimension (see Fig. 2 in Paper 3). Similarly, the characteristics of medication are well correlated with the first two dimensions of the latent health space (Fig. 2 and Table 2 in Paper 3). However, as Fig. 2 in Paper 3 shows, nearly all kinds of medication are positively associated with the analogical physical symptoms. This also validates our conceptual space of health.

Mapping age in Fig. 2 (Paper 3), we found the profiles of the youngest people in the mental health space and the profiles of the oldest people in the physical health space. The 'general health' dimension is weakly associated with age.

As shown in Fig. 3 (Paper 3) household income is mainly related to physical health. This becomes visible by projecting the categories on a right angle towards the bisectional dimension of 'physical health': On bottom left there is 'up to 3,000 SFR', on top right there are the two highest income groups ('6,001-9,000 SFR' and '9,000+ SFR'). Furthermore, men reported less physical problems than women and both household income and sex are uncorrelated with mental health symptoms; on this bisectional dimension their 90-degree projections are close to the centroid.

Educational level correlates with physical health symptoms: the lower the educational level, the stronger the reported physical health symptoms; starting with primary school, followed by secondary and vocational school, high school and university. Respondents who are still in education reported to have mental health symptoms above average, the members of this group should mainly belong to the young people. Respondents with no educational degree at all have a relatively poor general health.

7.4 Visualising areas in 'Swiss health space'

Paper 4: Keller-Lengen, Ch., Blasius, J., Kistemann, Th. (submitted). Visualising areas in „Swiss Health Space'. Health & Place.

7.4.1 Introduction

Following Bourdieu (1979, 1984), Gatrell et al. (2004) visualised inequalities within a social space consisting of the two dimensions of economic and social capital. As variables for constructing this space they used, among others, income, age groups, education, work status, articles of daily life in the household, and willingness to move out. In this social space, Gatrell et al. (2004) included two localities: Lancaster and Salford, and classified them in zones with high and low socio-economic status. Whereas the area 'Lancaster, high' can be described by a high economic and a high social capital, the area 'Salford, high' is described by a high social capital only (Gatrell 2004, p. 252). Additionally, loneliness is related to economic capital, and long-standing illness mainly to social capital. In contrast to Gatrell et al. (2004) and Bourdieu (1979, 1984), we constructed a health space based on health perception characteristics.

Based on the same 16 mental and physical health characteristics of the Swiss Health Survey 1997 (SHS97), a two-dimensional health space was constructed (see Paper 3). With reference to previous work of Keller-Lengen (2005a, 2005b), and Keller-Lengen and Blasius, (submitted), we expected to find a first dimension reflecting a gradient of general health, running from good to bad general health. The second dimension should reflect a composition of mental and physical symptoms, which can be interpreted as Cartesian mind-body dualism. This solution would be analogous to Bourdieu's social space (1984): His first dimension is the capital volume, i.e. the weighted sum of economic and cultural capital, the second dimension is the composition of economic and cultural capital. Because the items are measured on four- and five-point scales and in order to keep the information ordinal in the data, we used Categorical Principal Component Analysis (CatPCA) instead of multiple correspondence analysis (Gatrell et al. 2004; Bourdieu, 1979, 1984).

In a second step, the area typologies are included in the computed health space to analyse the potential relationship between health perception and geographic area types. This allows the modelling of distances between the 'geographic world' and characteristics of health perception. The purpose of this study is (i) to construct a health space using mental and physical symptoms, (ii) to identify potential area differentiation within the Swiss health space, and (iii) to interpret the resulting spatial pattern within the Swiss health space.

7.4.2 Data and methods

A health space was constructed by the same set of 16 health characteristics depicting self-reported general health and moods, symptoms and medication as in the previous studies. We employed the following spatial classifications of regions for the present study: three Swiss language areas (LAN) - German, French and Italian; seven statistical regions (REG) following the European Nomenclature of Territorial Units; eight classes of municipalities by population size (POP); 22 municipality types (MUT); and 106 Mobilité spatial regions (MSR). The explorative data analysis was be done by CatPCA.

7.4.3 Results and conclusions

Correspondence analysis (CA) showed similar coherence between health-related well-being and municipality types (Keller-Lengen, 2005, Paper 1) as between the 16 health symptoms and MUT in the present study. Both methods, CA and CatPCA, confirm that in peri-urban and affluent areas, including tourist and semi-tourist destinations, people frequently assess their health-related well-being as good or very good. These results verify Koller's (2000) conclusion that people who live in the Swiss rural and mountain areas have a better health-related well-being than people in other areas. In both studies (Paper 1 and Paper 4), large centres (MUT1), middle-sized centres (MUT2) and the agrarian working population

(MUT21) as well as municipalities with a strong population decline (MUT22) are associated with the poorest health-related well-being. People living in city centres and in the rural periphery feel relatively unhealthy. In Switzerland, people in the most remote periphery and in the large centres seem to share a tendency towards poor health. They reported on average more negative moods and physical symptoms. Despite the lower socioeconomic status and deprived living conditions that are found in the centre and periphery, does social isolation have an effect on health perception?

8 Discussion

This chapter provides a synthesis of the four individual publications, discussing the important approaches and findings in these four studies concerning the research questions.

8.1 Overview of the four studies

The principal aim of this thesis is to investigate the relationship between health perception, socio-demographic factors and area effects in Switzerland considering complex structures of health. In the first study, self-reported health-related well-being, only one health characteristic, and its relationship to self-reported socio-demographic factors and composite spatial variables such as municipality typology is investigated with simple correspondence analysis. The underlying health model is one-dimensional. The 1997 Swiss Health Survey (SHS97) is the database of the analysis. In the second, multiple correspondence analysis, the relationship between moods and health-related well-being is analysed based on SHS97. Based on a set of 16 self-reported health characteristics, a multidimensional health space is constructed in the third study. This conceptual 16-dimensional health space can be reduced to a two dimensional geometrical Euclidian space. The first dimension represents 'general health' and the second 'body/mind dualism'. The dimensions three, four and five represent some physical symptoms, which are symptomatic for specific illnesses. Age is correlated with the second dimension. Income and education are not strongly correlated with health space. Similar to the socio-demographic variables, with the exception of age, the Swiss area typologies are not very strongly correlated with health space. However, CatPCA shows some interesting patterns for health perception and spatial differentiation, after zooming into the centroid that represents the average profile of the health space.

8.2 Complexity of health perception and Swiss health survey

Swiss Health Survey (SHS) reflects a 'complex and dynamic concept of measuring health' and is based on self-reports (Calmonte et al., 1998). Even if complex and dynamic health concepts are considered, SHS is not constructed for system and/or process oriented research. As a snapshot, SHS can only be a static picture of a complex and dynamic system of self-reported health. According to Capra (1997), who emphasizes the 'relations' between system components as pre-eminent, and stressing the 'profound relationality' (Bourdieu, 1979, 1984) of such a system structure, Swiss health space can be seen as a conceptual model, which

visualises relations of the health perception. Self-reported health is based on perception and cognition - an open, nonlinear, emergent system.

SHS provides variegated components of health, including self-reported lifestyle and environmental data. More objective health data such as mortality, the diagnoses of physicians and pathogenetic investigations are excluded in this health approach. The limitations of a health survey appear in connection with complexity theory. A systemic network approach, which considers both objective health data and subjective health perception as well as social and environmental aspects outside of the perception, is not the intention. SHS only gives us the possibility to visualise the relationships between individual characteristics of health perception, knowledge about health and characteristics of self-reported behaviour, lifestyle and socio-economic aspects.

However, based on a conceptual space approach and explorative data analysis we visualised interesting patterns and latent structures in a dataset of SHS. A clear limitation of our study is set by the data quality. Much missing data in some health, behaviour and lifestyle characteristics cause the selection of 16 well-responded to health characteristics to create a conceptual health space. That is the reason why we do not tap the full potential of SHS in explorative data analysis.

8.3 Conceptual space approach and explorative data analysis

Scaling methods allow us to reorder large amounts of data based on data similarities. This powerful feature proves to be useful to investigate health perception, especially the Swiss health survey (SHS). Correspondence analysis and categorical principal component analysis make it possible to uncover the latent structure of SHS and to construct a conceptual space. However, conceptual spaces are static and describe only the structure of representations.

The methodology used in this thesis can be compared to that of Bourdieu (1979, 1984) and Gatrell et al. (2004). They used mainly nominally scaled variables, and therefore applied CA to construct the social space. In contrast, our data is ordinal, and is on three, four or five point scales, respectively. Therefore, we use CatPCA to include this ordinal information and to avoid a methodological bias when applying CA to this data (De Leeuw, 2006; Gifi, 1990).

The advantage of using CA or CatPCA is the possibility of visualising complex structures in a low-dimensional space, usually within two dimensions. Applying these data reduction techniques allows for a geometrical interpretation of the data. Whereas Bourdieu (1979, 1984) and Gatrell et al. (2004) constructed a social space on the basis of life-style characteristics, we constructed a health space on the basis of health perception characteristics. CatPCA gives us the opportunity to include a major set of health perception variables, not necessarily aiming at

data reduction, but to depict health perception more appropriately than based on 1-2 self-reported or composite indicators of a regression model, and with respect for its multi-faceted character.

An advantage of CatPCA over other multidimensional scaling methods is the possibility to introduce supplementary variables in a space constructed with active health variables. The supplementary variables, for example nominal scaled socio-demographic characteristics and area typologies, do not influence the geometrical construction of health space. This allows for visualising associations between ordinal and nominal scaled variables, between health symptoms, medication as well as socio-demographic characteristics. In the case of the nominally scaled variables, there are no restrictions on the variables; in the case of ordinally scaled variables, the only restriction is on the categories' order. Furthermore, the method allows for detecting and visualising non-linear associations, e.g., the relationship between health variables and the highest educational level, for instance.

Compared to Hays and Stewart (1990), Cella et al. (2005) and Ruini et al. (2003) this explorative data analysis approach shows a relatively low variance in the data. The first dimension explains 23% of the variation in the data and the second dimension explains 10% of the total variation. However, considering the other three calculated dimensions of the constructed health space, the third dimension represents only 7.5% of the total variance, the fourth dimension 6.9% and the fifth dimension 6.4%. In a five-dimensional space the explained variance is 53.4% for 16 health characteristics (N = 13,004). The five-factor analytic model of Ruini et al. (2003) accounted for 65% of the variance for a sample size of N = 450 respondents. They investigated 17 psychological well-being characteristics. Hays and Stewart's (1990) factor model, on the other hand, only explains 20% of the variance for their first two dimensions physical and mental health (N = 1,980; 19 health variables). The two dimensional solution in this thesis seems acceptable in comparison to the other studies.

8.4 The Swiss health space and its dimensions

Health space can be interpreted as a collective individual perception of health. Important components of this space are 'general health' ordered from very good to very poor health characteristics and represented by the first axis, and the distinction between mental symptoms and physical symptoms represented by the second axis. Calculating a five-dimensional model, the last three dimensions reflect some specific somatic symptoms and can be interpreted as symptoms of an illness. The third dimension can be seen as a representation of intestinal

problems, dimension four as a representation of influenza and the fifth dimension as a representation of cardiac and circulatory troubles. However, there only exist two or three variables that are factor loadings on the dimensions three, four and five, respectively. These dimensions can be interpreted. Based on this fact and on our interest in latent cultural structures, we decided to consider the more interesting two-dimensional solution.

The construction of our health space is similar to the construction of Bourdieu's social space. Bourdieu's (1979, 1984) dimension 'capital volume' in social space is comparable with 'general health' in health space; and 'composition of economic and cultural capital' can be compared to 'composition of mental and physical symptoms'. According to the purpose, the implemented characteristics differ; whereas Bourdieu used life-style characteristics, we applied characteristics of perceived mental and physical symptoms. While the social space has often been constructed to describe social relationships, the health space has been created to describe differences in the perception of health.

We discuss the identified dimensions in turn starting with the first dimension. We interpret the first dimension as a continuum of general health, spanning from good general health on the one end of the axis to poor general health on the other. Similarly, Ruini et al. (2003) found that their first dimension positively correlated with well-being and negatively correlated with depression. One can argue that the good vs. bad dichotomy is a generic categorization scheme of human thought. Young (1994) suggests that humans need to classify things, experiences, situations feelings, emotions, thoughts etc. into good and evil. In accordance with new public health approaches and traditional medicine, this dimension mirrors the fundamental assumption of dichotomy between healthy and sick individuals (Antonovsky, 1997).
In his salutogenetic concept Antonovsky (1997) suggests a health-illness continuum. In the constructed health space, based on more than one health characteristics, the first axis could be seen as an approximation to Antonovsky's health-illness continuum.

Hays and Stewart (1990) and Cella et al. (2005), on the other hand, identified mental health as the first dimension, and physical health as the second. In this thesis, the second dimension of the constructed health space represents the distinction between mental and physical symptoms. This dimension may reflect a deeply rooted cultural structure - the body/mind dualism. This dualism is a cultural structure of Western society, and is also manifested in the style and order of the SHS questionnaire that defines the data structure of generic health measurements. The associations found between mental and physical symptoms rather support the idea of a body-mind connection in contrast to the generally perceived body-mind dualism. Historical and current studies discussed different aspects of body/mind relationship, in

particular the complex neural correlates of mental structure and differing organization of psychological and physical reality (Chiesa, 1995; Freud, 1940). Discussions about somatization also influence the dichotomy of Western medical and therapeutic culture: mind versus body, physical versus psychological causation, reality versus 'phantasy' (Redekop, Stuart, & Mertens, 1999). This is utterly odd, since who we are is all mixed up with how we feel about our bodies, yet we seem to live in our minds, while our feelings often get put into our bodies – 'somatized' – in ways that are odd, distressing and sometimes fatal, as in some psychosomatic and eating disorders (Young, 1994). Our humanity, however, is a feature of ourselves as persons, an amalgam of mind and body.

One has to see health in a broader context to be able to better interpret the cultural dimensions. Young's (1994) concept of mind could be a valuable approach to interpreting health space. Young (1994) postulates a mental space as a 'congenial place for thinking, for reflecting, for rumination, for nourishment. It connects readily to comforting boundaries – containment, being held in mind.' For Young (1994) the point of origin of mental space is the point about misinterpreting the reality of the psyche's experience as normal and basic and hallucinatory is the essential point – the ur-fact – about human nature. It is also the essential basis for the theory of knowledge and our hopes for better human relationships in couples, families, groups, institutions, communities and nations. It provides the potential space within which we can re-evaluate, ruminate and reconsider our relations with the world (Young, 1994). Reconsidering self-reported health, each respondent answers based upon his conscious and unconscious thoughts, emotions and feelings. Young's mental space is also based on cultural space. Young suggests that a large component of culture is below the level of conscious awareness and cultural patterns structure both thought and perception. As mentioned above, the body/mind dualism is one such cultural mental component. It is not surprising that regional differences in Switzerland do not carry huge weight as compared to such important strong cultural dimensions. Analysing the conceptions and questions of health, which SHS is based on, the dimensions are found as an inherently cultural structure.

Accepting this mental space, well-being may also be a part of mental space. Inside health space it is possible to compare the positions of each health profile, which represents mental and physical aspects as well as good or poor profile assessments. Pitching on the well-being variable - commonly called general health or health-related well-being, it is interesting to interpret the position of general health well-being in health space. According to George and Landerman (1984), who noted that there is a strong correlation between health and subjective well-being for self-reported health measures, but not for the more objective health status given by physicians (Watten et al., 1997), a strong correlation of health-related well-being to the general health axis exists. In terms of the second dimension, health-related well-being is

more related to physical health; respondents think about physical health rather than mental health when answering general health questions.

8.5 Swiss health space and health-related well-being

The health-related well-being (hrwb) variable, frequently used to assess general health, is strongly correlated with our health space. Hrwb is a predictor for general health. Health-related well-being is only based on one general health question. The use of hrwb as an important health characteristic is justified, assessing the good correlation to health space, especially to the first general health dimension.

Hrwb is less associated to the second dimension than to the first dimension. In the second dimension hwrb is more orientated towards physical symptoms than mental symptoms. This aspect should be considered when applying hrwb for health assessments. In SHS the hrwb question was asked at the beginning of the survey. People were not yet affected by special health questions and themes and they answered intuitively. We assume that respondents think about physical health and illness when answering the question of health-related well-being. This insight is interesting concerning people's health perception and should be considered when interpreting health outcomes.

8.6 Swiss health space and socio-demographic factors

8.6.1 Age and gender

Age is related to the second dimension of our health space, reflecting the 'composition of mental and physical health symptoms': the younger the people are, the higher is the share of mental symptoms with the exception of 18 outliers representing people aged 92 years and older. The relationship between age and the second dimension of the health space is much stronger than the relationship between age and the first general health dimension. Hence, age is a better predictor for the composition of mental and physical symptoms. Gatrell et al. (2004) also reports a significantly lower psychological morbidity among the elderly. Mental health increases in our study by age. Other survey-based studies showed similar effects (Calmonte et al., 1998; Calmonte et al., 2000; Rodin, 1986; Ware and Sherbourne, 1992). Kobau et al. (2004) mentioned that in the United States young adults aged 18-24 years reported the highest amount of subsyndromal levels of depressive symptomatology, such as feeling sad, blue or depressed. The first manifestation of a mental disorder, such as depression or schizophrenia, appears very often in young adults. Burke et al. (1991) compared age at onset of major depression and other psychiatric disorders by birth cohorts in the population of

five U.S. communities. They uncovered a gradual shift towards increased rates of major depression in those aged 15-19 years. Their findings also suggest a similar shift for drug abuse and dependence and similar, but less pronounced changes were found for alcohol abuse, dependence and obsessive-compulsive disorder (Burke et al., 1991). Current studies agree that life satisfaction often increases, or at least does not drop, with age (Herzog and Rodgers, 1981). People's ability to adapt to their conditions (Campbell et al., 1976), the closer fit between ideal and actual self-perceptions (Ryff, 1991) and the decreasing gap between one's goal and circumstances (Campbell et al., 1976) result in an increase in satisfaction and well-being in older adults.

Physical symptoms concern the elderly more severely than young adults. This corresponds to clinical experience: cardiac dysrhythmia, thoracic pain and pressure are direct symptoms for coronary heart disease. Furthermore, the prevalence of coronary heart disease, rheumatism and cancer, increases with age (Anonymous, 1997; Kasper et al., 2004). Our findings are similar to these of Gatrell et al. (2004) who have found associations between profiles of people aged over 65 and the presence of long-standing illness.

Due to a small sample size (N = 18), we have to be careful with the interpretation of the 92+ age group profile. Nevertheless, for the oldest respondents, the influence of mental health in the second dimension indicates two factors being important for their quality of life – isolation and loneliness (Calmonte et al., 1998; Calmonte et al., 2000).

We can confirm the findings of Faltermaier (1994) and Helfferich (1993), as well as Schulze and Welters (1998) that women report more physical symptoms than men. In describing their health status, men prefer to talk about their productiveness and the absence of illness. Women's understanding of health is more differentiated and complex. For women, well-being and body experience are central health aspects. The gender specific different health understanding is associated with a higher symptom attention by women than by men. However, young women and men differ less in understanding health than older women and men (Calmonte et al., 1998; Schulze and Welters, 1998).

8.6.2 Socio-economic characteristics

Another advantage of explorative data analysis is the possibility of uncovering weak relationships in the data (Le Roux and Rouanet, 2004). For example, we found a relatively weak but non-significant association between socio-demographic characteristics and health symptoms, also reported by Hays and Stewart (1990). Even though this relationship is far weaker than that between medication and health-related well-being, it should not be neglected.

In accordance with Walter-Busch's (1997) Swiss quality of life findings, we assume that the influence of income in Switzerland is also not particularly relevant for health perception. Walter-Busch has not found any correlation between the socioeconomic status of the Swiss cantons and the subjective estimated quality of life in these cantons (Walter-Busch, 1997). Other studies also suggest that income in affluent nations is only weakly related to subjective well-being (Diener et al., 1995; Veenhoven, 1996). Some of our health variables (health-related well-being, optimism, depression and others) are also components of subjective well-being. Campbell et al. (1976) found that demographic factors such as age, sex, income, race, education, and marital status accounted for less than 20% of the subjective well-being variance.

These effects could be explained by personality trait and lifestyle, which is either innate or acquired, but is stable and independent of living conditions. Someone having a more pessimistic nature will always take less pleasure from changes in life than someone having an optimistic disposition. Similarly to the trait theory (Scherpenzeel, 2004), which postulates satisfaction as a 'national trait', health perception can also be seen as a national perspective on life in general, based on cultural norms, religion, and history. Regardless of the aggregation level of the trait theories (e.g., national or individual) people stay as happy or unhappy as they are, independent of changes in life circumstances (Scherpenzeel, 2004).

Macintyre et al. (2003) critically reflected different socio-economic classifications by comparing their predictive power for a range of health measures. The investigation of a random sample (N = 2,867) of adults in the West of Scotland showed that associations between social position and health vary by socio-economic classification, health measure and gender (Macintyre et al., 2003). Our findings support Macintyre's results. In the first study we used a complex socio-professional classification based on socio-economic characteristics of SHS and found it well associated with health-related well-being. In the third study we directly applied the socio-economic variables, for example questions on education and income such as questions about income and education, which are weakly related to health perception. This difference can be explained in that the socio-economic characteristics of SHS have a lot of missing data. Our findings also support (Sturm and Gresenz, 2002) conclusions. They found a significant correlation for self-reported health with inequality at the population level, but this correlation disappeared after adjustment for individual characteristics. Their study does not provide any evidence for the hypothesis that income inequality is a major risk factor for common disorders of physical and mental health. They conclude that there is little to no association between complex health variables and socio-economic factors.

A different way of demonstrating such an association was performed by Gatrell et al. (2004), who used multiple correspondence analysis to visualise health characteristics within a 'social space'. Gatrell et al. (2004) constructed a social space mainly on the basis of socio-demographic characteristics and induced some indicators of mental well-being and psychological morbidity (responses to the General Health Questionnaire, GHQ) into their social space. Their results indicate that the first dimension (financial circumstances, loneliness) is strongly associated with GHQ score; economic and social capital are closely intertwined. A limiting factor of this thesis is that only recent symptoms are investigated. For limiting long-standing illness, Macintyre et al. (2003) reports limiting long-standing illness being more socially patterned than recent illness. In contrast Gatrell et al. (2004) maps of social space and psychological morbidity and log-term illness relativise these findings. Loneliness and psychological morbidity are much more strongly associated with financial worries than long-standing illness.

8.7 Swiss health space and area typologies

Differing from Gatrell et al. (2004) who 'mapped localities' in a social space constructed on the basis of social survey variables and correspondence analysis, we mapped area types as 'localities' in our health space. Subsequently, we explored the inter-relationship between health perception and five different Swiss area typologies as well as for age and gender. Analogous to age and gender, the „locations' of most Swiss area types are relatively close to the centroid of the health space. This can be interpreted such that the association between health symptoms and area types is similar to that between the health symptoms and socio-demographic factors. In other words, the influence of area types on health perception has the same magnitude as the influence of socio-demographic factors on health perception.

Creating a health space and mapping positions of area types within this health space does not appear to have been done before. Bourdieu's classical analysis of socio-cultural life in France (Bourdieu, 1979, 1984) and Gatrell's reconstruction of social space, based on a British social survey, focused the social space and social inequalities. After constructing a social space, Gatrell et al. (2004) investigated the relationship between social space and 'localities' as well as the relationship between social space and, subsequently, loneliness and long-standing illness. However, in this research we focused our attention directly on health perception, and the respondents of Swiss Health Survey may have been especially sensitised to health perception.

In accordance with Ecob and Macintyre (2000) who noticed that the influence of area on health-related behaviour varies according to the way it is measured, we may conclude the same for measuring and analysing health perception. This might contribute to the understanding of different results concerning area effects related to 'objective health indicators' - standardised mortality rates (SMR), disability adjusted life years (DALY) and potential years of life lost (PYLL), and our area effects related to self-reported health. For Switzerland (Bopp, 1997; Bopp and Gutzwiller, 1999) as well as for Sweden (Malmström et al., 2001; Sundquist et al., 1997c), Britain (Boyle et al., 2004) and the U.S.A. (Wilkinson, 1996), differences of SMR related to area classifications or regions have been discovered. For Switzerland, Wanner et al. (2001) reported cantonal SMR differences of up to 50% for men aged 35 to 64 – reflecting a regional difference in the mean life expectancy of up to two years. Bopp (1997) detected SMR differences of 75% to 100% for the MS regions. Bopp's findings correspond to regional differences in mean life expectancy of up to four years. The regional differences between Wanner's and Bopp's results are probably to be ascribed to a small number problem for the MS regions, which we also find in our results. The MSR types are more dispersed over the health space than the types of any other area typology. It is worthwhile noting that we analysed the mean scores of the area types. Had we shown the positions of the individual respondents, they would spread out over the whole health space, as can be seen in the example given by Gatrell et al. (2004, Fig.2, p.252).

How strong is the area effect related to health perception, respectively? The 'locations' of most Swiss area types are relatively close to the centroid of the health space. The individual socio-demographic variables, age and gender are used as comparative measures. On the first dimension, the dispersion of area types is similar to the dispersion of gender and age groups. Our results are in line with the results of previous work showing that health is differentiated by age (see Ware and Sherbourne, 1992) and gender (see Calmonte et al., 1998). As we found a similar differentiation for area typologies in health space as for age and gender, we may conclude that area effects on health perception are of similar magnitude to that of age and gender effects on health perception. However, if we consider Gatrell's (2004) findings concerning gender, which was not retained as a significant covariate for psychological morbidity, we have, analogously, to be careful about ascribing area types too strong an association to health perception.

An area effect can be detected for the Italian-speaking region, the Ticino, and especially the MS regions Bellinzona, Lugano and Mendrisio, which are all positioned in the poor mental health part of the health space. According to Walter-Busch (1997), who in a non-health-related quality of life study reported a more negative assessment by respondents from the Ticino, we have to take into consideration that our result may indicate a cultural difference in

the interpretation of questions about health and quality of life. For different social groups (e.g. ethnic groups, unemployed, students), different cultural biases were also detected by Boyle et al. (2001). They suggest 'that cultural factors may influence the likelihood of a positive answer to the question on limiting long-term illness [...] have been shown to be higher in Wales than would be expected from the mortality rates' (Boyle et al., 2001, p. 798).

In the first paper of Keller-Lengen (2005a) we detected coherence between health-related well-being and municipality types (MUT). In the Paper 4 we found that the municipality types are also related to the perception of physical and mental symptoms. Both studies confirm that in semi-rural and affluent areas, including tourist and semi-tourist destinations, people frequently assess their health as good or excellent. Thus, our results verify Koller's (2000) conclusion that people who live in the Swiss rural and mountain areas have better health-related well-being than people in other areas.

People living in city centres (MUT1, MUT2) and in the rural periphery (MUT21, MUT22) feel less healthy. It can be shown that health-related well-being is highly related to the general health dimension (see Keller-Lengen and Blasius, submitted). People in the most remote periphery and in the large centres seem to share a tendency towards poor health perception. They reported on average more negative moods and physical symptoms. Despite the lower socio-economic status and less affluent living conditions that people more frequently experience both in the centres and in the periphery, does social isolation of anonymous metropolitan areas and depopulated peripheries have an effect on health perception? To thoroughly address this question, within the Swiss health inequality debate, aspects of people's home, neighbourhood and area environment, which might affect physical and mental health perception as well, should not be neglected.

9 Conclusions

The purpose of this research is to uncover potential relationships that might exist between people's self-reported health, their socio-demographic backgrounds, and the place where they live in Switzerland. Furthermore, this thesis aims to provide a new conceptual and methodological perspective for the field of geography of health, employing an inductive, exploratory data analysis approach postulated by Tukey (1977). The following research questions are addressed:

- *What kinds of health assessments are available to analyse individual health, in particular health perception in Switzerland?*
- *What kind of conceptual health model can be constructed to explore individual health and health perception?*
- *What kind of latent structures can be uncovered in the Swiss health survey?*
- *Do relationships exist between self-reported health characteristics?*
- *Do relationships exist between self-reported health, socio-demographic backgrounds, cultural differentiation, and geographical locations?*

The contributions of this thesis are summarized in the order of the research questions listed above.

9.1 Available health assessments to analyse individual health in Switzerland

A major hurdle to health related data analysis is the issue of data privacy, which can severely hinder the analysis of geographical differentiation. This is mostly due to the small number problem in data sets at high spatial resolution. The first research question concerning existing health assessments was examined and addressed in the first report of the 'Swiss network of public health' (Keller-Lengen and Bopp, 2004). The study reviewed about 50 available datasets including governmental health records register data, insurance data, health and quality of life surveys, etc. The datasets reviewed were compared with respect to the health information they contain, sampling strategies applied, geographical representativeness, and their applicability for scientific purposes. The outcome of this analysis suggests that the following health datasets can be linked with the Swiss National Cohort. In addition, in record linkages with the Swiss National Cohort the following databases are to be considered:

- records of mortality cases and mortality causes,
- records of live births,
- records of still births and causes of still births,
- the hospital records of VESKA ('Vereinigung Schweizerischer Krankenhäuser'),

- the obligatory registration of the Federal Office of Health,
- the Swiss Health Survey,
- the Swiss Household Panel,
- the Socio-Medical Indicator System of Swiss Population and
- the dataset of cardiovascular risks.

Current health assessments are embedded within a much broader concept than health, that is, the concept of quality of life. This broader health concept encompasses among others, issues of standard of living, quality of housing and neighbourhood, job satisfaction, and general health. In contrast to numerous studies of medical geography, which typically only use one or two survey questions to evaluate general health, currently available worldwide health surveys include physical and mental dimensions of health. These refer to the body and bodily needs, and its emotional and intellectual status. Well-being–including soundness and vitality–is also part of the health surveys' dictionary definition of health.

The 'Swiss Health Survey' (SHS) as reviewed in the above-mentioned study was selected for further analysis for several reasons. Firstly, it captures the health perceptions of a large sample of individuals living in Switzerland. The SHS provided the most comprehensive concept of health in the available datasets. This included individual health, lifestyle and environmental factors. The SHS health concepts are based on general health perceptions, physical functioning, psychological well-being, psychological distress, bodily pain, energy/fatigue, sleep, cognitive functioning, sense of coherence, social functioning, and the use of health care systems. SHS best fulfilled the requirements to take an 'internal' point of view, and to analyse the multidimensionality and complexity of an individuals' health perception, together with socio-demographic and geographical aspects.

Secondly, the selected SHS includes a representative sample of 13,004 respondents, surveyed with detailed interviews. This kind of data collected at the individual level provides a more profound insight into personal health perception than commonly used aggregated health indices such as, SMR, DALY and PYLL.
This dataset was used to construct a conceptual health space to explore health perception in Switzerland.

9.2 Conceptual health space

In the construction of a health space, the Categorical Principal Component Analysis (CatPCA) method was applied to project sixteen SHS variables into a two-dimensional health space. CatPCA was chosen as a data reduction method as it provides the opportunity to map supplementary variables (e.g., socio-demographics, etc.) into the constructed health space. These additional variables do not influence the geometry of the constructed space, but can be explored as attributes together with the scaled variables.

To best represent the health concept in a health space, one could argue for the inclusion of as many available variables as possible. There are several reasons, however, why this might not be an optimal approach. First, some of the variables might be correlated. Therefore, removing redundant variables might improve the detection of potential patterns. Another reason might be data quality, in particular the missing data problem. Many SHS variables have missing data, for example, health behaviour, health knowledge, disabilities, and various risk factors (e.g., hypertension, elevated blood cholesterol levels, diabetes, and cancer prevention).

The 16 chosen health variables include a variety of health characteristics. In order to identify the optimal space model with the fewest necessary dimensions to meaningfully capture the 16-dimensional SHS health dataset three, four, five and six dimensional solutions were computed. Even though the five-dimensional solution represents 53% of the total variance, we selected a two-dimensional solution covering 33% of the total variance. The 2D solution uncovers the cultural complexity of the Swiss health space particularly well. Additional dimensions reflect specific somatic symptoms of various illnesses.

9.3 Uncovering latent structures in the Swiss health survey

The constructed Swiss health space represents health perceptions from a large sample of the Swiss population. Important characteristics of the health space are the perception of 'general health' spanning a continuum from 'very good' on the one hand to 'very poor' health on the other along the first axis of the constructed 2D health space. The second dimension of the health space encapsulates what we might describe as the Cartesian body/mind dualism, including mental and physical health related aspects. Young's (1994) concept of mind could be a valuable approach to interpret the second axis of the health space. Mental space can be understood as a space of thinking, reflecting, rumination, and nourishment. It connects readily to comforting boundaries – containment, being held in mind.' Reconsidering self-rated health, each respondent answers based upon his/her conscious and unconscious thoughts, emotions and feelings. The structures of Young's mental space are deeply rooted in cultural space. A large component of culture is below the level of conscious awareness and cultural patterns

structure both thought and perception. As mentioned above, the body/mind dualism could be one such cultural mental component. These cultural and structural dimensions are inserted into the SHS data structure. Regional cultural differentiations such as language turn out to be much weaker when compared to such dominant cultural dimensions, which are an inherent cultural structure of health surveys.

9.4 Relationships amongst self-reported health characteristics

Latent structures found in the health space were further analysed statistically. Multiple Correspondence Analysis yielded a strong and probably linear association (i.e., 'Horseshoe effect' on the second dimension) between health-related well-being, moods, loneliness, satisfaction with childhood, and fear of becoming ill along the first dimension in the space. Mental symptoms and physical symptoms form two clearly identifiable clusters in the health space. There is a third cluster (including fear of becoming ill; weak, tired and lacking energy;, headache and facial pain as well as sleep disorders) located between the mental and physical symptom clusters. This cluster is more difficult to interpret, and is characterized by weak factor loadings on the first five dimensions. This might suggest additional relationships related to the health phenomenon, which were not specifically investigated in this study.

9.5 Influence of socio-demographic characteristics, cultural differentiation, and geographic location

Socio-demographic characteristics seem to have a limited influence on health perception. Our findings support previous findings that income in affluent nations is only weakly related to subjective well-being. These effects could be explained by individual personality traits and/or individual outlook on life in general, which is either innate or acquired, but is stable and independent of living conditions. Someone with a pessimistic nature will always take less pleasure from changes in their life than someone having an optimistic disposition. According to the trait theory, which takes satisfaction rather as a 'national trait', health perception of a population could also be seen as a collective outlook on life based on cultural norms, religion, and history. Trait theories, both at the individual and aggregated levels, assume that people stay as happy or unhappy as they are, independent of changes in life circumstances.

As this study suggests, using self-reported health characteristics we can gain additional insights on health that might be different from traditional clinical, epidemiological, and medical geography approaches. However, as this thesis suggests, at least weak relationships

seem to exist between socio-demographic characteristics and mental, and physical health which should not be overlooked.

Additionally, a relationship between health-related well-being and municipality types was discovered (see Paper 1 and 3). People living in peri-urban and affluent areas, including tourist and semi-tourist destinations, more frequently assess their health-related well-being as being good or very good. In contrast, people with the poorest health-related well-being are typically found in large to mid-sized urban areas, municipalities dominated by agriculture, or in municipalities exhibiting a severe population decline. Specifically, people living in city centres and in the rural periphery feel relatively unhealthy. People living in remote areas and in large centres on average report more negative moods and more physical symptoms. This seems to be associated with lower socio-economic status and deprived living conditions. This raises the question whether social isolation may have an additional effect on health perception? It must be noted that the relationship between locational characteristics (e.g., municipality types) and perceived health is somewhat weak. As mentioned above, cultural aspects seem to have a greater explanatory power in the Swiss health space than areal differentiation.

9.6 Relevance of findings for the geography of health

This thesis is squarely positioned within the research field of geography of health.
The broad, interdisciplinary approach adopted in this thesis integrates research ideas and methods borrowed from psychology, sociology, epidemiology and, of course, geography, and thus emphasizes the interdisciplinary tradition of geography of health.

Inspired by Bourdieu's (1979, 1984) social space concept, a health space was created concerning people's individual health perception. However, in contrast to sociologists and social geographers who emphasize human action as the basis of the social world, this thesis is focused upon humans' individual perceptions, attitudes, and feelings, in accordance with Young's (yr) mental space concept. Following the recent tradition of categorical data analysis in social science (see for example Parsons et al. (1952), Bourdieu (1979), de Leeuw (1982), Greenacre and Blasius (1994), and Gatrell et al. (2004) scaling methods such as MCA and CatPCA were employed for the Swiss Health Space construction. This permitted the depiction, exploration, and analysis of health perception characteristics, and their potential associations with the social and geographical world.

Capitalizing on explorative data analysis methods, a Swiss health space was constructed from the ground up. The sum of the collected micro-level health perceptions is embedded in the macro-level latent structures that are discernible in this constructed space. The Swiss health space encapsulates people's perception and understanding of the health concept measured by the Swiss Health Survey.

Although cultural, socio-demographic and locational aspects were investigated, human agency is not directly considered in the thesis. This is in contrast to Bourdieu (1979, 1984) and Werlen (1993) who try to localize 'meanings of action' within a social space.

An individual's perception is inseparable from attitudes, values, emotions, desires, and motives, as well as sensations, cognition, and learning. This is in the tradition of social researchers such as Husserl (1965) and more specifically Schutz (1962). They placed an individual's contribution to the meaning-content of the 'world' at the centre of discussion.

Individual factors should not be investigated independently. Not only do they play a role in the stream of consciousness of each individual, but also in the interaction with other people. The Swiss Health Survey database has not been designed to investigate the implications of social interaction with respect to health.

9.7 Outlook

The Swiss health space model provides a valuable basis for further health-related research. Specifically, it is hoped that the results will provide new inputs to the discussion on data privacy and respective data collection methods (e.g., health surveys). Results presented here on individual health perceptions should have consequences for health care and health politics in Switzerland. It should be of interest for health system research to consider the relationship between perceived health and continuously increasing health system costs.

One strength of the constructed Swiss health space is that it is generic enough to be expanded and further explored with any combination of additional explanatory variables. For example a sense of coherence (Antonovsky, 1997), coping strategies, health knowledge, attitude and philosophy to life, fear of becoming ill, control over life and satisfaction might be worth exploring further. Additionally, aspects of social capital, which could explain heterogeneities in a population's health status (Locher et al., 2002), could be included in the health space model. Health perception is not a static concept. Since SHS surveys for 1992/93, 1997, 2002 and soon 2007 exist, the development of health perception over time could be considered. Multilevel correspondence analysis (Greenacre and Blasius, 1994) allows the investigation of time-dependent differentiations and relationships of health perception. Different places and

locations as well as different time windows could be compared and visualised in a multilevel approach.

Health perception and health indicators such as SMR, DALY, PYLL and others seem to be associated (Idler and Benjaimini, 1999). However, according to findings by the sociologist Walter-Busch (1997) in Switzerland, a divergence seems to exist between subjective perception and 'objective' factors. This contention in the Swiss health space could be investigated by associating mortality and morbidity (e.g., by diagnosis) statistics. Swiss area typologies are not strongly related to physical and mental health perception in the constructed health space. To better investigate spatial differentiation one could consider additional record linkages of SMR. Based on health regions, high-risk regions of poor health could be delineated using records of mortality causes, records of health surveys, and census data. compared to differences of health perception.

In this context, the scale problem has to be emphasized. Due to privacy issues, a relatively high aggregation level had to be used. If the data were available at the municipality level than one could explore different types of aggregations to overcome the small number problem. Furthermore, it would be interesting to compare health areas delineated with traditional health identifiers, with health perception areas distinguished in the health space.

Considering the results of the present study, there are obvious cultural and psychological dimensions affecting health perception. It would be interesting to compare the Swiss health space with health spaces of other countries, cultures and societies. The same study design, questions and the ordinal answer possibilities could be reused in health surveys, including the same inductive quantitative analysis for creation of the health space.

For cross-cultural studies, it might be useful to consider additional, qualitative research and analysis methods to better capture health perception. Eighty percent of the SHS respondents feel that their health is good or excellent. In other countries different response distributions might exist that would require a more detailed fine-grained analysis. Similarly to Popay's et al. (2003) detailed interviews on 'proper places, lives and identities', a research perspective emphasizing the individual is a worthwhile endeavour in geography of health research.

Also Abel et al. (1999), Lundberg (1999) and Ware (1995), contend that additional qualitative and quantitative studies on the individual's quality of life and lifestyle need to be conducted. This is supported by McHorney (1999) who postulated that a fundamental problem with health-related study outcomes has been the underlying assumption that 'one size fits all'–that a given measure can meet the needs of multiple stakeholders. McHorney (1999) suggests that 'different applications in different populations or settings require different health concepts and different degrees of precision' (McHorney, 1999, p. 330). Analysing health perception

and individual geographies in different cultures and societies could contribute to a better understanding of the quality of life and provide the needed basis for a more holistic health understanding.

Considering Swiss health care and illness prevention, Swiss health care policy needs to concentrate on those 20% of SHS respondents who do not feel healthy. Identifying the conditions, in which people live and why they feel unhealthy is an important assignment for health geographers.

Appendix A

Table 5: Applied health variables of 1997 Swiss health survey (N = 13,004) and their frequencies

Categories	Absolute frequencies	Relative frequencies
How is your current health status?		
Very good	3418	26.3
good	7363	56.6
moderate	1683	12.9
poor	439	3.4
Very poor	97	.7
Missing	4	.0
How often do you feel lonely?		
Very often	242	1.9
Quite often	463	3.6
Sometimes	4269	32.8
Never	7778	59.8
Missing	252	1.9
How strong are you generally in fear of becoming ill?		
Very strong	132	1.0
Quite strong	368	2.8
Somewhat	2594	19.9
Hardly	2813	21.6
Not at all	4742	36.5
Missing	2355	18.1
Last week: How many days have you been depressive and moody?		
Every day	457	3.5
3-4 days	578	4.4
1-2 days	3687	28.4
Never	8000	61.5
Missing	282	2.2
Last week: How many days have you been calm and well-balanced?		
Every day	8791	67.6
3-4 days	2347	18.0
1-2 days	1063	8.2
Never	495	3.8
Missing	308	2.4
Last week: How many days have you been strained and nervous?		
Every day	706	5.4
3-4 days	970	7.5
1-2 days	5262	40.5
Never	5760	44.3
Missing	306	2.4
Last week: How many days have you been full of power, energy and optimism?		
Every day	7785	59.9
3-4 days	2637	20.3
1-2 days	1573	12.1
Never	681	5.2
Missing	328	2.5

Categories	Absolute frequencies	Relative frequencies
Did you have back-ache during the last 4 weeks?		
Not at all	7097	54.6
Somewhat	4475	34.4
Strong	1416	10.9
Missing	16	.1
Did you feel weak and tired during the last 4 weeks?		
Not at all	6796	52.3
Somewhat	5236	40.3
Strong	965	7.4
Missin	7	.1
Did you have abdominal pain and pressure during the last 4 weeks?		
Not at all	10474	80.5
Somewhat	2021	15.5
Strong	500	3.8
Missing	9	.1
Did you have diarrhoea, constipation or both during the last 4 weeks?		
Not at all	10576	81.3
Somewhat	1967	15.1
Strong	453	3.5
Missing	8	.1
Did you have any sleep disorders during the last 4 weeks?		
Not at all	7992	61.5
Somewhat	3868	29.7
Strong	1137	8.7
Missing	7	.1
Did you have head-ache or facial pain during the last 4 weeks?		
Not at all	7733	59.5
Somewhat	4124	31.7
Strong	1143	8.8
Missing	4	.0
Did you have heart palpitation or heart dysrhythmia during the last 4 weeks?		
Not at all	11604	89.2
Somewhat	1158	8.9
Strong	226	1.7
Missing	16	.1
Did you have pain or pressure in the thorax during the last 4 weeks?		
Not at all	11788	90.6
Somewhat	1009	7.8
Strong	197	1.5
Missing	10	.1
Did you have fever during the last 4 weeks?		
Not at all	11919	91.7
Somewhat	855	6.6
Strong	223	1.7
Missing	7	.1
Did you have articular and rheumatic pain during the last 4 weeks?		
Not at all	8016	61.6
Somewhat	3813	29.3
Strong	1168	9.0
Missing	7	.1

Categories	Absolute frequencies	Relative frequencies
Did you take vitamin preparations during the last 7 days?		
Daily	1752	13.5
Several times per week	615	4.7
Once per week	269	2.1
Never	10358	79.7
Missing value	10	.1
Did you take reconstituent agents during the last 7 days?		
Daily	869	6.7
Several times per week	239	1.8
Once per week	109	.8
Never	11776	90.6
Missing value	11	.1
Did you take hypotensive medication during the last 7 days?		
Daily	1351	10.4
Several times per week	103	.8
Once per week	56	.4
Never	11478	88.3
Missing value	16	.1
Did you take heart medication during the last 7 days?		
Daily	707	5.4
Several times per week	41	.3
Once per week	21	0.2
Never	12223	94.0
Missing value	12	.1
Did you take somnifacient medication during the last 7 days?		
Daily	453	3.5
Several times per week	184	1.4
Once per week	142	1.1
Never	12216	93.9
Missing	9	.1
Did you take anti-rheumatic medication during the last 7 days?		
Daily	419	3.2
Several times per week	235	1.8
Once per week	190	1.5
Never	12151	93.4
Missing	9	.1
Did you take analgetic medication during the last 7 days?		
Daily	563	4.3
Several times per week	675	5.2
Once per week	1023	7.9
Never	10734	82.5
Missing	9	.1
Did you take sedative medication during the last 7 days?		
Daily	368	2.8
Several times per week	130	1.0
Once per week	114	.9
Never	12381	95.2
Missing	11	.1

Categories	Absolute frequencies	Relative frequencies
Did you take medication for constipation and diarrhoea during the last 7 days?		
Daily	141	1.1
Several times per week	98	.8
Once per week	81	.6
Never	12676	97.5
Missing	8	.1
Did you take anti-asthmatic medication during the last 7 days?		
Daily	150	1.2
Several times per week	35	.3
Once per week	28	.2
Never	12784	98.3
Missing	7	.1

Table 6: Absolute and relative frequencies of area types

Swiss area typologies and Swiss regions	Absolute frequencies	Relative frequencies
Three Swiss language areas (LAN)		
1 German	8506	65.4
2 French	3309	25.4
3 Italian	1177	9.1
Seven Swiss regions (REG)		
1 Lake Geneva region	3862	29.7
2 Swiss Midland	2689	20.7
3 North-Western Switzerland	1528	11.8
4 Zurich	1413	10.9
5 Eastern Switzerland	1210	9.3
6 Central Switzerland	1282	9.9
7 Ticino	1020	7.8
Municipality typology (MUT)		
MUT1 Large centres	1871	14.4
MUT2 Middle-sized centres	1555	12.0
MUT3 Small centres	940	7.2
MUT4 Centres of peripheral regions	395	3.0
MUT5 Affluent municipalities	604	4.6
MUT6 Tourist municipalities	633	4.9
MUT7 Semi-tourist municipalities	269	2.1
MUT8 Municipalities with homes and institutions	266	2.0
MUT9 Employment municipalities in metropolitan regions	620	4.8
MUT10 Suburban municipalities in metropolitan regions	843	6.5
MUT11 Periurban municipalities in metropolitan regions	332	2.6
MUT12 Employment municipalities in non-metropolitan regions	857	6.6
MUT13 Suburban municipalities in non-metropolitan regions	545	4.2
MUT14 Periurban municipalities in non-metropolitan regions	952	7.3
MUT15 Allochthonous commuter municipalities	400	3.1
MUT16 Autochthonous commuter municipalities	217	1.7
MUT17 Municipalities with industrial-tertiary working population	595	4.6
MUT18 Municipalities with industrial working population	345	2.7
MUT19 Municipalities with agrarian-industrial working population	333	2.6
MUT20 Municipalities with agrarian-tertiary working population	291	2.2
MUT21 Municipalities with agrarian working population	93	.7
MUT22 Municipalities with huge population decline	48	.4

Swiss area typologies and Swiss regions	Absolute frequencies	Relative frequencies
Population >100,000	2408	18.5
50,000 – 99,9999	1044	8.0
20,000 – 49,999	1135	8.7
10,000 – 19,999	1784	13.7
5,000 – 9,999	1756	13.5
2,000 – 4,999	2541	19.5
1,000 – 1,999	1286	9.9
<1,000	1050	8.1
MS regions (selected)		
MSR21 Saanen-Obersimmental	26	.2
MSR23 Oberland-Ost	65	.5
MSR29 Entlebuch	24	.2
MSR30 Uri	46	.4
MSR33 March	105	.8
MSR35 Nidwalden	67	.5
MSR36 Glarner Unterland	37	.3
MSR43 Glâne-Veveye	29	.2
MSR46 Solothurn	110	.8
MSR54 Rheintal	40	.3
MSR55 Werdenberg	27	.2
MSR56 Sarganserland	33	.3
MSR61 Prättigau	29	.2
MSR62 Davos	26	.2
MSR64 Mittelbünden	20	.2
MSR65 Hinterrhein/Domleschg	21	.2
MSR73 Mutschellen	72	.6
MSR76 Thurtal	48	.4
MSR79 Tre Valli	63	.5
MSR81 Bellinzona	167	1.3
MSR82 Lugano	443	3.4
MSR83 Mendrisio	141	1.1
MSR88 Aigle	27	.2

Appendix B
Complete publication list

- Keller-Lengen, C., Keller, F., Ledergerber, R. (1998). Die Gesellschaft im Umgang mit Lawinengefahren. Arbeitsbericht NFP 31 (Nationales Forschungsprogramm 31), Fallstudie Graubünden, vdf Hochschulverlag AG an der ETH Zürich, 229 Seiten.
- Keller-Lengen, C. (1999). Anomale Hirndominanz und immunologische Erkrankungen. Dissertation an der Universität Zürich.
- Keller, F., Keller-Lengen, C., Accola, M., Gehrig, D. (2000). Vom Geographischen Informationssystem (GIS) zum Touristischen Marketing Informationssystem. In: Jahrbuch 1999/2000 Schweizerische Tourismuswirtschaft, 213-226.
- Kilgus, E., Keller, F., Haller B., Keller-Lengen, C., Rothenbühler, C. (2001). Spital Oberengadin: Wertschöpfungsstudie. Herausgeber Institut für Tourismus und Landschaft, Samedan 2001, Druck Walter Gammeter, 59 Seiten.
- Keller-Lengen, C. und Bopp, M. (2004). Gesundheitsrelevante Personendaten in der Schweiz. Zusammenstellung und Evaluation von Datenquellen. Bericht zuhanden des network_public_health, Swiss National Cohort, Report Nr. 1, 37 Seiten.
- Keller-Lengen, C. (2004). Geographical milieux of health and diseases in Switzerland. In: Abstracts of Presentations: Emerging Issues in Medical Geography. IGU Commission on Health and the Environment, Preconference Meeting to the 30the IGC – UK 2004 Glasgow, Irsee Germany, S. 9-10.
- Keller-Lengen, C. (2004). Space of health-related well-being. In: Textes des communications: Peut-on pretendre a des espaces de qualité et de bien-être? Colloque international de centre national de la recherche scientifique, Espaces Géographiques et Sociétés, Université d'Angers, S. 19-22.
- Keller-Lengen, C. (2004). Space of health-related well-being. In: Geodaten: Mehrwert für die Gesundheit. Jahrestagung 2004 des Arbeitskreises für Medizinische Geographie der deutschen Gesellschaft für Geographie und der Arbeitsgruppe Räumliche Statistik der Deutschen Region der internationalen biometrischen Gesellschaft, Remagen bei Bonn, S. 26.
- Keller-Lengen, C. (2005). Geodaten: Mehrwert für die Gesundheit? Bericht zur Jahrestagung Arbeitskreis für Medizinische Geographie und Arbeitsgruppe

Räumliche Statistik der deutschen Region der internationalen biometrischen Gesellschaft, Rundbrief Geographie, 192, S. 34-36.

- Keller-Lengen, C. (2005). Regionale Muster im gesundheitlichen Wohlbefinden der Schweizer Bevölkerung. Geographica Helvetica, 60, 97-104.
- Keller-Lengen, C. (2005). Space of health-related well-being. In Fleuret, S.: Espace, Bien-Être et qualité de vie. Actes du Colloque EQBE „Peut-on prétendre à des Espaces de Qualité et de Bien-Être?' Colloque international, Angers (France) les 23 et 24 septembre 2004. Presses Universitaires d'Angers, 287-296.
- Keller-Lengen, C., Blasius, J., Kistemann, Th. (submitted). Visualising areas in the „Swiss Health Space'. Health & Place.
- Keller-Lengen, C. and Blasius, J. (submitted). Constructing a space of mental and physical health. Social Science & Medicine.
- Keller-Lengen, C., Regard, M., Joller, H., Lalive, P., Landis, T. (in revision). Anomalous brain dominance and immune diseases: do left-handers have specific immunological patterns? Neurology.

Appendix C
Curriculum vitae

DR. MED. CHARIS LENGEN
born October 21st, 1967, in Winterthur, ZH, Switzerland
citizen of Embd, VS, Switzerland
mother of Bengiamin (1994), Inglina (1996) and Joris (1998)

Education and positions

1974 - 1980	Primary school in Steckborn (TG), Muttenz (BL) and Siebnen-Galgenen (SZ).
1980 - 1982	Secondary school in Lachen (SZ).
1982 - 1987	High school in Nuolen (SZ), concluded with 'Matura' exam type 'A' (humanistic education with Latin and Greek).
1987 - 1993	Degree in Medicine, University of Zurich, concluding with diploma as a physician.
1994	Assistant Surgeon in cantonal hospital, Uznach.
1996 - 1998	Research assistant in a project of the Swiss National Foundation Program 31 'Climate change and natural hazards'.
1999 - 2000	Position in Public Relations for Academia Engiadina, Samedan.
1999 - 2002	Research assistant in the Institute for Tourism and Landscape (ITL), Academia Engiadina, Samedan.
2000	Dissertation in the Neuropsychological Division of the Neurological Clinic, Zürich University Hospital. Thesis titled 'Anomalous brain dominance and immune diseases', advised by Prof. Dr. med. Klaus Hess, Prof. Dr. med. Theodor Landis, Prof. Dr. Marianne Regard, Dr. Helen Joller, and Dr. Norman Cook.
2001 - 2003	Study in Geography, Science Faculty, University of Zurich and courses in spatial information systems at Swiss Federal Institute of Technology Zurich (ETHZ). Attainment of funding by 'Forschungskredit' from the University of Zurich for October 2003 – September 2004 and the financial foundation of the Marie Heim-Vögtlin-Program of Swiss National Foundation for October

	2003 – March 2006.
2002	Teaching assistant, Human Geography Division, Department of Geography, University of Zurich.
2003 - 2006	Dissertation in the Geographic Information Analysis & Visualisation Division. Title of the thesis 'Swiss health Space', advised by Prof. Dr. Sara Fabrikant, Prof. Dr. Kurt Brassel, Prof. Dr. Ulrike Müller-Böker funded by the 'Forschungskredit' of University of Zurich and the Marie Heim-Vögtlin-Program (SNF)
2006	Research assistant, Geographic Information Analysis & Visualisation Division, Department of Geography, University of Zurich.

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Regionale Muster im gesundheitlichen Wohlbefinden der Schweizer Bevölkerung

Untersuchung des gesundheitlichen Wohlbefindens aufgrund der Schweizerischen Gesundheitsbefragung 1997 und der Schweizer Raumtypologien

Charis Keller-Lengen, Zürich

1 Einleitung

Der Wandel der natürlichen und soziokulturellen Umwelt stellt eine Herausforderung an unsere Gesellschaft dar. Neben Veränderungen in ökonomischen und ökologischen Bereichen haben der Wandel der Arbeitsbedingungen, der sozialen Beziehungen, aber auch der Lebensstile Auswirkungen auf die Gesundheit und das Wohlbefinden. Wie wichtig der sozioökonomische Status eines Individuums für eine gute oder schlechte Gesundheit ist, zeigen Studien von MILES (1991) und BARTLEY (1994). Sie stellten fest, dass Angehörige der unteren sozialen Klassen, Arbeitslose und Frauen im Verhältnis zu sozioökonomisch Bessergestellten häufiger von einer schlechteren Gesundheit berichten. Die Ursachen für die gesundheitlichen Unterschiede sind vermutlich komplexer als angenommen (MITCHELL et al. 2000). Neben sozioökonomischen Faktoren wie Beruf, Bildung, Einkommen scheinen auch vom Individuum nicht direkt beeinflussbare kollektive Faktoren und Rahmenbedingungen eine Rolle für die Gesundheit und das Wohlbefinden zu spielen. Für geographische Ansätze sind gebietsgebundene Faktoren wie Charakteristika des Wohnortes und des sozialen Umfelds in der Nachbarschaft, das Vertrauen und die Interaktion mit der Gemeinschaft sowie die regionale Identität besonders erfolgversprechend (SUBRAMANIAN et al. 2001; LOCHNER et al. 2000).

In der Schweiz werden seit einigen Jahren soziale und gesundheitliche Unterschiede in verschiedenen Regionen diskutiert. BOPP und GUTZWILLER setzten sich mit den regionalen Sterblichkeitsunterschieden in der Schweiz und Unterschieden in der Gesamtsterblichkeit zwischen Grossstadt und Umland (BOPP & GUTZWILLER 1999) auseinander. KOLLER zeigt in seinem Bericht «Regionale Unterschiede und Gesundheit», basierend auf den Schweizerischen Gesundheitsbefragungen 1992/93 und 1997, dass Kultur und Geographie wichtige Grössen im Zusammenhang mit Gesundheit sind. So sind beispielsweise Unterschiede im gesundheitlichen und psychischen Wohlbefinden nach Höhenlage, in der Hospitalisationsdauer sowie in der Prävalenz individueller Risikofaktoren feststellbar (KOLLER 2000).

Aufgrund der kleinteiligen Vielfalt an Sprachen, Kulturen, Identitäten und sozialem Kapital sowie den dahinter stehenden Einstellungen und Weltbildern ist die Schweiz prädestiniert für die Analyse der Interaktion von individuellen und kollektiven Einflussfaktoren (*compositional vs. contextual effects*). Als kollektive Faktoren wurden bezüglich des gesundheitlichen Wohlbefindens verschiedene, vom Bundesamt für Statistik gebildete Raumindikatoren wie die Sprachgebiete (3 Kategorien), die sieben Grossregionen (7 Kategorien), der Indikator Stadt/Land (2 Kategorien), die Gebiete nach Gemeindegrösse (8 Kategorien), die 22 Gemeindetypen (22 Typen) und ihre Klassifizierung (8 Klassen) sowie die Gebiete in Höhe über Meer (4 Kategorien) untersucht. In diesem Beitrag soll das gesundheitliche Wohlbefinden anhand der von JOYE, SCHULER, NEF und BASSAND nach dem Zentrum-Peripherien-Ansatz entwickelten und seit den 1980er Jahren verwendeten Raumtypologien (22 Gemeindetypen und ihre Klassifizierung) in verschiedenen Schweizer Gebieten erläutert werden (JOYE et al. 1988). Wie nun das gesundheitliche Wohlbefinden der Bevölkerung in diesen teils räumlich zusammenhängenden Regionen und teils nicht zusammenhängenden Raumtypen eingeschätzt wird, soll unter Berücksichtigung von Alter, Geschlecht, Bildung und sozioprofessionellem Status anhand der Schweizerischen Gesundheitsbefragung 1997 gezeigt werden. Als statistisches Verfahren wurde die einfache Korrespondenzanalyse gewählt. Dass die Erfassung des gesundheitlichen Wohlbefindens als wichtige Variable sinnvoll ist, zeigen diverse Studien (SUNDQUIST & JOHANSSON 1997). Ein schlechtes gesundheitliches Wohlbefinden ist ein starker Prädiktor für die Mortalität.

2 Methoden

2.1 Datengrundlage

Als Datengrundlage dienten die Individualdaten der Schweizerischen Gesundheitsbefragung (SGB) 1997. Diese beruhte auf einer 2-stufigen, geschichteten Zufallsstichprobe mit 13.004 befragten Personen aus der Schweizer Wohnbevölkerung (Schweizerinnen und Schweizer, niedergelassene Ausländerinnen und Ausländer) von 15 und mehr Jahren, die in einem Privathaushalt mit Telefonanschluss lebten. Um die Repräsentativität der von der Stichprobe gewonnenen Aussagen für die Schweizer Wohnbevölkerung zu gewährleisten, wurde vom Bundesamt für Statistik ein Gewichtungsfaktor

nach dem Horwitz-Thompson-Schätzer eingeführt. Für die Gesundheitsbefragung wurden Stichprobe und Gesamtbevölkerung in Bezug auf Geschlecht, Alter, Wohnort und Nationalität (Schweizer/Ausländer) verglichen. Die gewichteten Daten betrafen die Schweizer Wohnbevölkerung von 15 und mehr Jahren Mitte 1997, insgesamt 5.889.186 Personen (CALMONTE et al. 2000). In den Ergebnissen wurden die Analysen der gewichteten Daten interpretiert.

2.2 Gesundheitliches Wohlbefinden

Die subjektive Einschätzung des gesundheitlichen Wohlbefindens wurde in der SGB mit der Frage erfasst: «Wie geht es Ihnen zur Zeit gesundheitlich?», wobei darauf mit «sehr gut», «gut», «mittelmässig», «schlecht» und «sehr schlecht» geantwortet werden konnte. Da die Stichprobengrösse der Merkmalsausprägung «sehr schlecht» unter 3% lag und dies in der Auswertung zu Verzerrungseffekten hätte führen können, wurden die Kategorien «schlecht» und «sehr schlecht» in der Korrespondenzanalyse zusammengefasst.

2.3 Raumtypologien

Folgende Raumtypen kamen zur Anwendung: die 22 Gemeindetypen und die 22 Gemeindetypen in 8 Klassen. Sie wurden aufgrund der Volkszählung 1990 gebildet und basierten auf dem Gemeinde Master File (GMF). Wichtige Grundlage war das Zentren-Peripherien-Modell nach JOYE, SCHULER, NEF und BASSAND (JOYE et al. 1988). Die Raumtypen wurden derart aufgebaut, dass zuerst nach Gross-, Mittel- und Kleinzentralen sowie peripheren Regionen unterschieden wurde. Innerhalb dieser wurden für die Agglomerationsgemeinden Kriterien wie Arbeitsplatzdichte, Wegpendleranteil, Gebäudestruktur und Einkommen der Bevölkerung bestimmend, für Gemeinden ausserhalb der Agglomerationen jedoch die dominante Wirtschaftsstruktur der Bevölkerung. Demographie und spezifisches Migrationsverhalten wurden in ein paar Sondertypen ebenfalls berücksichtigt (SCHULER & JOYE 1997). Die Kategorien der Raumindikatoren sind aus der Tabelle 1 ersichtlich.

2.4 Alter, Geschlecht, Bildung und sozioprofessionelle Kategorien

Alter und Geschlecht konnten zu sechs Kategorien mit 15- bis 35-jährigen, 36- bis 65-jährigen und über 65-jährigen Männern und Frauen zusammengefasst werden (Tabelle 1). Das Bildungsniveau wurde aufgrund der Fragen bezüglich obligatorischer Schule, Ausbildung nach der obligatorischen Schule, Zweitausbildung und der höchsten abgeschlossenen Ausbildung entwickelt. Die sozioprofessionellen Kategorien wurden anhand von Fragen zur beruflichen Stellung, zur Anzahl Angestellten sowie zum zuletzt ausgeführten Beruf, ferner zu Arbeitnehmern und Selbständigen gebildet (Tabelle 1).

2.5 Statistische Methoden

Da es sich bei der Variablen «Gesundheitliches Wohlbefinden» und den Gebietsindikatoren um ordinal- und nominalskalierte, d.h. kategoriale Daten handelt, wurden die Kontingenztabellen mit Chi-Quadrat-Statistik auf Unabhängigkeit und Homogenität getestet. Die Stärke des Zusammenhangs zwischen zwei kategorial aufgegliederten Merkmalen wurde mit CRAMERS V geprüft. Als geeignete Methode zur Untersuchung des kategorialen Datenmaterials wurde die in der Geographie selten zur Anwendung kommende Korrespondenzanalyse gewählt, da sie im Gegensatz zu den loglinearen Modellen, die nur eine eng begrenzte Anzahl der Variablen(ausprägungen) zulässt, eine nahezu unbegrenzte Anzahl der Variablen analysiert. Die Korrespondenzanalyse ist ein exploratives Verfahren zur graphischen und numerischen Darstellung von Zeilen und Spalten beliebiger Kontingenztabellen. Wie bei der multidimensionalen Skalierung ist die Distanzinterpretation zwischen Variablen und ebenso zwischen den Objekten von Bedeutung. Faktorenwerte der Objekte und Variablen können ähnlich wie bei der Hauptkomponentenanalyse bezüglich der einzelnen Achsen berechnet werden. Bei der Korrespondenzanalyse ist im Gegensatz zur Hauptkomponentenanalyse die graphische Darstellung von zentraler Bedeutung (BLASIUS 2001).

3 Ergebnisse

Im Schnitt fühlten sich 83% der Schweizer Bevölkerung gesundheitlich «gut» und «sehr gut». Die restlichen 17% fühlten sich «mittelmässig», «schlecht» und «sehr schlecht». Aufgrund dieser Frequenzen wird die statistische Problematik erkennbar. Die Profile «sehr gutes» und «gutes» Wohlbefinden sind aufgrund ihrer Stichprobengrösse aussagekräftiger als die Profile «mittelmässiges» und «schlechtes/sehr schlechtes» gesundheitliches Wohlbefinden. Da die relativen Häufigkeiten der 22 Gemeindetypen bezüglich des gesundheitlichen Wohlbefindens oft bei 3% liegen, sind die Ergebnisse bezüglich der 22 Gemeindetypologien mit Vorsicht zu geniessen.

Aufgrund des Korrelationsmasses von CRAMER, das bei völliger Unabhängigkeit den Wert Null aufweist, scheint der Zusammenhang zwischen Alter/Geschlecht, Bildung und sozioprofessionellen Kategorien und gesundheitlichem Wohlbefinden stärker zu sein als zwischen den Raumtypen und dem gesundheitlichen Wohlbefinden. Obwohl der Zusammenhang zwischen Raumtypen und gesundheitlichem Wohlbefinden zwei- bis viermal schwächer ist, lohnt es sich, anhand der Korrespondenzanalyse nach allfälligen Mustern zu suchen. Auch im weissen Rauschen können Strukturen erscheinen, die sozialgeographisch interpretierbar sind.

Raumtypen, Alter/Geschlecht, Bildung und sozioprofessionelle Kategorien	Gesundheitliches Wohlbefinden in Prozent der Gesamtstichprobe			
	sehr gut	gut	mittelmässig	schlecht/ sehr schlecht
22 Gemeindetypen				
Chi-Quadrat p = < 0,0001, Cramers V = 0,05				
GT1 = Grosszentren	3,4	7,8	1,8	0,7
GT2 = Mittelzentren	2,6	6,1	1,6	0,6
GT3 = Kleinzentren	2,0	4,1	0,8	0,3
GT4 = Peripheriezentren	0,4	1,0	0,2	0,1
GT5 = Reiche Gemeinden	1,2	2,5	0,5	0,1
GT6 = Touristische Gemeinden	0,6	1,0	0,2	0,1
GT7 = Semitouristische Gemeinden	0,3	0,5	0,1	0,0
GT8 = Heim- und Anstaltsgemeinden	0,1	0,4	0,0	0,0
GT9 = Arbeitsplatzgemeinden grosszentraler Regionen	1,9	3,8	0,8	0,2
GT10 = Suburbane Wohngemeinden grosszentraler Regionen	2,0	4,5	1,2	0,3
GT11 = Periurbane Gemeinden grosszentraler Regionen	1,1	1,9	0,3	0,1
GT12 = Arbeitsplatzgemeinden nicht-grosszentraler Regionen	1,8	4,0	1,0	0,3
GT13 = Suburbane Wohngemeinden nicht-grosszentraler Regionen	1,2	2,3	0,4	0,2
GT14 = Periurbane Gemeinden nicht-grosszentraler Regionen	2,1	4,3	1,0	0,2
GT15 = Zuzügergemeinden mit mässigem Wegpendleranteil	1,1	2,1	0,5	0,2
GT16 = Einheimischengemeinden mit mässigem oder hohem Wegpendleranteil	0,5	1,0	0,3	0,0
GT17 = Gemeinden mit industriell-tertiärer Erwerbsbevölkerung	1,2	3,2	0,7	0,2
GT18 = Gemeinden mit industrieller Erwerbsbevölkerung	1,0	2,2	0,4	0,1
GT19 = Gemeinden mit agrar-industrieller Erwerbsbevölkerung	0,8	2,0	0,5	0,1
GT20 = Gemeinden mit agrar-tertiärer Erwerbsbevölkerung	0,7	1,6	0,3	0,1
GT21 = Gemeinden mit agrarischer Erwerbsbevölkerung	0,1	0,7	0,1	0,0
GT22 = Gemeinden mit starkem Bevölkerungsrückgang	0,1	0,2	0,1	0,0
22 Gemeindetypen in 8 Klassen				
Chi-Quadrat p = < 0,0001, Cramers V = 0,04				
GTKL1 = Zentren	8,0	18,0	4,3	1,5
GTKL2 = Suburbane Gemeinden	6,9	14,6	3,5	1,0
GTKL3 = Reiche Gemeinden	1,2	2,5	0,5	0,1
GTKL4 = Periurbane Gemeinden	3,2	6,1	1,3	0,3
GTKL5 = Touristische Gemeinden	0,9	1,5	0,3	0,1
GTKL6 = Industriell-tertiäre Gemeinden	2,8	6,8	1,3	0,4
GTKL7 = Ländliche Pendlergemeinden	1,6	3,1	0,8	0,2
GTKL8 = Agrar-gemischte und periphere Gemeinden	1,7	4,4	1,0	0,3
Alter und Geschlecht				
Chi-Quadrat p = < 0,0001, Cramers V = 0,13				
AS1 = 15- bis 35-jährige Männer	6,0	10,0	1,2	0,3
AS2 = 15- bis 35-jährige Frauen	5,4	10,2	1,5	0,4
AS3 = 36- bis 65-jährige Männer	6,4	13,9	2,5	0,9
AS4 = 36- bis 65-jährige Frauen	5,7	13,7	3,5	1,2
AS5 = > 65-jährige Männer	1,4	3,9	1,3	0,4
AS6 = > 65-jährige Frauen	1,5	5,3	2,9	0,8
Bildung				
Chi-Quadrat p = < 0,0001, Cramers V = 0,09				
B0 = Ohne Ausbildung, unbestimmt	0,9	1,7	0,3	0,2
B1 = Obligatorische Schule	4,6	12,1	4,5	1,5
B2 = Sekundarstufe	15,5	33,4	6,8	2,0
B3 = Tertiärstufe	5,3	9,7	1,3	0,3
Sozioprofessionelle Kategorien				
Chi-Quadrat p = < 0,0001, Cramers V = 0,06				
SPK1 = Höhere Führungskräfte, freie Berufe	2,6	4,7	0.7	0,2
SPK2 = Höherqualifizierte nicht-manuelle Berufe, mittleres Kader	7,5	15,0	2,8	0,7
SPK3 = Büroangestellte und andere nicht-manuelle Berufe	7,1	15,4	3,4	1,0
SPK4 = Kleinunternehmer, selbständige Handwerker	2,4	4,8	1,0	0,2
SPK5 = Vorarbeiter, qualifizierte manuelle Berufe	3,8	9,4	2,3	0,8
SPK6 = Au- und ungelernte manuelle Berufe	3,2	7,8	2,4	0,9
Landesdurchschnitt	26,27	56,9	12,8	4,0

Tab. 1: Gesundheitliches Wohlbefinden, nach Raumtypologien, Alter/Geschlecht, Bildung und sozioprofessionellen Kategorien
State of health according to spatial typology, age/gender, level of education and socio-professional categories
Le bien-être physique, selon les typologies spatiales, l'âge/le sexe, le niveau de formation et les catégories socio-professionnelles

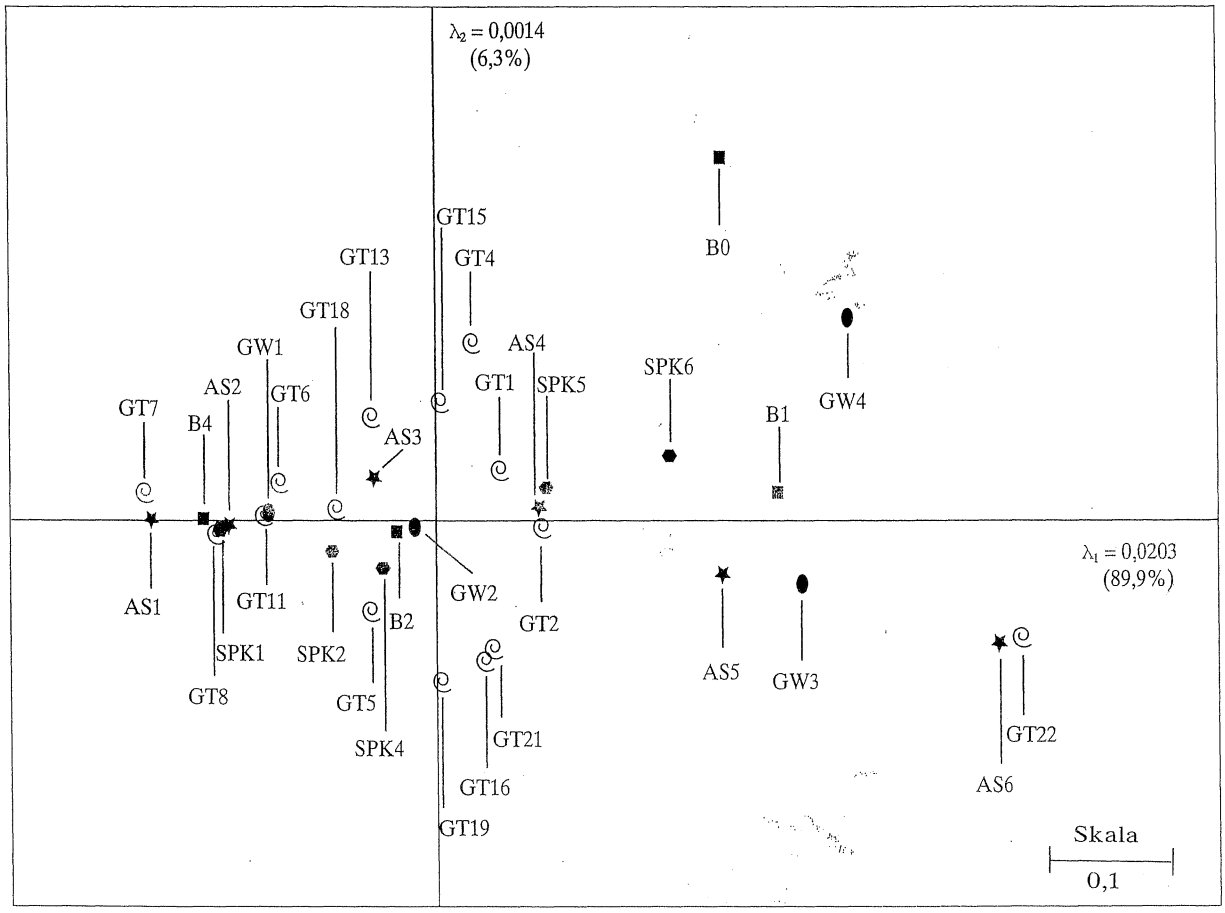

Abb. 1: Symmetrische Darstellung der Zeilen- und Spaltenprofile bezüglich gesundheitlichem Wohlbefinden und den 22 Gemeindetypen (Legende siehe Tabelle)
Symmetrical representation of bar and column profiles reflecting states of health in 22 communities (see table for legend)
Représentation symétrique des profils des lignes et des rubriques en fonction du bien-être physique et des 22 types de communes (Légende: voir le tableau)

Gesundheitliches Wohlbefinden und Gebiete nach Gemeindetypologien. Wenn das gesundheitliche Wohlbefinden bezüglich der Raumtypen nach dem Zentrum-Peripherien-Ansatz untersucht wird und dabei die 22 Gemeindetypologien als Raummerkmal dienen, erhält man unter Berücksichtigung der soziodemographischen sowie sozioökonomischen Variablen eine Matrix von 38 Zeilen und 4 Spalten. Die Dimensionalität des Projektionsraumes ist somit 37. Die dazugehörigen Achsen werden durch Trägheitsgewichte (Inertia = quadrierte kanonische Korrelationskoeffizienten, Werte zwischen 0 und 1) in absteigender Ordnung und die dazugehörigen erklärenden Varianzen beschrieben. Die Inertia der ersten Achse ist $\lambda_1 = 0{,}0203$. Wird dieser Wert auf die Gesamtvariation der zu untersuchenden Daten, also auf die Gesamtinertia bezogen, so ist das Ergebnis die erklärende Varianz der ersten Achse. Erstaunlicherweise wird die Gesamtvarianz durch drei Achsen erklärt. Die erste Achse weist 89,9%, die zweite 6,3% und die dritte 3,7% der erklärenden Varianz auf. In der geometrischen Darstellung (Abbildung 1) stehen somit die ersten zwei Dimensionen für 96,2% der Gesamtvarianz. Werden die Ergebnisse inhaltlich interpretiert, so spiegelt die erste Achse in ordinaler Ordnung von links nach rechts das «sehr gute» (GW1) bis «schlechte/sehr schlechte» (GW4) gesundheitliche Wohlbefinden sowie das Alter von 15 (AS1 und AS2) bis über 65 Jahre (AS5 und AS6) wider. Auch die Bildung lädt mit der Tertiärstufe bis zur obligatorischen Schule unter ordinaler Folge von links nach rechts auf die erste Achse. Nur die Gruppe ohne Ausbildung (B0) ist hierin eine Ausnahme. In derselben Weise laden auch die sozioprofessionellen Kategorien mit den höheren Führungskräften (SPK1) von links bis mit den an- und ungelernten manuellen Berufen (SPK6) nach rechts (Ausnahme SPK3) auf die erste Achse. Die linke Seite spiegelt

somit die jungen, sich gesundheitlich wohl fühlenden, gebildeten und beruflich höher qualifizierten Frauen und Männer wider, im Gegensatz zur rechten Seite, die für eine ältere, gesundheitlich sich eher «schlecht» fühlende, weniger gebildete und in einfachen manuellen Berufen tätige Bevölkerung steht. Die zweite Achse, die nur 6,3% der verbleibenden Variation erklärt, könnte in Ansätzen im negativen Bereich durch die Peripherie (GT19, GT16, GT21) im Positiven durch die Zentren und die umliegenden Gemeinden (GT1, GT4, GT15) beschrieben werden. Mit «sehr gutem» gesundheitlichem Wohlbefinden sind in erster Linie die Profile der touristischen (GT6) und semitouristischen Gemeinden (GT7), die periurbanen Gemeinden grosszentraler Regionen (GT11) sowie Heim- und Anstaltsgemeinden (GT8) assoziiert. Auch im linken Achsenbereich zwischen «gutem» und «sehr gutem» gesundheitlichem Wohlbefinden stehen die Gemeinden mit industrieller Erwerbsbevölkerung (GT18), die reichen Gemeinden (GT5) und die suburbanen Wohngemeinden nicht grosszentraler Regionen (GT13). Mit «mässigem» und «schlechtem/sehr schlechtem» gesundheitlichem Wohlbefinden fallen besonders die Gemeinden mit starkem Bevölkerungsrückgang (GT22) auf. Interessanterweise sind sie sehr stark mit den über 65-jährigen Frauen assoziiert. Die Grosszentren (GT1), die Mittelzentren (GT2), die Peripheriezentren (GT4), die Zuzügergemeinden mit mässigem Wegpendleranteil (GT15), die Gemeinden der vorwiegend Einheimischen mit mässigem oder hohem Wegpendleranteil (GT16) und die Gemeinden mit agrarischer Erwerbsbevölkerung (GT21) kommen zwar auf die rechte Seite der ersten Achse zu liegen, sind aber doch noch mehr mit dem «guten» als dem «mittelmässigen» gesundheitlichen Wohlbefinden assoziiert. Ein «mittelmässiges» und «schlechtes/sehr schlechtes» gesundheitliches Wohlbefinden ist eher mit dem höheren Alter, einer tieferen Bildung und beruflichen Stellung assoziiert als mit den Raumtypen (ausser GT22). Zudem müssen die Resultate hier bezüglich der 22 Gemeindetypen wegen der geringen relativen Häufigkeit in jeder Zelle der zugrunde liegenden Kontingenztabelle mit Vorsicht interpretiert werden. Die Profile GT3, 9, 10, 12, 14, 17, 20, SPK3 und B3 kamen nahe beim Zentroid zu liegen und wurden nicht interpretiert.

Nach der Zusammenfassung der 22 Gemeindetypen in 8 Klassen verändert sich das vorher gezeichnete Bild wenig. Wieder erklären drei Dimensionen die Gesamtvarianz der Daten (Dimension 1 = 92,3%, Dimension 2 = 4,8%, Dimension 3 = 2,9%). Die Achsen können wie oben beschrieben interpretiert werden. Die erste Achse links wird durch junge, gebildete, beruflich gut gestellte Männer und Frauen mit einem «guten» bis «sehr guten» gesundheitlichen Wohlbefinden bestimmt. Die rechte Seite zeichnet das Gegenteil. Die zweite Achse spiegelt oben eher die Zentren (GTKL1) mit ihrer Suburbia (GTKL2, GTKL7) und die industriell-tertiären Gemeinden wider, während unten die Peripherie (GTKL8) zu liegen kommt. Mit «sehr gutem» gesundheitlichem Wohlbefinden sind touristische Gemeinden (GTKL5) assoziiert. Zwischen «sehr gutem» und «gutem» gesundheitlichem Wohlbefinden stehen die periurbanen und reichen Gemeinden (GTKL4, GTKL3) (Abbildung 2).

4 Diskussion

Was ist nun für das gesundheitliche Wohlbefinden der Schweizer und Schweizerinnen wichtiger: sind es kollektive Einflussfaktoren wie die untersuchten Raumtypen oder die soziodemographischen und -ökonomischen Kriterien? Die Kontingenzkoeffizienten zeigen einen zwei- bis viermal höheren Zusammenhang zwischen gesundheitlichem Wohlbefinden und dem Merkmal Alter/Geschlecht (Cramers V = 0,13) als zwischen gesundheitlichem Wohlbefinden und den untersuchten Raumtypen (Cramers V = 0,4 und 0,5, Tabelle 1). Die Bildung (Cramers V = 0,09) und die sozioprofessionellen Kategorien (Cramers V = 0,06) weisen einen etwas stärkeren Zusammenhang auf als die Raumtypen. Es lohnt sich trotzdem nach allfälligen Strukturen und Mustern zu suchen und aufgrund der aus der Korrespondenzanalyse gewonnenen geometrischen Darstellung eine vorsichtige Interpretation bezüglich der Raumtypen zu wagen.

4.1 «Gutes» und «sehr gutes» gesundheitliches Wohlbefinden

Die periurbanen Gemeinden grosszentraler Regionen sind mit «sehr gutem» gesundheitlichem Wohlbefinden assoziiert und gehören meist dem äusseren Agglomerationsgürtel an. Der Anteil an Wohnungen in Ein- und Zweifamilienhäusern (jüngeren Datums, ältere Einfamilienhausgemeinden finden sich meist im Typ der reichen Gemeinden) beträgt mehr als 35% bis 40%. Auch die Einkommen sind hier relativ hoch. Die Bevölkerung ist vergleichsweise jung und zeigt extrem hohe Wegpendleranteile. Der Landwirtschaftsanteil liegt leicht über dem nationalen Durchschnitt (Joye et al. 1988). Die Ergebnisse bezüglich Alter/Geschlecht, Bildung und sozioprofessionellen Kategorien bestätigen dieses Bild.

Die reichen Gemeinden sind über das Steueraufkommen, das Mietzinsniveau und den Direktorenanteil definiert. Gut zwei Drittel der Gemeinden dieses Typs gehören dem Umland der fünf Grosszentren an, vor allem von Zürich (Seegemeinden) und Genf. Dieser Typ zeigt nicht nur in seiner Definition, sondern auch bezüglich des «guten» bis «sehr guten» gesundheitlichen Wohlbefindens Affinitäten zum Typ periurbaner Gemeinden grosszentraler Regionen.

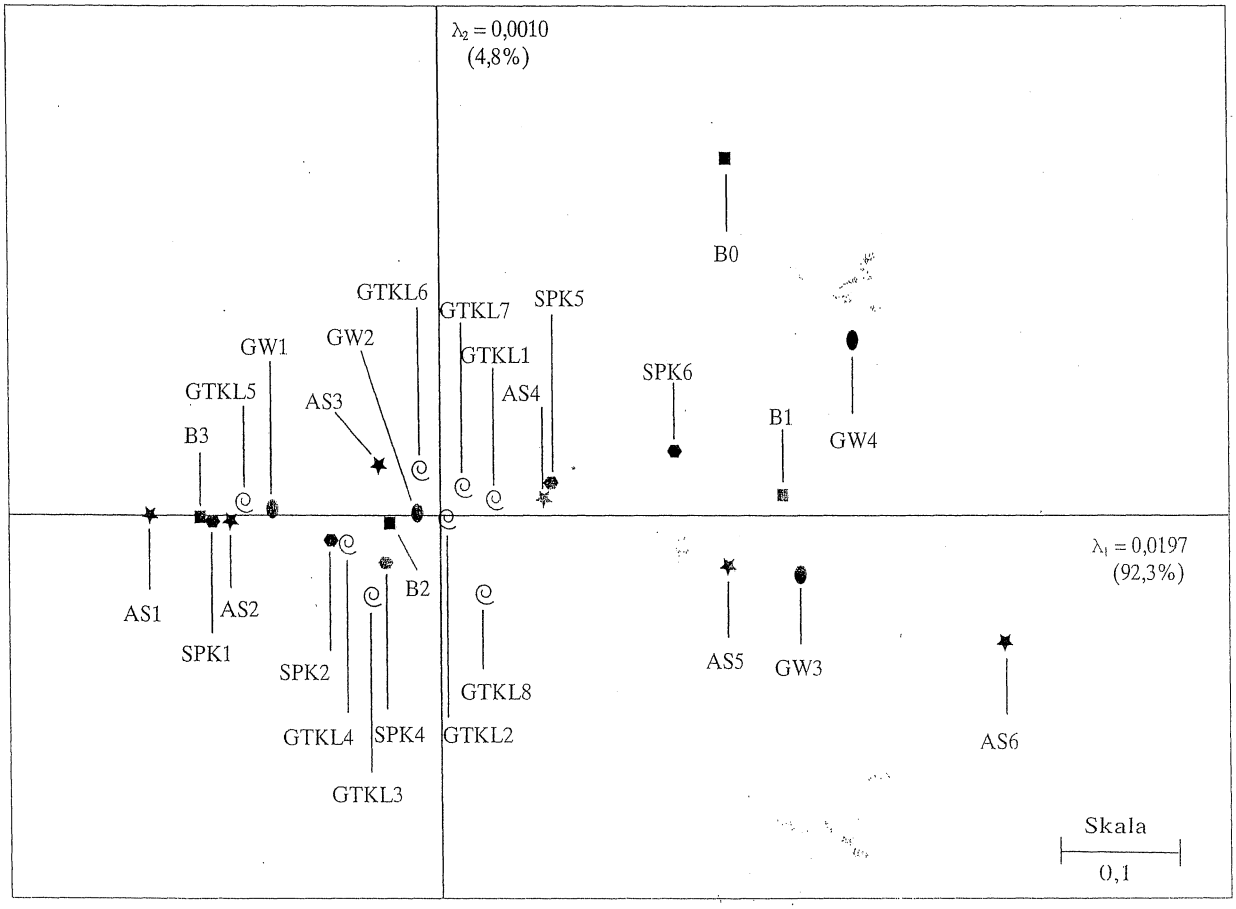

Abb. 2: Darstellung der Zeilen- und Spaltenprofile bezüglich gesundheitlichem Wohlbefinden und den Gemeindetypen in 8 Klassen (Legende siehe Tabelle)
Representation of bar and column profiles reflecting states of health in 22 communities according to 8 categories (see table for legend)
Représentation des profils de lignes et de rubriques selon le bien-être physique et les types de communes regroupées en 8 classes (Légende: voir le tableau)

Für die bezüglich des «sehr guten» gesundheitlichen Wohlbefindens auffälligen touristischen und semitouristischen Gemeinden sind Variablen wie Logiernächte, Zweitwohnungen und Erwerbstätige im Gastgewerbe massgebend. Dem touristischen Typ wurden grössere, klassische und auch jüngere Gemeinden zugewiesen. Sie liegen in den Kantonen Graubünden und Wallis, im Berner Oberland und am Vierwaldstättersee. Einzelne Bäderorte wurden ebenfalls berücksichtigt. Das Tessin ist nur mit wenigen Gemeinden vertreten. Lugano und Locarno sind als Zentren definiert. Im semitouristischen Gemeindetyp sind kleinere touristische Gemeinden wie Hasliberg, Lungern, Elm, Amden, Obersaxen, Cadenmario, Evolène im Alpenraum und Tessin sowie Vororte hochtouristischer Gemeinden wie Ringgenberg, Bever, Parpan, Brione sopra Minusio, Veytaux, Täsch oder Saas Almagell zusammengefasst. Die ländlichen Merkmale wie hoher Anteil der Landwirtschaft, der Einheimischen, der Selbständigerwerbenden und der Wohneigentümer fallen hier ins Gewicht. Wegen der geringen Anzahl n muss dieses Resultat jedoch mit Vorsicht genossen werden. Die periurbanen, reichen und touristischen Gemeinden sind in den 8 Klassen ebenfalls stark mit «gutem» bis «sehr gutem» gesundheitlichem Wohlbefinden assoziiert.

4.2 «Mittelmässiges» und «schlechtes» gesundheitliches Wohlbefinden

Die Grosszentren liegen zwischen den Profilen «gutes» und «mittelmässiges» gesundheitliches Wohlbefinden. Im Vergleich zu den anderen Gemeindetypen geben die in Grosszentren lebenden Personen ein weniger gutes gesundheitliches Wohlbefinden an. Was die Grosszentren besonders auszeichnet, ist der hohe Zentralitätsgrad sowie eine besondere Bevölkerungs- und Wohnstruktur. Hier sind der Kinderanteil, die

Haushaltgrösse und der Anteil an Eigentumswohnungen am geringsten. Die höchste Bevölkerungs- und Arbeitsplatzdichte sowie ein sehr hoher Ausländeranteil (besonders in Genf) sind für die Grosszentren charakteristisch. Die Mittelzentren der Gemeindetypologie, die 20 Städte mit 25'000 bis 100'000 Einwohnern auf sich vereinen, sind Zentren von mittelzentralen Regionen gemäss der Raumtypologie und von mittelgrossen Agglomerationen (z.B. Solothurn). Ihr Profil tendiert im Vergleich zu den Grosszentren noch mehr zum «mittelmässigen» gesundheitlichen Wohlbefinden.

Eine ähnliche Tendenz zum «mittelmässigen» Wohlbefinden, nur im peripheren Raum, zeigen die Gemeinden mit agrarischer Erwerbsbevölkerung, in denen mehr als 40% der Erwerbstätigen im Primärsektor beschäftigt sind. Da in diesem Gemeindetyp nur etwas mehr als 2% der Schweizer Wohnbevölkerung wohnen und auch der Anteil der mit «sehr schlecht» Antwortenden gesamtschweizerisch relativ gering ist, ist dieses Resultat mit Vorsicht zu bewerten. Die agrarischen Gemeinden sind in der Regel kleine geschlossene Dörfer und zum Teil auch grössere Einheiten in typischen Streusiedlungsgebieten des Alpenvorlandes (Napfgebiet, Schwarzenburg). Dieser Typ ist in der westlichen Landeshälfte mehr vertreten als in der östlichen. Der höchste Anteil an Selbständigerwerbenden, der geringste Anteil an Ausländern, Frauen und Geschiedenen, das tiefe Einkommen und die tiefen Mietpreise sind für diese in jeder Hinsicht sehr ländlichen Gemeinden typisch (Joye et al. 1988). Das Profil der agrar-gemischten und peripheren Gemeinden der Gemeindetypen nach 8 Klassen liegt beinahe am selben Ort im Projektionsraum und bestätigt mit einer höheren Anzahl n diese Tendenz.

Gemeinden mit starkem Bevölkerungsrückgang, die mit «mässigem» und «schlechtem» gesundheitlichem Wohlbefinden assoziiert sind, stehen für eine extrem periphere Situation. In diesem Typ erscheinen Zwerggemeinden mit starkem Bevölkerungsverlust und grosser Überalterung. Dies zeigt sich vor allem in den Kantonen Tessin, Graubünden und Freiburg. Daher ist auch verständlich, dass das Profil GT22 so stark mit den über 65-jährigen Frauen assoziiert ist. Auch wenn die relative Häufigkeit bei diesem Typ gering ist, zeigt gerade dieses Ergebnis die Bedeutung des in dieser Studie verwendeten Korrespondenzanalysemodells.

5 Fazit

Aus den Untersuchungen geht klar hervor, dass besonders das Alter ein starker Prädiktor für das gesundheitliche Wohlbefinden ist. Auch der sozioökonomische Status scheint relevanter als die untersuchten Raumtypen zu sein. Dass Zentrum und Peripherie in den Raumtypen eher Assoziationen zum «mittelmässigen» gesundheitlichen Wohlbefinden aufweisen, ist interessant. Die beiden Extreme Zentrum und ländliche Peripherie weisen beide einen reduzierten sozialen Kontakt in unterschiedlicher Form und eine ältere, sich wenig reproduzierende Gesellschaft auf. Sie sind jedoch extrem gegensätzlich in den Merkmalen wie Einwohnerzahl und Ausländeranteil sowie in den Wirtschaftsstrukturen. Die Extreme und mit ihnen die erschwerten sozialen Kontakte scheinen das gesundheitliche Wohlbefinden zu belasten. Die in vielen Studien nachgewiesene Korrelation zwischen Sozioökonomie und Gesundheit (Wilkinson 1996; Miles 1991; Bartley 1994) kann mit dieser Studie bestätigt werden. Entsprechend sind auch die Gemeindetypen mit einer eher jungen, einkommensstarken Bevölkerung im Projektionsraum der gebildeten und beruflich gut positionierten Bevölkerung zu finden. Dass neben Beruf, Bildung und Einkommen auch vom Individuum nicht direkt beeinflussbare kollektive Faktoren und Rahmenbedingungen eine wichtige Rolle für die Gesundheit und das Wohlbefinden spielen können, kann mit diesen Ergebnissen nicht von der Hand gewiesen werden. Dass sie aber wichtiger als das Alter und der sozioökonomische Status sind, konnte hier nicht gezeigt werden.

Dank

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Zusammenfassung: Regionale Muster im gesundheitlichen Wohlbefinden der Schweizer Bevölkerung. Untersuchung des gesundheitlichen Wohlbefindens aufgrund der Schweizerischen Gesundheitsbefragung 1997 und der Schweizer Raumtypologien
Seit den 1990er Jahren werden für das gesundheitliche Wohlbefinden neben individuellen Verhaltensfaktoren oder dem sozioökonomischen Status auch kollektive, regionengebundene Charakteristiken wie der Wohnort und Nachbarschaften diskutiert. In dieser Studie wurden als kollektive Einflussfaktoren die 22 Gemeindetypologien nach JOYE, SCHULER, NEF und BASSAND bezüglich des gesundheitlichen Wohlbefindens unter Berücksichtigung von Alter, Geschlecht, Bildung und sozioprofessionellen Kategorien untersucht. Besonders das Alter, aber auch der sozioökonomische Status scheint ein stärkerer Prädiktor zu sein als die Raumtypen. In den Zentren und der Peripherie ist das gesundheitliche Wohlbefinden im Vergleich zum Landesmittel häufiger weniger gut. In den periurbanen und reichen sowie in den touristischen und semitouristischen Gemeinden fühlt man sich gesundheitlich «gut» bis «sehr gut».

Summary: Regional patterns in the state of health of the Swiss population. Investigation of state of health combining results from the Swiss Survey of Health in 1997 and Swiss spatial typologies
Since the 1990s, discussions on state of health have taken collective and regional characteristics such as place of residence or neighbourhoods into consideration, besides typical factors such as individual behaviour or socio-economic status. In this article, 22 community typologies as defined by JOYE, SCHULER, NEF and BASSAND were investigated with regard to states of health taking collective factors of influence into consideration, namely age, gender, level of education and socio-professional influences. In particular, the factor «age» appears to have a stronger influence on state of health results than spatial factors, although socio-economic status may also be considered an important factor. In city centres and in the rural periphery, personal state of health is often below the national average. In peri-urban and well-off areas, including touristic and semi-touristic destinations, people consider their state of health to be «good» to «very good».

Résumé: Modèles régionaux en matière de bien-être physique de la population suisse. Analyse du bien-être physique sur la base de l'enquête suisse sur la santé, en 1997, et selon les typologies spatiales suisses
Depuis les années 1990, la discussion est ouverte sur les rapports entre le bien-être physique, les facteurs de comportement individuels, le statut socio-économique, ainsi que les caractéristiques collectives régionales, telles que le lieu d'habitation et les voisinages. La présente étude comporte l'analyse des facteurs d'influence collectifs des 22 typologies de communes, selon JOYE, SCHULER, NEF et BASSAND, en ce qui concerne le bien-être physique eu égard à l'âge, mais aussi au statut socio-économique, qui semble être un facteur d'influence plus important que les types spatiaux. Dans les centres et à la périphérie le bien-être physique est moins prononcé qu'en moyenne à la campagne. Dans les communes périurbaines et les communes touristiques et semi-touristiques riches, on se sent physiquement en «bonne» ou en «très bonne» forme.

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Partie 4 : Terrains, approches

SPACE OF HEALTH-RELATED WELL-BEING

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Introduction

Changes in the natural and socio-cultural environment represent a challenge to societies. Economic and ecological developments, but also changes in working conditions, social relationships and life-styles, affect human health and well-being. In Switzerland, the noticeable variety of languages, cultures, identities and social capital, with their respective attitudes and "conceptions of the world", creates pronounced regional differences in health-relevant behaviour and in well-being. Switzerland therefore provides a particularly suitable context for the analysis of interactions between individual and collective factors (compositional vs. contextual effects). The overall goal of the project is to uncover multi-causal contexts of the health-disease continuum and to analyse the reciprocal effects of collective regional factors and individual well-being. To this end, we investigate the ways in which health varies in particular socio-cultural regions and regional environments of Switzerland and the factors of influence that are responsible for these differences. The database is Swiss Health Survey 1997. Preliminary results with simple correspondence analysis shows the eigenvalue of total inertia is low (λ = 0.0197) and there are not so many variations in the data. If we consider socio-demographic factors such as age, sex, education and socio-professional categories, the simple correspondence analysis shows the following results: By projecting the column and row variables on the first axis it can be seen that on the left side, profiles of young men and women, profiles of well educated people in a higher socio-professional status are associated with profiles of very good health-related well-being. On the right side of the first axis, profiles of old men and women, profiles of low educated people in a lower socio-professional status are associated with profiles of poor and very poor health-related well-being. Periurban municipalities of large and small centres as well as touristic and semi-touristic municipalities are associated with a very good health-related well-being. Large cities and middle-sized cities as well as municipalities with industrial-tertiary working populations and municipalities with agrarian and agrarian-tertiary working populations and municipalities with a higher than average proportion of homes and sanatoriums and municipalities with out-migration tend to have a higher number of people who perceive their health-related well-being to be poorer than in other municipality types (Keller-Lengen, 2005).

Health is recorded on a subjective level. The health variable is the subjective estimate of health-related well-being and correlates very well with mortality (Sundquist & Johansson 1997). Thus e.g. a poor health-related well-being is a strong predictor for high mortality. In numerous studies, self-rated health factors, e.g. self-rated long-term illness by Malmström et al. (2001) self-reported physical health by Mitchell et al. (2000), self-reported limiting long-term illness by Boyle et al. (1999, 2000) and reported health status by Sundquist and Johansson (1997), represent the health aspect. However, which psychosocial factors may be behind the motivation of people to answer with "Yes, I have a good or bad health-related well-being"? Siegrist postulate that subjective well-being refers to people's judgments about their own state. "These judgments concern their enduring mood (e.g. happiness) as well as their evaluation of the self (e.g. satisfaction with one's physical and mental health and functioning) and its relation to the material and psychosocial environment (e.g. life satisfaction, work satisfaction). Moods reflects the perception and evaluation of an individual's affective state whereas satisfaction with one's life conditions involves cognitive judgments that are based on some standard of comparison. These cognitive judgments point to existing or non-existing discrepancies between expectation and real experience"(Siegrist, 2003). Ryan and Deci postulate three innate psychological needs – competence, autonomy, and relatedness – which when satisfied yield enhanced self-motivation and mental health and when thwarted lead to diminished motivation and well-being (Ryan and Deci, 2000). Subjective vitality, a positive feeling of aliveness and energy is also to consider as a dynamic reflection of well-being (Ryan and Frederick, 1997). In this sense, health-related well-being is a diverse construct with psychological and somatic aspects. In Swiss Health Survey 1997, we investigate health-related well-being with moods such as depression and bad moods, loneliness, irritation and nervousness, optimism, full of power and energy, being calm and well-balanced. If we consider psychological aspects in health-related well-being, there are associations between socioeconomic and regional factors and health-related well-being? That is the second question we analyse.

Research design and methods

Individual-based data from the Swiss Health Survey 1997 (SHS) is a micro-census based on data disclosed by individual subjects by telephone. The present study contains information from 13,004 respondents aged from 15 to 97 years. For health-related well-being the clients were asked, "How healthy feel you today?" There were five response alternatives: very good, good, average, bad and very bad. The psychological variables were defined as follows: 1. Loneliness – It was possible to answer with "I feel me very often, quite often, sometimes or never alone", 2. Fear to getting ill – "I fear very strong, quite strong, a little bit, hardly and not at al to getting ill", 3. Depressed and in bad mood – "If you think about the last week, in how many days were you depressed and in a bad mood: nearly

each day, in three or four days, in one or two days or never? 4. Being calm and well-balanced – " In the last week, in how many days were you calm and well-balanced: nearly each day, in three or four days, in one or two days or never? 5. Irritation and nervousness – "In the last week, in how many days were you irritated and nervous: nearly each day, in three or four days, in one or two days or never? 6. Optimism, full of power and energy – "In the last week, in how many days were you full of energy, power and optimism: nearly each day, in three or four days, in one or two days or never? 7. Satisfaction with childhood – "Are you very just not satisfied with childhood?"

In the present study socioeconomic factors are education, income and work situation. Education was defined in terms of education completed after compulsory schooling, highest level of education achieved, kind of education, period of education and satisfaction with education. For income the clients were asked if their income is more or less then 9,000 Swiss Francs and in a second question were they asked if their income is more ore less then 6,000 Swiss Francs. The work situation was asked as follows: "Are you employed, self-employed, in education or sometimes employed?" Common social geographical approaches using structural data from census and tax statistics indicate 22 municipality types (Schuler, 1988). Other variables for investigating regional effects were defined as follows: language areas such as the German-, French- and Italian-speaking areas, four regions of altitude, 106 MS (Mobilité spacial) regions, urban and rural regions and eight regions calculated after total population. The data were analysed by Frequencies Analysis, Multiple Correspondence Analysis (MCA), Homogeneity Analysis (HOMALS) and Categorical Principal Component Analysis (CATPCA). Age and sex were included in the model.

Results

The results of HOMALS analysis are presented in figure 1. Both, first dimension with eigenvalue $\lambda 1 = 0.362$ and second dimension with eigenvalue $\lambda 2 = 0.258$ represent the psychological aspects. The strongest discrimination measures (dm) on both dimensions are follows: depressed and in bad mood (dm1 = 0.561, dm2 = 0.439), being calm and well-balanced (dm1 = 0.539, dm2 = 0.430), irritation and nervousness (dm1 = 0.435, dm2 = 0.410) and optimism, power and energy (dm1 = 0.523, dm2 = 0.364). Discrimination measures of health-related well-being are not so strong on the first and second dimension (dm1 = 0.326, dm2 = 0.158) in contrast to psychological aspects. If we interpret the position of the profiles of the calculated variables, we can detect a grouping of the profiles on the left side of the space of health-related wellbeing such as very good health-related well-being, never feeling alone, nearly every day calm, never depressed, never nervous, nearly every day optimistic, never fear to getting ill and very satisfied with childhood. The position of the other profiles of each variable follows on order to the right side of the first dimension. Here the following profiles are associated: not

satisfied with childhood, very fear to getting ill, never optimistic and full of energy, nearly every day nervous, never calm and well-balanced, nearly every day depressed and poor/very poor health-related well-being. The horseshoe effect in the second dimension shows a linear correlation between health-related well-being and all psychological factors. Multivariate correspondence analysis shows an association between age and health-related well-being, especially in the second dimension.

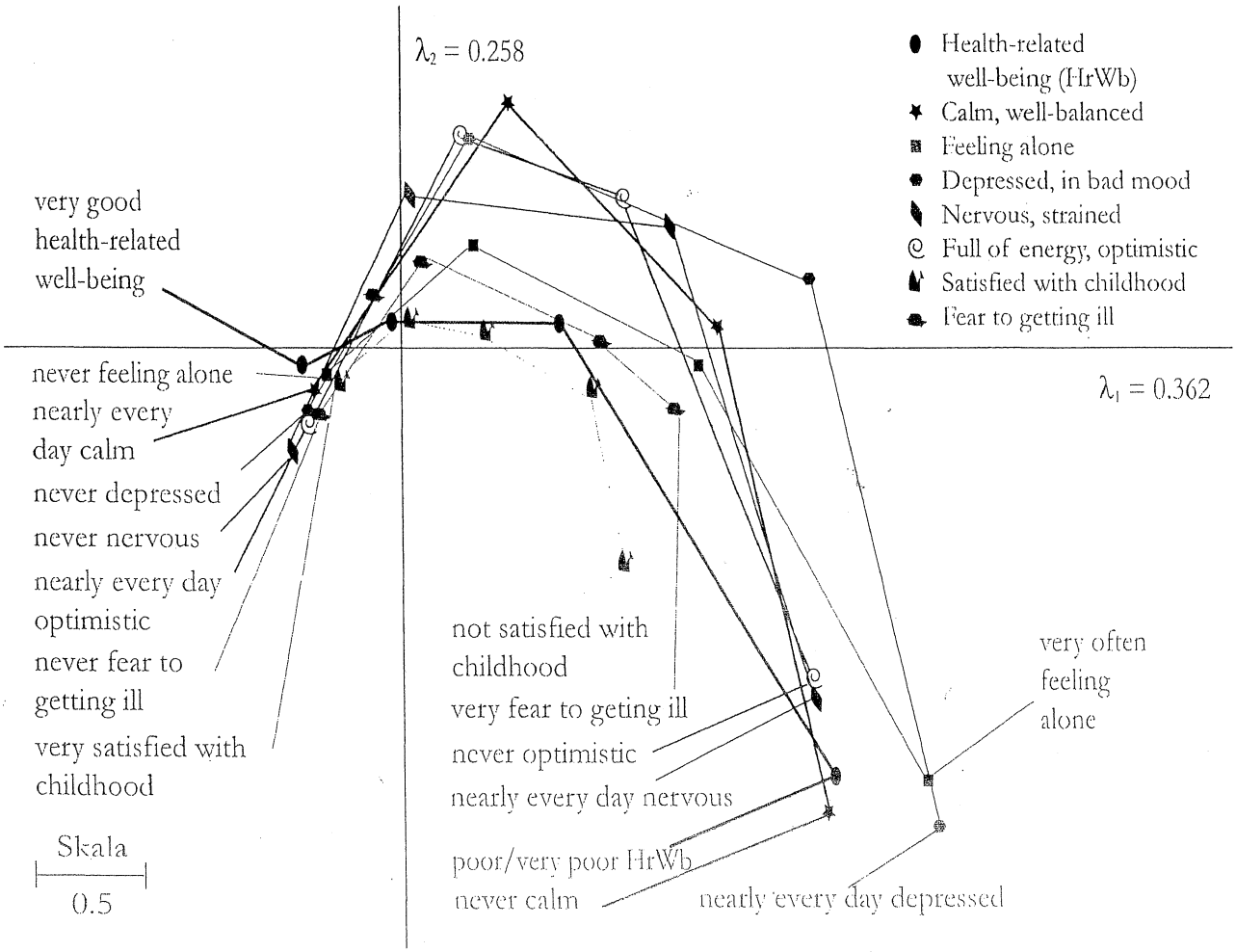

Fig. 1: Space of health-related well-being and his psychological aspects (HOMALS)

With CATPCA we can create the same space of health-related well-being as described above. Eigenvalue in the first dimension is $\lambda 1 = 2.764$ and in the second dimension $\lambda 2 = 1.343$. In figure 2 the profile of very good health-related well-being and the associated profiles of a very good mood are positioned on the right side and the profiles of very poor health-related well-being and bad moods are distributed on the left side. For the psychological aspects the component loadings on the first dimension are very high: loneliness 0.532, depressed and in bad

mood 0.759, being calm and well-balanced -0.749, irritation and nervousness 0.676 and optimism, full of power and energy -0.721. Health-related well-being has a component loading on the first dimension of –0.469. All socioeconomic factors have a very low impact on all investigated health factors, except satisfaction with education. All component loadings on the first dimension are lower than 0.084. Only satisfaction with education has a component loading of –0.181 on the first dimension. For all socioeconomic variables there are also no correlation in the second and third dimension of space of health-related well-being. Figure 2 shows the position of education aspects, which are all nearby the centroid (average profile). Only satisfaction with education follows in order the curve of health-related well-being. People, which didn't completed the compulsory schooling or are in education may have a poorer health-related well-being and are in bad moods. However, profiles of income and work situation are also positioned nearby the centroid. They show no association between health and socioeconomic factors.

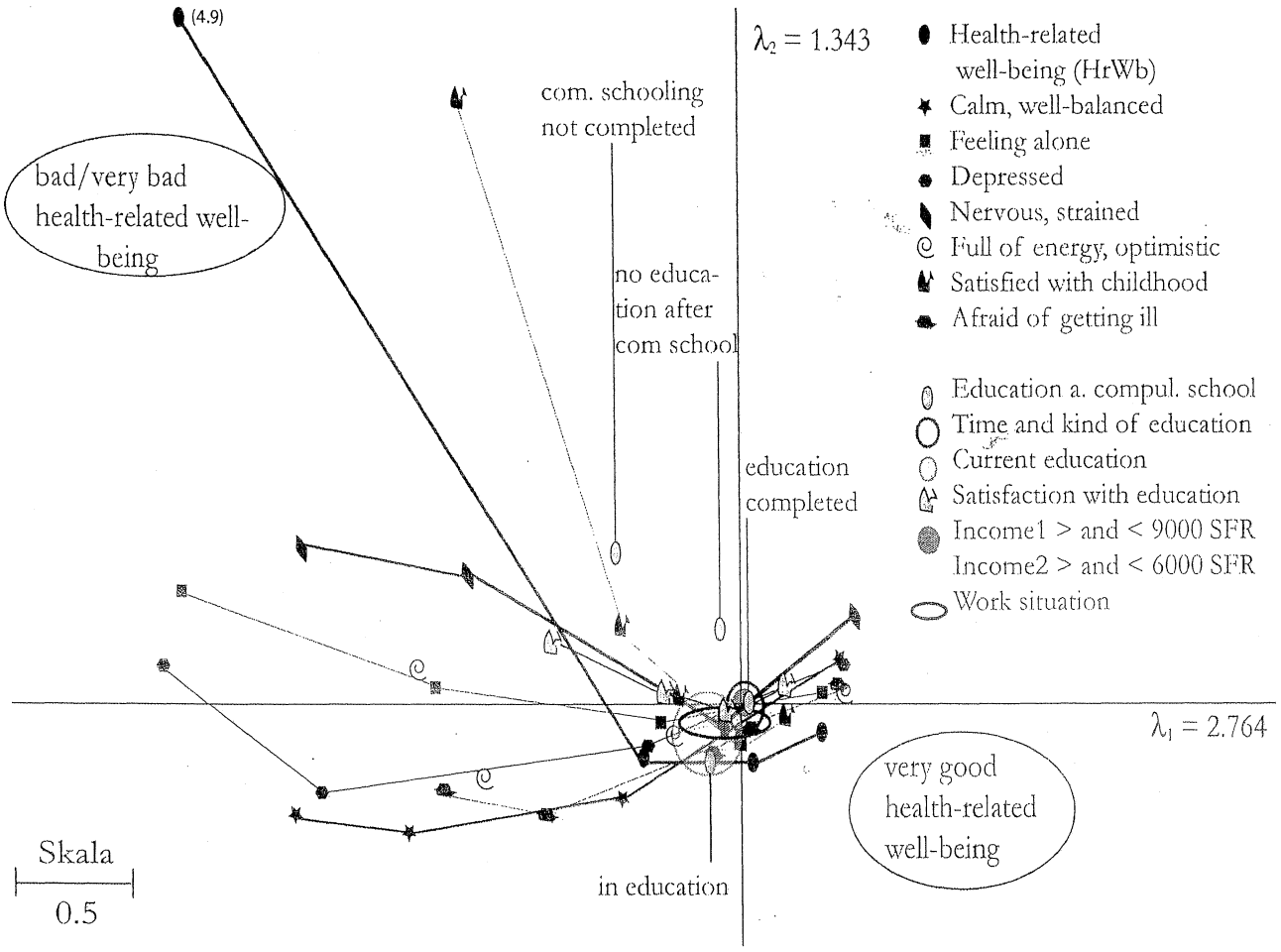

Fig. 2: Space of health-related well-being and the association to socioeconomic factors (CATPCA)

Furthermore, MCA shows a very weak association between health-related well-being and municipality types. Only inertia of the profile "municipalities with a

higher than average proportion of homes and sanatoriums" and inertia of the profile "municipalities with a marked decline in population" is higher, but their masses are very low, because the sample sizes in these types are too small. CATPCA for the described health factors and the different regional types shows also no association between the space of health-related well-being and the regions. Only few MS region profiles are not quite nearby centroid. However, these MS regions have a very low sample number in Swiss Health Survey 1997. In this case we not assume an association between these MS regions and the space of health-related well-being.

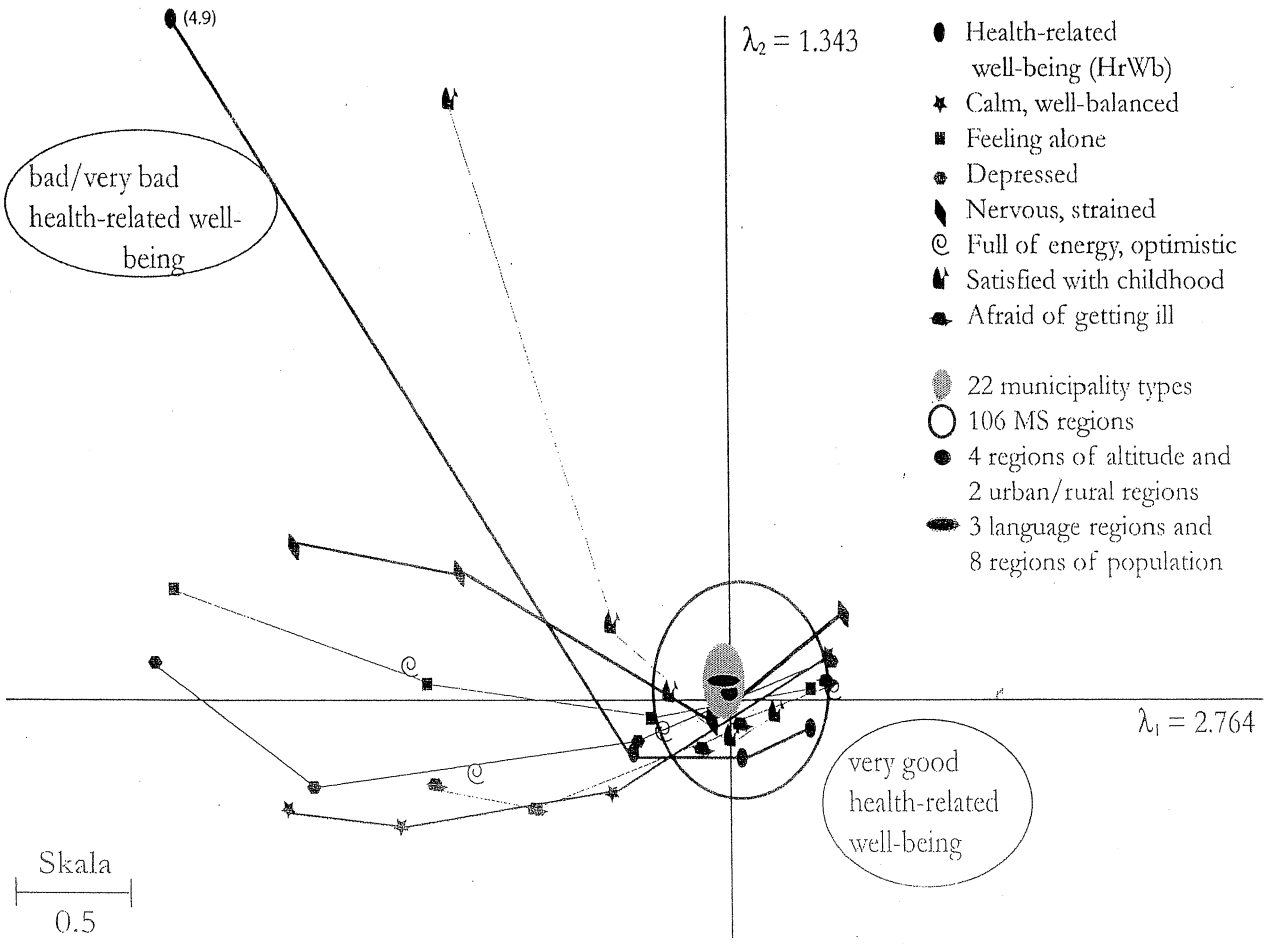

Fig. 3: Space of health-related well-being and the association to regional aspects (CATPCA)

Discussion

Wilkinson (1996) shows that in developed countries health and income are very closely related, but the differences in income and health between developed countries are only very weakly related. Wilkinson asks, "why is life expectancy higher in countries like Greece, Japan, Iceland and Italy than it is in richer countries like the United States or Germany?" There is increasing evidence that

certain characteristics of the area of residence may play a significant role in mediating these individual level relationships (Macintyre 1996, Mitchell et al. 2000). Lochner and Kawachi et al. (1999) demonstrated the importance of trust and interaction with the community for maintaining high chances of good health. We originally assumed that the association between areas of different Swiss municipality typology, especially municipality types with a strong socioeconomic and centre-periphery impact, and health-related well-being was much stronger than the results demonstrate. The other region types especially language areas, regions of altitude, MS regions, urban and rural regions and regions calculated after total population are not associated with health factors such as health-related well-being and psychological aspects. In general, weak theoretical accounts of how and why the characteristic of an area exists, which might exert an influence on the health of its resident population (Macintyre et al., 1993). Lack of theory has often resulted in a choice of variables with which to characterise an area, which is guided more by what is available "off-the-shelf" than by careful theoretical consideration. It also sidelines the important question of what is the appropriate spatial scale for analysis. Without an explicit consideration of how the characteristics of an area are expected to influence health, it is no surprise that contrasting results have been obtained in the search for area effects. It is also hard to translate the field's results into a coherent and potent policy message. In particular, there has been little attention to the fact that shared residence in an area does not necessarily mean that individuals will draw the same influences from it. This is because those who are spatial neighbours are not always social neighbours. Area classification cannot take account of the fact that people vary in their interactions with those who live close them.

Furthermore, the low impact of socioeconomic factors on health we did also not expect. Numerous studies show an association between health and education, indicators of socioeconomic position and income inequality. However, also critical opinions about the strong association between socioeconomic factors and health get before the public. In 1998 Gravelle shows mathematically that the aggregate relation is consistent with a negative, curvilinear relation between income and the probability of dying for individuals. Wagstaff and Doorslaer criticize studies of income inequality and poor health status because of their inability to disentangle the effects of individual income from the contextual effects of income inequality. In other words, an ecologic association between income inequality (e.g., measured by the Gini coefficient of income distribution at the US state level) and poor health (e.g., measured by age-adjusted mortality rates within each state) may reflect either a contextual effect of income inequality on health, or a compositional effect of income-poor individuals residing in unequal states, or both (Subramanian and Kawachi 2004). In this context other aspects has also to be discussed. First, in Switzerland health care system is well developed. Each person in Switzerland has to be health insured with a basic insurance for doctor consultations and stays in hospital. In Switzerland health insurance as a social system has a puffer effect. Income inequality not directly

results in health inequality. Second, in sociology the difference between objective and subjective indicators of life quality is well discussed. The Swiss study "Regional life quality in Switzerland", results of recruit interviews from 1996, 1987 and 1978, shows also no association between population income of the cantons and the subjective estimated life quality in the cantons (Walter-Busch, 1998).

At last but not at least our findings show a interesting association between health-related well-being and psychological aspect such as depressed and in bad mood, being calm and well-balanced, irritation and nervousness and optimism, full of power and energy, but also loneliness, fear to getting ill and satisfaction with childhood. In the sense of Bourdieu's social space we can create a mental space of health-related well-being. The association between health-related well-being and psychological factors such as moods, energy as an aspect of vitality and satisfaction is visible in the two dimensional illustration. Siegrist, Ryan, Deci and other investigators postulate self efficacy and self esteem, competence, relatedness and autonomy for the psychological dynamics of subjective well-being. If we use this variable health-related well-being we should know why people answer with "yes, I feel me healthy". Then we can estimate the value of this variable and use it as an indicator for health or not. Our investigation shows an association between psychological aspects and health-related well-being. However, the relation is not so strong how the association between the psychological factors. To understand the space of health-related well-being we should analyse also physical health, health behavior and using the health care system in relation to psychological dynamics.

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Constructing the 'Swiss health space' of self perceived health

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Abstract

With reference to Bourdieu's empirical work on constructing a 'social space' for the visualisation of complex social relationships (Bourdieu, 1984), we construct a 'health space' for analysing and visualising complex relationships between self-reported health symptoms. We use data from the 1997 Swiss Health Survey. The constructed health space can be interpreted as a collective individual perception of health. The first dimension of the constructed health space reflects the 'level of general health', the second dimension the 'composition of physical and mental health symptoms'. These dimensions may reflect deeply rooted cultural structures - the good vs. bad dichotomy as a generic categorization scheme of human thought and the body/mind dualism. These latent structures provide a framework of the health space and allow a better interpretation of the relationships of health perception characteristics and its related socio-demographic aspects.

Introduction

A considerable body of research exists, in which self-reported mental and physical symptoms and disorders are investigated considering social inequalities or socio-

demographic factors (Macintyre et al., 2003, Sturm & Gresenz, Cella et al., 2005, Hays & Steward, 1990). Often investigators use mortality rates or life expectancy or create health indicators based on self-reported health characteristics. Self-rated health factors, e.g. self-rated long-term illness (Malmström et al., 2001, Macintire et al, 2003), self-reported physical health (Mitchell et al., 2000), self-reported limiting long-term illness (Boyle et al., 2001), reported health status (Sundquist and Johansson, 1997b), or health-related behaviours such as smoking, alcohol consumption, diet and exercise (Ecob & Macintyre, 2000), were used to represent the health aspect. Kaplan et al. (1996), Welin et al. (1985), and Carlson, 1998), as well as Sundquist and Johansson (1997b) correspondingly report that self-perceived health reliably predicts mortality in individual longitudinal follow-up studies. They evaluated health status with one question: 'How would you describe your general health?' and gave three response alternatives 'good', 'bad', or 'anywhere between good and bad'.

In our paper, we address the question of which latent structures may be behind individuals' motivation to choose one of the response alternatives. In contrast to many health studies based on mortality and social inequality research, self-reported health is based on the answers of the laity. Their beliefs and knowledge concerning health and illness differ from scientific and medical 'knowledge' (Popay & Williams, 1996). Lay concepts of health and illness were conceptualised informally and separately from formal scientific expertise (Popay et al., 2003). The answers of the respondents are affected by these lay concepts and theories, as well as personality trait and cultural background.

An important aspect of how people answer a health question relates to the most capacious space within which we think about ourselves – the culture. 'Culture is the way of life of a people. It consists of conventional patterns of thought and behaviour, in-

cluding values, beliefs, rules of conduct, political organisation, economic activity, and the like, which are passed on from one generation to the next by learning – and not by biological inheritance' (Hatch, 1985, p. 178).

This paper aims to analyse profound relationships and latent cultural structures in the Swiss Health Survey. Psychometric and sociologic studies consider 'profound relationality' (Bourdieu, 1984) of a latent structure based on explorative data analysis. In accordance with Bourdieu (1984), who constructed a 'social space' based on a set of lifestyle characteristics, we develop a conceptual 'health space': First, on the basis of characteristics on self-reported symptoms from the Swiss Health Survey 1997 (sample size: 13,004) we construct a 'health space'. Second, we describe the structure of this 'health space' and portray the inter-relationships between the health characteristics we used for its construction. Third, with the help of supplementary, passive variables, we seek to extend the interpretation. As passive variables we use ten characteristics of medication to test the health space. General health (health-related well-being) is also analysed as a passive variable in the health space. We are interested in the position of health-related well-being in the health space. Finally, self-reported socio-demographic variables sex, age, income and education are integrated in the health space model. We use categorical principal component analysis (CatPCA) as an explorative data analysis tool to analyse and visualise structure patterns and their dimensionality.

Health perception

An important aspect of health perception and reporting subjective well-being is personality trait. Ryff (1989) proposed a multidimensional model of psychological well-being encompassing constructs such as autonomy, environmental mastery, personal

growth, positive relationships with others, purpose in life and self-acceptance. The relationship between psychological well-being and personality traits has also been explored considering the ageing process, life changes and stressful life events and resilience (Ryff, 1989, 1995). Negative correlations were uncovered between psychological well-being and depression, neuroticism and personality disorders. Positive correlations exist between psychological well-being and extroversion and openness to experience (Ryff, 1991). The relationship between well-being and personality trait as well as distress is complex.

Personality trait is also affected by culture. Cultural patterns structure both thought and perception. These patterns are conscious or unconscious and reflect people's congregation and act in ways associated with particular activities, values and social relationships (Young, 1994). The rituals, belief systems and the structures and dynamics of a social system are a result of the culture. We may also expect that in self-reported health cultural structures exist, which are important for interpreting health perception. The question arises, as to which patterns and structures we can expect in health surveys. The World Health Organisation (1948) defined health as a state of complete physical, mental and social well-being, and not merely as the absence of disease or infirmity. This assessment of health is embedded in the quality of life concept, which encompasses – among other factors – standard of living, quality of housing and neighbourhood, and job satisfaction. The 'general health status' is a part of health-related quality of life and it includes both a physical and a mental dimension of health. It refers to the body and bodily needs as well as its emotional and intellectual state. Ware (1995) pointed out that 'among the attributes of these definitions most important in constructing measures are dimensionality, particularly the distinction between physical and mental components, and the full range of health levels implied' (Ware,

1995, p. 329). In terms of measurement there are single indicators such as the 'health-related well-being' question and sets of health characteristics such as mental and physical health symptoms.

Ruini et al. (2003) analysed the psychological well-being of 450 Italian subjects and found by exploratory factor analysis four main factors or dimensions that accounted for 64% of the variance in the Psychological Well-Being Scales (PWB). The first dimension showed positive correlations with all well-being dimensions and a negative correlation with depression. Dimensions two and three were more related to somatic symptomatology. Dimension four was described as mixed factor, reflecting characteristics of reliable personality disorder diagnosis, personal growth and positive relationships. Hays and Stewart (1990) analysed with confirmatory factor analysis self-reported health status in 1,980 patients with one ore more chronic medical conditions. Their findings support the suggestion that health is multidimensional and indicate clearly that self-reports of physical and mental health are distinguishable. The physical and mental health constructs shared about 20% of the variance in common. This moderate association indicates that physical and mental health are distinct, but correlated components of overall health status. To identify significant, higher order substructures in the data, Cella et al. (2005) conducted a factor analysis of the data residuals, revealing two definable higher order dimensions: physical well-being and mental well-being.

Methods

Data collection

General health surveys often include a broad spectrum of different health concepts, which attempt to be appropriate for groups differing by disease, severity of symptoms and co-morbidity (McHorney, 1999). The health data used in this study are drawn from the Swiss Health Survey collected in 1997 (SHS97) by the Swiss Federal Statistical Office. The Swiss Health Survey is a well-established generic assessment based on comprehensive and dynamic approaches including self-reported individual health, lifestyle and environmental data. According to an augmented WHO health definition, a complex and dynamic concept of measuring health forms the background of the SHS97 (Calmonte et al., 2000).

The dataset contains a random sample of 13,004 interviews collected mainly by a telephone survey representing all Swiss geographical areas. The response rate was relatively high (69%). The sample was collected in a two-step procedure: first, a random sample was drawn representing all Swiss geographical areas, although areas with a low population density have been over-sampled to allow for firm analyses of them. Second, within the areas, households were randomly selected and within the households the target people. For more details on field characteristics, see (Calmonte et al., 2000).

Included variables

Due to the high frequency of missing data in many health variables such as handicap variables, health behaviour variables, cognitive functioning, sense of coherence, social functioning, and use of health care system, we expected a relative low level of

explained variance. Based on a frequency analysis, we selected a set of 16 health indicators covering self-reported mental and physical health, recent symptoms and medication, in order to construct the 'Swiss health space'. Six items measuring 'moods' were chosen: (1) not calm or well-balanced, (2) nervous and strained, (3) depressive and moody, (4) pessimistic and unmotivated, (5) feeling lonely as well as (6) fear of becoming ill; all items with four categories 'nearly every day', 'three or four days in the last week', 'one or two days in the last week' and 'not at all during the last week'. As symptoms, to be considered in the last four weeks, we included the following ten items: (7) weak, tired and lacking energy, (8) headache and facial pain, (9) sleep disorders, (10) abdominal pain and pressure, (11) backache, (12) fever, (13) cardiac dysrhythmia such as cardiac palpitation and tachycardia, (14) thoracic pain and pressure, (15) articular pain as well as (16) diarrhoea or constipation or both; all items with three categories 'not at all', 'a little bit' and 'strong'. All variables are measured on ordinal scales. To standardize the direction of the items, some of them had to be inversely formulated. All items are 'negatively' formulated and therefore we have a negative health model.

To confirm the interpretation of the 'health space' we include the following ten ordinally scaled items on medication as passive variables: (a) sedative agent, (b) vitamin preparation, (c) analgesic agent, (d) reconstituent agent, (e) somnifacient agent, (f) anti-asthmatic agent, (g) anti-rheumatic agent, (h) medication against constipation, (i) cardiac agent, and (j) hypotensive agent; all items with categories 'daily', 'several times a week', 'weekly', and 'not in the last week'. Furthermore, for comparison with previous studies, we include the 'health related well-being'-question: 'How is your

state of health today?'; with categories 'excellent', 'good', 'moderate, 'poor' or 'very poor'?'

In SHS97 all items measuring moods, symptoms and medication as well as the health-related well-being question have a very skewed distribution. The share of people reporting no particular health symptom or no medication is much larger than the share of people reporting symptoms or medication.

To test the association of socio-demographic variables with mental and physical health symptoms, we include as passive variables sex, age (15-21, 22-28, ..., 85-91, 92+ years), household income (≤ 3,000 Swiss Francs (SFR), 3,001-6,000 SFR, 6,001-9,000 SFR, > 9,000 SFR), and educational level (in education, primary school, secondary school, vocational school, high school, university, no education). Since we cannot expect linear relationships between socio-demographic variables with the dimensions of the health space, these variables have to be treated as nominal.

From the 'social space' to the 'health space'

In this study, space is a conceptual space, which enables us to 'order the immense mass of experience'(Kutschera, 1972). The conceptual space is built upon geometrical structures based on a number of quality dimensions, which represent various qualities of objects. Judgements of similarity and difference generate an ordering relation of characteristics. The dimensions assign properties to objects and specify relations among them. Our objects are experiences and perceptions related to the health of a Swiss population. The similarity of the relative frequency of the health perception characteristics specifies the relationship among them. The coordinates of an object,

displayed as a point, within a conceptual space represent particular instances of each dimension. The structure of many quality dimensions within a conceptual space will make it possible to talk about distances along the dimensions (Gärdenfors, 2000).

This space modelling allows to visualise the 'profound relationality' (Bourdieu, 1984) as a part of the complexity of health (Gatrell, 2005). However, conceptual spaces are only static and describe the structure of representations. The assumption to describe processes is a description of the dynamics of the representations. Gärdenfors interprets 'conceptual spaces as theoretical entities that can be used to explain and predict various empirical phenomena concerning concept formation. In particular, the distances associated with metric space should be seen in theoretical terms. If similarity is defined by distances via equation..., similarity will be a theoretical term, too...' (Gärdenfors, 2000, p. 31). He regards the dimensions of conceptual spaces as instruments for predictive and constructive purposes.

Constructing a conceptual space based on explorative data analysis is well-known in psychometrics (Heiser & Meulmann, 1994; Steyer et al., 1993) and sociology. In his work 'Distinction', Bourdieu (1984) introduced the concept of the 'social space' for describing and differentiating different groups of a population. Instead of using statistical coefficients, such as correlation and regression, he favoured a geometrical presentation to show the relationships between large sets of variables and population groups. Within a two-dimensional map, which he called 'social space', he could show how different lifestyle indicators are related to each other and how they are related to socio-demographic characteristics. Similarities are exhibited by small distances in the social space, dissimilarities by large distances. His method used techniques of 'geometric data analysis' (Le Roux and Rouanet, 2004; 'Analyse des Données', Benzécri

et al., 1973), mainly multiple correspondence analysis (Rouanet et al., 2000). The social space is described by its axes. As typical for factorial approaches, the factors (or dimensions) are labelled according to the variables that are highly correlated with them. Bourdieu's (1984) lifestyle indicators as well as the socio-demographic characteristics have an economic dimension ('capital volume') and a cultural dimension ('composition of cultural and economic capital').

In accordance to Gärdenfors (2000) and with respect to Bourdieu (1984) Gatrell et al. (2004) constructed a social space on the basis of a set of socio-demographic variables. After constructing a social space with dimensions 'economic capital' and 'social capital', they included health and other indicators, such as loneliness and long-standing illness. The idea of a conceptual space has been applied to different areas of research, for example, 'political spaces' (Bourdieu, 1979; Rosenlund, 1996), and health-related behaviour (Abel & Rütten, 1994; Gatrell et al., 2004). We apply the space concept to construct a health space on the basis of health characteristics.

Constructing the 'Swiss health space': Categorical principal component analysis

Categorical principal component analysis (CatPCA) is a way of displaying graphically the rows and columns of cross-tabulated, *ordinally* scaled data (Gifi, 1990; Michailidis and De Leeuw, 1998; De Leeuw, 2006). Multiple correspondence analysis (Greenacre and Blasius, 1994; Le Roux and Rouanet, 2004), as used by Bourdieu (1984) and Gatrell et al. (2004), is suitable to construct a 'social space' on the basis of *nominal* data (Rouanet et al., 2000). Calculations were performed using SPSS®.

In an iterative process the category values are replaced by 'optimal scores'. The CatPCA optimal scoring process allows order-constraints to be imposed so that ordered categorical variables get increasing, or at least non-decreasing, quantified scores (as well as 'optimal scores' to the single dimensions) within the r-dimensional space (with $r = 1, 2, ...$).

If the responses are not consistent with the implied ordering in r dimensions, this manifests itself by giving tied optimal quantifications for two or more subsequent categories. In CatPCA the number r of dimensions required must be specified in advance, because the solutions for different numbers of dimensions are not nested. In addition to the quantifications (the new estimated category scores in the r-dimensional solution), CatPCA provides eigenvalues (explained variances) and factor loadings (object scores).

Since the health variables are restricted to be ordinal, the quantifications of the successive categories from the single items can be connected by straight lines within the r-dimensional space (so-called biplot-axes; Gabriel, 1971, 1981; Gower and Hand, 1996). They run from the lowest value via the origin (the centroid) to the highest value. Comparing the biplot-axes provides the structure of responses. We apply this methodology to visualise the inter-relationships between the 16 items on mental and physical health symptoms within the 'health space'.

Passive variables can be included in a given solution and have no influence on the geometric orientation of the axes or the location of the active variables. They can however be interpreted together with the active variables. These types of variables are

often used for including information from a different substantive background. Within the CatPCA approach it is possible to keep the nominal scaling of the variables (Gifi, 1990). We include the ten items on medication as well as the health related well-being question as passive variables in the given 'health space'. Finally, we include the socio-demographic characteristics (age, income, sex, and educational level) in order to relate them to the health symptom indicators, medication, and health related well-being.

Results

The constructed health space has a maximum of 16 dimensions. We fit the data into five dimensions. The goodness of fit is shown in a Shepard plot (Fig. 1). The first dimension explains 23.0% of the variation in the data ($\lambda_1 = 3.686$, Fig. 2), and fits the data best in comparison with the other dimensions (Fig. 1). The second dimension explains an additional 10% of the total variation ($\lambda_2 = 1.598$), and represents the distinction between two kinds of health indicators: mental and physical symptoms. The third dimension with an eigenvalue of $\lambda_3 = 1.200$ mainly represents the component of 'diarrhoea or constipation, or both' and 'abdominal pain and pressure'. The fourth dimension distinguishes 'fever', 'articular pain' and 'no cardiac dysrhythmia' from the remaining physical health symptoms; the fifth dimension 'cardiac dysrhythmia such as cardiac palpitation and tachycardia' and 'thoracic pain and pressure' as well as 'no sleep disorders', 'no backache' and 'no articular pain'. Dimensions three, four and five represent special physical symptoms, which can be interpreted as symptoms of an illness. Dimension three could be seen to represent intestinal problems, dimension four acute infection and the fifth dimension as a representation of heart problems.

Based on the eigenvalues of the dimensions, as depicted in the Shepard plot, we decided on a two dimensional solution, because the first two dimensions fit the data best. The following dimensions three, four and five do not substantially change the interpretation of the first two dimensions.

The factor loadings of the first two dimensions (Table 1) show that all loadings are positive, i.e. all items have a common latent factor, which we call 'level of general health', in short 'general health'. Including the respondent in the 'health space' (using their 'object scores', not shown in the figures due to large sample size) provides us with a straight forward interpretation: The further right a respondent is located, the better is his/her general health.

The second dimension reflects the distinction between items measuring mental and physical health symptoms; the six items on mental health symptoms are located in the negative part of the second dimension, the ten items measuring physical health are located in the positive part. We call this dimension 'the composition of mental and physical health symptoms'. With respect to the direction of the item yields: the nearer to the top a respondent is located, the stronger his/her mental symptoms and the lower his/her physical symptoms; the nearer to the bottom a respondent is located, the higher his/her physical symptoms and the lower his/her mental symptoms.

Relationships between the health perception characteristics

In order to interpret the two-dimensional health space we focus on a negative health model and interpret mainly the 'poor general health' field of the health space. We can subdivide this into three clusters of respondents (Fig. 2). The first cluster reflects

poor mental health, indicated by 'not calm and not well-balanced', 'nervous and strained', 'depressive and moody', 'pessimistic and unmotivated' as well as 'feeling lonely'.

This group is contrasted by a second cluster, which consists of the indicators 'abdominal pain and pressure', 'backache', 'fever', 'cardiac dysrhythmia', 'thoracic pain and pressure', 'articular pain' and 'diarrhoea or constipation or both'. All active health variables are most strongly correlated with the first, i.e. general health dimension.

We can identify four of the variables, which form their own, intermediate cluster, and fall somewhat between mental and physical health. This cluster includes 'fear of illness', 'weak, tired and lacking of energy', 'headache and facial pain', and 'sleep disorders' (Fig. 2). These four characteristics are not properly explained in the two-dimensional solution as indicated by their low factor loadings (see Table 1).

Medication and health-related well-being

Nearly all kinds of medication show a strong positive association with physical symptoms (Fig. 3; the cluster areas of mental and physical symptoms, as well as the intermediate cluster are visualised as shadows). All of them are within or close to the 'physical health symptoms shade' and all of them keep their ordinality in the latent space: the stronger the symptoms are, the more medication is used. Sedative agents, vitamin preparations, analgesic agents and somnifacient agents are mainly used by those who report physical symptoms.

The lengths of the lines between the intersections are different, but there are no ties, i.e. the items are ordinal and the successive order of the categories is kept in the health

space. Since the categories reflecting 'good health' in all single symptoms are clearly more often chosen than the others, they are very close to the centroid of the map.

Health-related well-being (hrwb) is strongly correlated with the constructed health space. Hrwb is mainly correlated with the first general health dimension (see factor loadings in Table 2), but also with mainly physical health symptoms (Fig. 3).

Socio-demographic characteristics

To improve the legibility of the space, we focus on the inner part of the health space and include bisectional lines (Fig. 4). The associations of the health characteristics with the socio-demographic variables are weaker than with the medication characteristics. In the health space the position of the sex, income and education categories are relatively close to the centroid.

Including the categories of age in the 'health space' and connecting the successive categories by a trajectory shows that the ordering of the categories almost follows a straight line along the second dimension (Fig. 4). Factor loadings show that the relationship between the age groups and the second dimension, the composition of physical and mental health, is stronger than the relationship between the age groups and the first general health dimension (Table 2). Thereby the youngest reported the largest amount of mental problems; the older the people are, the less they reported mental and the more they reported physical problems. The only exception from this finding refers to the group of respondents aged 92 and more, they have general health problems clearly above average.

Socio-demographic and socioeconomic variables loads low on the first two dimensions of constructed health space (Table 2). Household income is mainly related to physical health. This becomes visible by projecting the categories on a right angle towards the bisectional dimension of 'physical health': On the bottom left there is '≤ 3,000 SFR', on top right there are the two highest income groups ('6,001-9,000 SFR' and '9,000+ SFR'). Furthermore, men reported less physical problems than women. Both household income and sex are uncorrelated with mental health symptoms (Fig. 4).

Educational level correlates with physical health symptoms: the lower the educational level, the stronger the reported physical health symptoms. Respondents who are still in education reported to have mental health symptoms above average, the members of this group are mainly young people. Respondents with no educational level at all have a relatively poor general health.

Discussion

A new way of connecting health indicators with socio-demographic characteristics was performed by Gatrell et al. (2004), who used multiple correspondence analysis to visualise health indicators within a 'social space'. We created a 'health space' on the basis of self-reported mental and physical health symptoms and included indicators of medication, the health-related well-being question as well as some socio-demographic characteristics into this health space.

Health space can be interpreted as a collective individual perception of health. Important components of this space are 'general health', ordered from very good to very poor health characteristics and represented by the first axis, and the distinction between mental symptoms and physical symptoms represented by the second axis. Calculating a five-dimensional model, the last three dimensions reflect some specific somatic symptoms and can be interpreted as symptoms of an illness: intestinal problems, acute infections, and cardiac and circulatory diseases, respectively. However, there only two or three variables exist that are factor loadings on the dimensions three, four and five (Table 3). Based on this fact and on our interest in latent cultural structures, we decided to consider the two-dimensional solution.

The construction of our health space is similar to the construction of Bourdieu's social space. Bourdieu's (1979, 1984) dimension 'capital volume' in social space is comparable with 'general health' in health space; and 'composition of economic and cultural capital' can be compared to 'composition of mental and physical symptoms'. According to the purpose, the implemented indicators differ; and whereas Bourdieu used lifestyle indicators, we applied indicators of perceived mental and physical symptoms. While social space has often been constructed to describe social relationships, health space has been created to describe differences in the perception of health.

Compared to Hays & Stewart (1990), Cella et al. (2005) and Ruini et al. (2003) this explorative data analysis approach shows a similarly low variance in the data. The first dimension explains 23% of the variation in the data and the second dimension explains 10% of the total variation. However, considering the other three calculated dimensions of the constructed health space, the third dimension represents only 7.5%

of the total variance, the fourth dimension 6.9% and the fifth dimension 6.4%. In a five-dimensional space the explained variance is 53.4% for 16 health characteristics. The five-factor analytic model of Ruini et al. (2003) accounted for 65% of the variance for a sample size of N = 450 respondents. They investigated 17 psychological well-being characteristics. Hays and Stewart's (1991) factor model, on the other hand, only explains 20% of the variance for their first two dimensions, physical and mental health (N = 1,980; 19 health variables). Our two dimensional solution thus seems acceptable in comparison to the other studies.

We interpret the first dimension as a continuum of general health, spanning from good general health on one end of the axis to poor general health on the other. Similarly, Ruini et al. (2003) found that their first dimension positively correlated with well-being and negatively correlated with depression. One can argue that the good vs. bad dichotomy is a generic categorization scheme of human thought. Young (1994) suggests that humans need to classify things, experiences, situations feelings, emotions, thoughts etc. into good and evil. In accordance with new public health approaches and traditional medicine, this dimension mirrors the fundamental assumption of dichotomy between healthy and sick individuals (Antonovsky, 1997).
In his salutogenetic concept Antonovsky (1997) suggests a health-illness continuum. In the constructed health space, based on more than one health characteristics, the first axis could be seen as an approximation to Antonovsky's health-illness continuum.

Hays and Stewart (1990) and Cella et al. (2005), on the other hand, identified mental health as the first dimension, and physical health as the second. The second dimension of our constructed health space represents the distinction between mental and physical

symptoms. This dimension may reflect a deeply rooted cultural structure - body/mind dualism. This dualism is a cultural structure of Western society, and is also manifested in the style and order of the SHS questionnaire that strongly influences the data structure of generic health measurements. The associations found between mental and physical symptoms rather support the idea of a body/mind connection in contrast to the generally perceived body/mind dualism. Historical and current studies discussed different aspects of body/mind relationships, in particular the complex neural correlates of mental structure and differing organization of psychological and physical reality (Chiesa, 1995; Freud, 1940). Discussions about somatization also influence the dichotomy of Western medical and therapeutic culture: mind versus body, physical versus psychological causation, reality versus 'phantasy' (Redekop et al., 1999). 'This is utterly odd, since who we are is all mixed up with how we feel about our bodies, yet we seem to live in our minds, while our feelings often get put into our bodies – 'somatized' – in ways that are odd, distressing and sometimes fatal, as in some psychosomatic and eating disorders' (Young, 1994). Our humanity however, is a feature of ourselves as persons, an amalgam of mind and body.

Our findings support the 'amalgam of mind and body' idea. The first cluster (mental symptoms) is placed between indicator 1 (not calm and not well balanced) and indicator 5 (feeling lonely); the second (physical symptoms) between indicator 10 (abdominal pain and pressure) and indicator 16 (diarrhoea or constipation or both). The angle between the resulting clusters is approximately 60°, which is equal to a correlation of $\rho = 0.50$. This solution supports the findings from Hays and Stewart (1990): they increased significantly their model fit by allowing a correlation between 'mental health' and 'physical health'.

Health has to be seen in a broader context to be able to interpret its cultural dimensions more appropriately. Young's (1994) concept of mind could be a valuable approach to interpreting health space. Young (1994) postulates a mental space as a 'congenial place for thinking, for reflecting, for rumination, for nourishment. It connects readily to comforting boundaries – containment, being held in mind.' For Young (1994) the point of origin of mental space is the 'point about misinterpreting the reality of the psyche's experience as normal and basic and hallucinatory is the essential point – the ur-fact – about human nature. It is also the essential basis for the theory of knowledge and our hopes for better human relationships in couples, families, groups, institutions, communities and nations. It provides the potential space within which we can re-evaluate, ruminate and reconsider our relations with the world'. Reconsidering self-reported health, each respondent answers based upon his conscious and unconscious thoughts, emotions and feelings. Young's mental space is also based on cultural space. He suggests that a large component of culture is below the level of conscious awareness and cultural patterns structure both thought and perception. The body/mind dualism is one such cultural mental component. Analysing the conceptions and questions of health, which SHS is based on, the dimensions are found as an inherently cultural structure.

Medication and health-related well-being

The specific medication variables are located near to the appropriate health symptoms. This occurrence confirms the conceptual health space.

The health-related well-being (hrwb) variable, frequently used to assess general health (Sundquist & Johansson, 1997 a, b, Keller-Lengen, 2005), is strongly correlated with our health space. Hrwb is a predictor for general health. It is only based on one gen-

eral health question. The use of hrwb as an important health indicator is justified, due to the good correlation with health space, particularly to the first general health dimension. George and Landerman (1984) noted that there is a strong correlation between health and subjective well-being for self-reported health measures, but not for the more objective health status given by physicians (Wattenet al., 1997). However, in the second dimension hwrb is more orientated towards physical symptoms than mental symptoms. This aspect should be considered when applying hrwb for health assessments. In SHS the hrwb question was asked at the beginning of the survey. People were not yet influenced by specific health questions and themes and they answered intuitively. We assume that respondents think about physical health and illness when answering the question of health-related well-being. This insight is interesting concerning people's health perception and should be considered when interpreting health outcomes.

Socio-demographic influences

In our study, age is related to the second dimension of the health space, reflecting the 'composition of mental and physical health symptoms': the younger the people are, the higher is the share of mental symptoms; only the small group of respondents aged 92 years and older (N=18) are out of the correctly mirrored order of the age categories. In accordance with the findings of Gatrell et al. (2004), Calmonte et al. (1998, 2000), Rodin (1986), Ware & Sherbourne (1992), Kobau et al. (2004) we could show that mental health problems decrease with increasing age. Kobau et al. (2004) mentioned that in the United States, young adults aged 18-24 years reported the highest amount of subsyndromal levels of depressive symptomatology. The first manifestation of a mental disorder, such as depression or schizophrenia, appears very often in

young adults. Burke et al. (1991) compared age at the onset of major depression and other psychiatric disorders by birth cohorts in the population of five U.S. communities. They uncovered a gradual shift towards increased rates of major depression in those aged 15-19 years.

We could show, that physical health symptoms increase with age. This corresponds to clinical experience: cardiac dysrhythmia, thoracic pain and pressure are direct symptoms for coronary heart disease. The prevalence of coronary heart disease, as well as rheumatism and cancer, increases with age (Anonymous, 1997; Kasper et al., 2004).

We can confirm the findings of Faltermaier (1994), Helfferich (1993) as well as Schulze and Welters (1998) that women report more physical symptoms than men. In describing their health status, men prefer to talk about their productiveness and the absence of illness (Schulze & Welters, 1998).

An advantage of explorative data analysis is the possibility of uncovering weak relationships in the data (Le Roux & Rouanet, 2004). We found a relatively weak but non-significant association between socio-demographic characteristics and health symptoms, also reported by Hays and Stewart (1990). Even though this relationship is far weaker than that between medication and health-related well-being, it should not be neglected.

Numerous studies showed that socio-demographic and socio-economic characteristics affect human health and well-being (Gravelle, 1998; Kennedy et al., 1998; Macintyre et al., 2005; Subramanian & Kawachi, 2003; Sundquist & Johansson, 1997a, b, 1998). Respondents belonging to lower social classes, the unemployed, and especially the

long-term unemployed report higher rates of illness and reduced well-being (Macintyre et al., 2003; Macintyre et al., 2005; Sturm & Gresenz, 2002; Sundquist & Johansson, 1997a, b). Other studies also suggest that income in affluent nations is only weakly related to subjective well-being (Diener et al., 1995; Veenhoven, 1996). Campbell et al. (1976) found that the demographic factors of age, sex, income, race, education, and martial status accounted for less than 20% of the subjective well-being variance.

In accordance with Walter-Busch's (1997) Swiss quality of life findings, we assume that the influence of income in Switzerland is also not particularly relevant for health perception. Walter-Busch has not found any correlation between the socioeconomic status of the Swiss cantons and the subjective estimated quality of life in these cantons (Walter-Busch, 1997).

These effects could be explained by personality trait and lifestyle, which is either innate or acquired, but is stable and independent of living conditions. Someone having a more pessimistic nature will always take less pleasure from changes in life than someone having an optimistic disposition. Similarly to the trait theory (Scherpenzeel, 2004), which postulates satisfaction as a 'national trait', health perception can also be seen as a national perspective on life in general, based on cultural norms, religion, and history. Regardless of the aggregation level of the trait theories (e.g., national or individual) people stay as happy or unhappy as they are, independent of changes in life circumstances (Scherpenzeel, 2004).

Conclusion

Following Bourdieu's empirical work on 'social space', we created a 'health space' based on a set of 16 health symptoms. The main dimensions of our health space are the 'level of general health' and the 'composition of mental and physical health symptoms', interpreted as a cultural dimension of the Cartesian mind/body dualism. Hrwb turned out to be strongly related to the first dimension. The passive medication variables which we included confirmed the validity of health space. Socio-demographic characteristics seem to have a limited influence on health perception. Our findings support previous work that income in affluent nations is only weakly related to subjective well-being. These effects could be explained by individual personality traits and/or individual outlook on life in general. According to the trait theory, which takes satisfaction rather as a 'national trait', the health perception of a population could also be seen as a collective outlook on life based on cultural norms, religion, and history. A large component of culture is below the level of conscious awareness and cultural patterns structure both thought and perception. Body/mind dualism may be seen as one such cultural mental component. These cultural and structural dimensions are inserted into the SHS data structure. Explorative data analysis could be demonstrated to be an appropriate approach to uncover such 'profound relationality' (Bourdieu, 1979, 1984).

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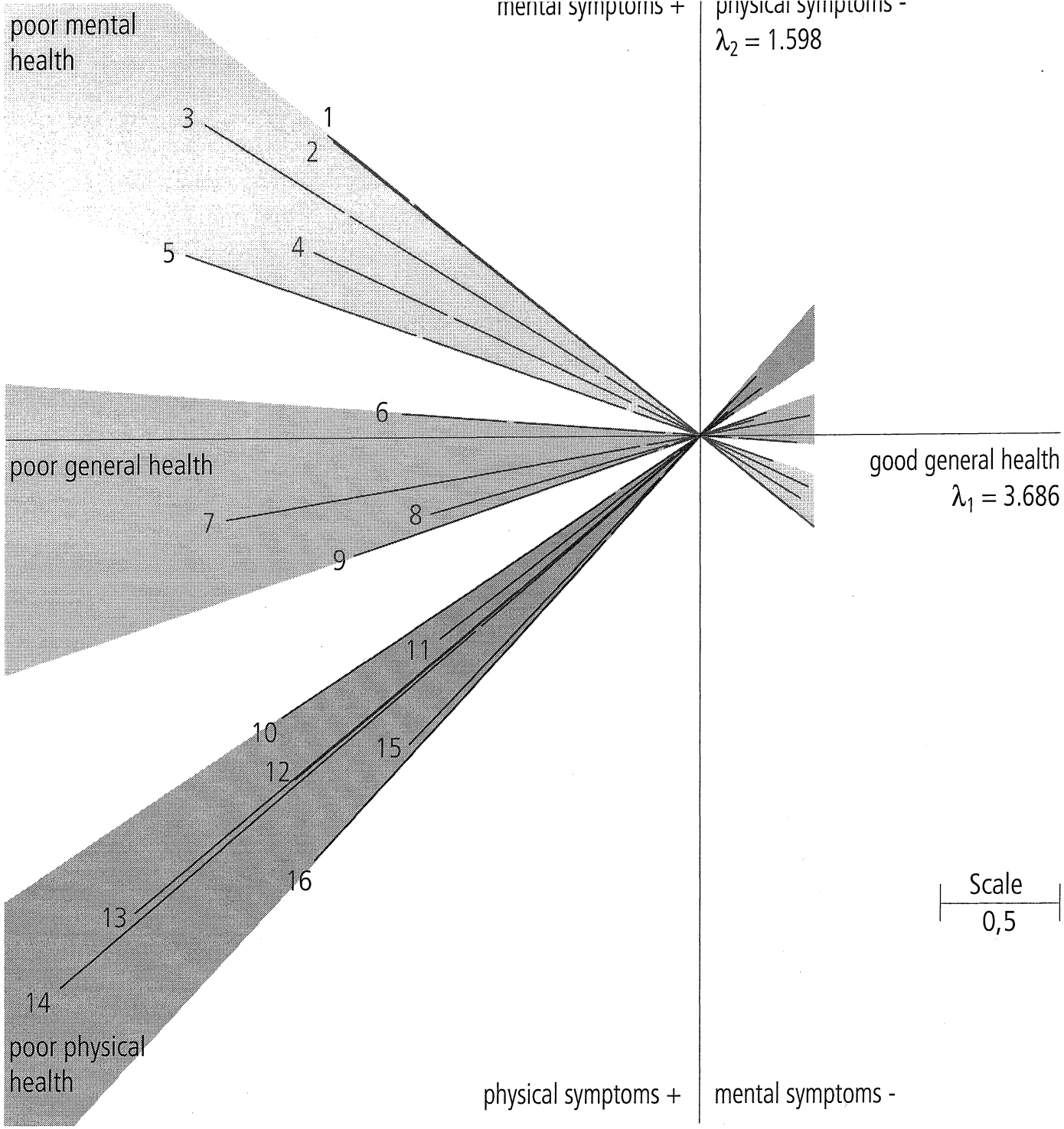
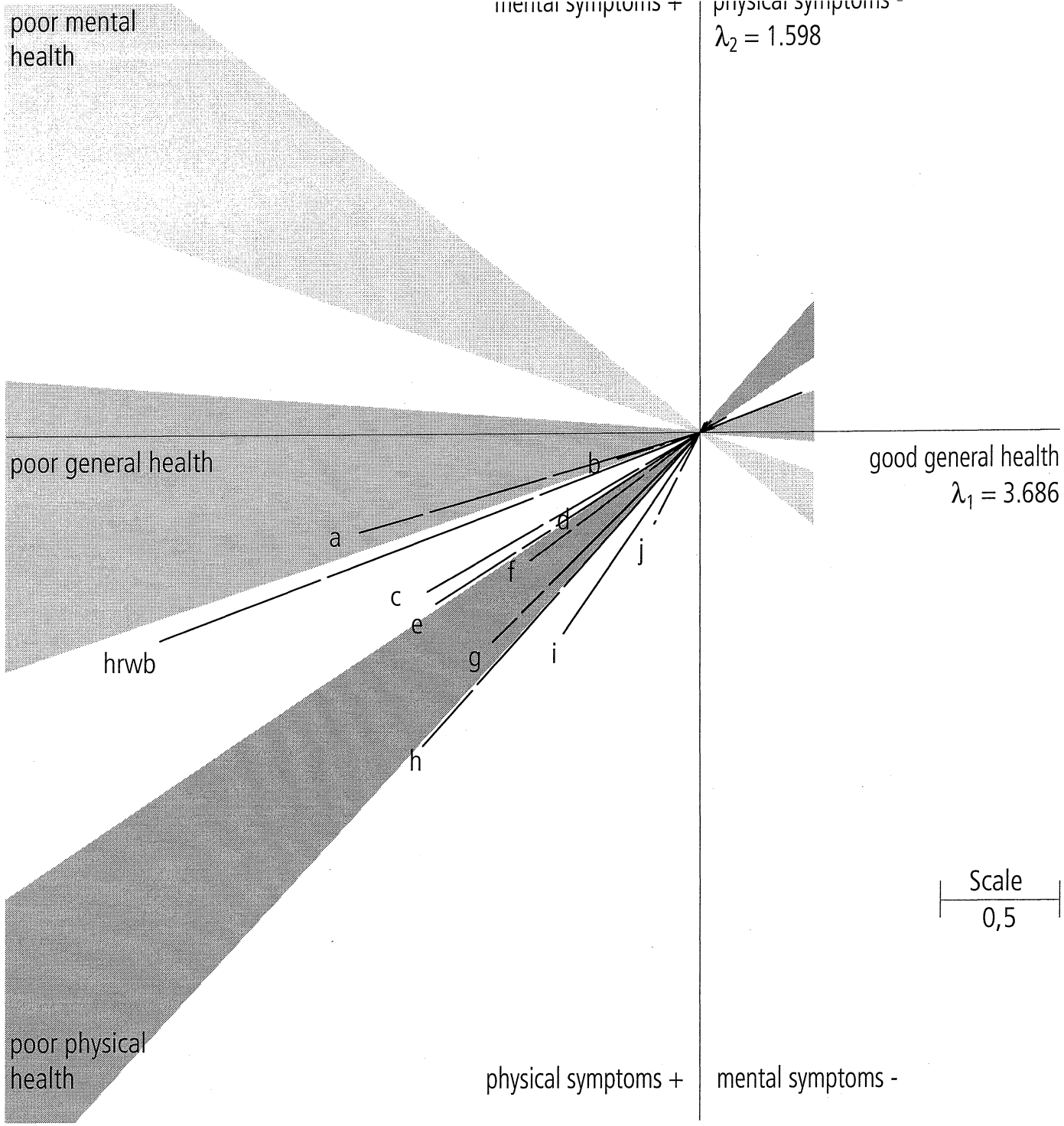
Figures



1. Not calm or well-balanced
2. Nervous and strained
3. Depressive and moody
4. Pessimistic and unmotivated
5. Feeling lonely
6. Fear of becoming ill
7. Weak, tired and lacking energy
8. Headache and facial pain
9. Sleep disorders
10. Abdominal pain and pressure
11. Backache
12. Fever
13. Cardiac dysrhythmia
14. Pain and pressure in the torax
15. Articular pain
16. Diarrhoea or constipation or both

Figure 1



a. Sedative agent
b. Vitamin preparation
c. Analgesic agent
d. Reconstituent agent
e. Somnifacient agent
f. Anti-asthmatic agent
g. Anti-rheumatic agent
h. Medication for constipation
i. Cardiac agent
j. Hypotensive agent

hrwb. Health-related well-being

Figure 2

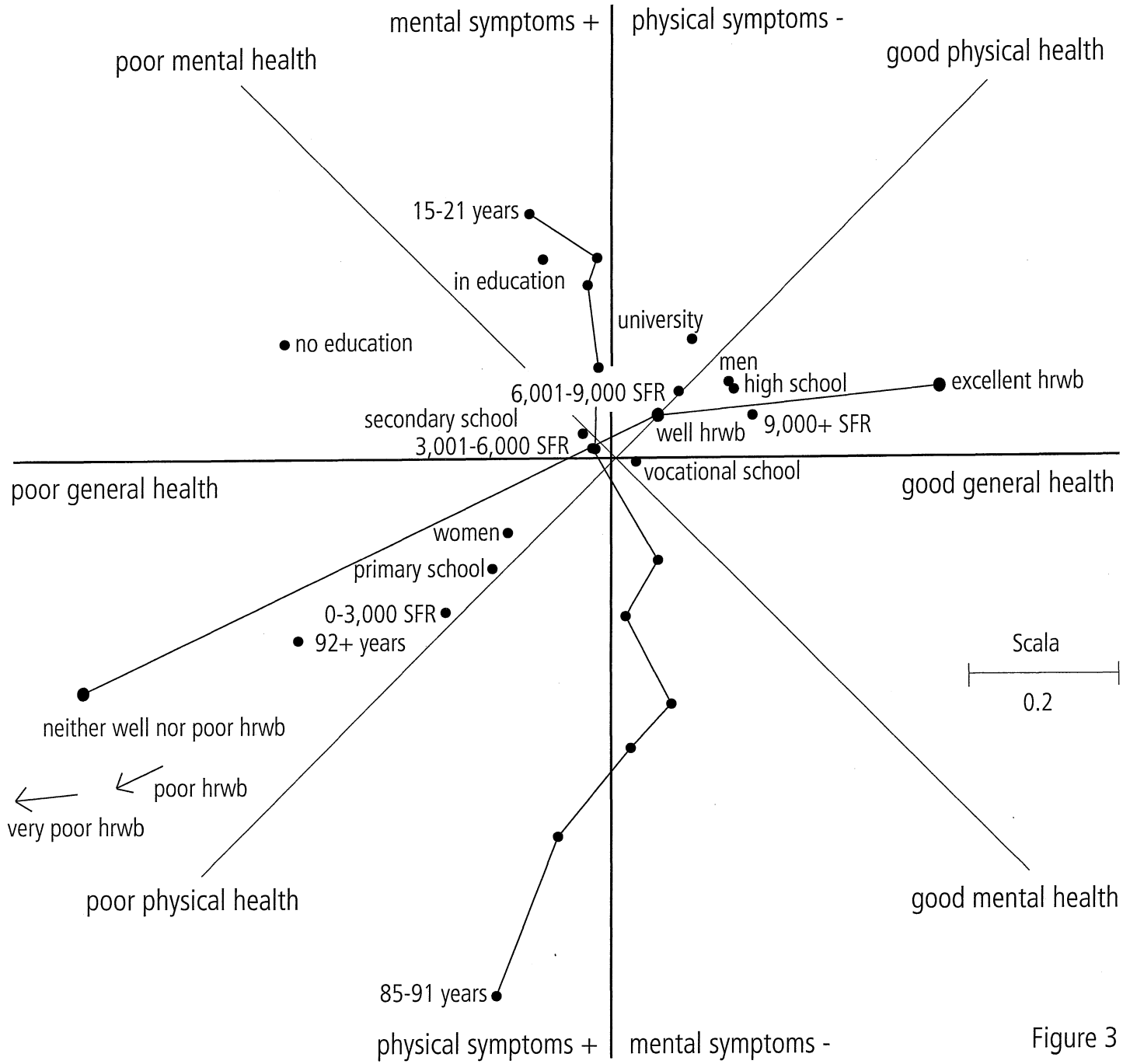

mental symptoms +
physical symptoms -
poor mental health
good physical health
15-21 years
in education
university
no education
men
high school
excellent hrwb
6,001-9,000 SFR
secondary school
3,001-6,000 SFR
well hrwb
9,000+ SFR
vocational school
poor general health
good general health
women
primary school
0-3,000 SFR
92+ years
Scala
0.2
neither well nor poor hrwb
poor hrwb
very poor hrwb
poor physical health
good mental health
85-91 years
physical symptoms +
mental symptoms -

Figure 3

Table 1: Factor loadings and explained variances of active variables

	Dimension 1	Dimension 2	Communality
Not calm or well-balanced (1)	.608	-.493	.613
Nervous and strained (2)	.558	-.449	.513
Depressive and moody (3)	.642	-.407	.578
Pessimistic and unmotivated (4)	.645	-.311	.513
Feeling lonely (5)	.475	-.170	.255
Fear of becoming ill (6)	.319	-.025	.102
Weak, tired and lacking energy (7)	.655	.114	.442
Headache and facial pain (8)	.385	.109	.160
Sleep disorders (9)	.492	.167	.270
Abdominal pain and pressure (10)	.393	.263	.224
Backache (11)	.410	.317	.269
Fever (12)	.253	.214	.110
Cardiac dysrhythmia (13)	.396	.333	.268
Pain and pressure in the thorax (14)	.432	.372	.325
Articular pain (15)	.418	.440	.368
Diarrhoea or constipation or both (16)	.355	.389	.277
Eigenvalues	3.686	1.598	
Explained variances	23.0%	10.0%	33.0%

Table 2: Factor loadings and explained variances of supplementary variables

	Dimension 1	Dimension 2	Communality
Health-related well-being	.489	.187	.274
Sedative agent	.279	.080	.084
Vitamin preparation	.144	.045	.023
Analgesic agent	.303	.174	.122
Reconstituent agent	.135	.086	.026
Somnifacient agent	.240	.154	.081
Anti-asthmatic agent	.083	.062	.011
Anti-rheumatic agent	.210	.209	.088
Medication for constipation	.156	.175	.055
Cardiac agent	.143	.208	.064
Hypotensive agent	.068	.132	.022
age	.020	-.188	
income	.112	.091	

Component Loadings

	Dimension				
	1	2	3	4	5
Not calm or well-balanced	.609	-.490	-.059	.014	-.074
Nervous and strained	.557	-.448	-.085	.022	-.067
Depressive and moody	.642	-.404	-.003	-.005	-.041
Pessimistic and unmotivated	.645	-.308	.014	-.029	.007
Feeling lonely	.474	-.167	.129	.161	.197
Fear of becoming ill	.316	-.028	.068	.019	.142
Weak, tired and lacking energy	-. 656	-. 112	-. 001	. 133	. 070
Headache and facial pain	-.387	-. 098	.063	.313	. 254
Sleep disorders	-.491	-.159	-.201	-.142	-.385
Abdominal pain and pressure	-.389	-.270	.660	-.212	-.058
Backache	-.409	-.308	-.241	.244	-.430
Fever	-.256	-.213	.146	.602	.430
Cardiac dysrhythmia	-.386	-.347	-.327	-.479	.342
Thoracic pain and pressure	-.421	-.388	-.271	-.294	.428
Articular pain	-.418	-.434	-.217	.351	-.227
Diarrhoea or constipation or both	-.352	-.396	.617	-.190	-.144

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Abstract: Based on health characteristics from the 1997 Swiss Health Survey and following Bourdieu's theory of "social space", we created a "health space" using 16 items of self-rated mental and physical health. The first dimension of our health space represents "general health", the second dimension contrasts "mental and physical symptoms". Into this health space we projected five different Swiss area typologies. The area types showed distinct "localities" within the health space, which vary with regard to the magnitude of age and gender differentiation. This type of visualising or "mapping" of area types in the health space has not previously been conducted.

Visualizing Areas in the „Swiss Health Space“

Introduction

For many years, associations between health and education, socio-economic position and income inequality have been discussed in numerous studies (Gravelle, 1998; Subramanian & Kawachi, 2004; Sundquist & Johansson, 1997a, 1997b). There is evidence that in addition to individual characteristics and behaviour, characteristics of the residential area are related to health (Hart et al., 1997; Macintyre et al., 1996; Mitchell, et al., 2000).

To examine the relationship between health inequalities and socio-economic indicators, Gatrell, Popay, and Thomas (2004) created a “social space”, according to the ideas of the French sociologist Bourdieu (1979, 1984). As variables for constructing the space, Gatrell et al. (2004) used, among others, groups of income, age, education, and work status, articles of daily life in the household, and willingness to relocate. Applying correspondence analysis to these variables they produced a social space consisting of two dimensions – economic and social capital. Four localities were included in this social space: Lancaster and Salford, both of which include areas of high and low socio-economic status. Whereas the area “Lancaster, high” is described by a high economic and a high social capital, the area “Salford, high” is described by a high social capital only (Gatrell et al., 2004, p. 252). Additionally, “loneliness” is related to economic capital, and “long-standing illness” mainly to social capital.

Considerable research has been addressed to describing and explaining spatial patterns in geography of health, for example regarding the spatial distribution of mortality rates. Further, a large number of papers exist dealing with perceived health (Boyle et al., 2001; Gatrell et al., 2004; Macintyre et al., 2003; Macintyre et al., 2005; Malmström et al., 2001; Mitchell et al., 2000; Sundquist & Johansson, 1997a, 1997b). Several studies support the choice of such self-rated health parameters as a valid measure of health, as self-reported health has been highly correlated with "objective" health outcome measures such as mortality rate (Idler & Benyamini, 1997; Sundquist & Johansson, 1997b).

For the investigation of health perception, we construct a two-dimensional health space based on 16 mental and physical health indicators from the Swiss Health Survey 1997 (SHS97). With reference to previous work (Keller-Lengen, 2005a, 2005b; Keller-Lengen & Blasius, submitted), it is expected that the first dimension of the health space reflects general health, running from good to poor general health. The second dimension should mirror a composition of mental and physical symptoms, which can be interpreted as Cartesian mind-body dualism.

In the next step we include the categories of different Swiss area typologies in the given health space to analyse the relationship between health perception and geographic areas. This allows us to uncover similarities between the "geographic world" and indicators of perceived health. The purpose of this article is to construct a health space using perceived health symptoms analogous to Bourdieu's social space, and to analyse and visualize differences of areas within the Swiss health space. Our aim is to investigating in an inductive way whether the typological area differentiation

corresponds with differences in health perception. As area typologies, we differentiate three language areas (German, French, Italian); seven statistical regions; eight classes of municipalities by population size; 22 municipality types and 106 regions of mobility ("mobilité spatial").

Area-related Health Research in Switzerland

In different areas of Switzerland, the variety of languages, cultures, identities, and the variation of attitudes and the "weltanschauung" of the residents may affect regional differences in health-related behaviour and in well-being. Switzerland provides a suitable context for the analysis of interactions between individual and area attributes influencing health.

In addition to municipalities and cantons with their own history and culture, coherent language areas and other area typologies were developed in Swiss National Foundation projects. Based on the 1980 Swiss Census and residential data, (Joye et al., 1988) conducted an area-wide comparison of socio-demographic structures on a regional and municipal level. In a centre-periphery model, 22 municipality types were discerned, concerning living and working conditions as well as the number of commuters in the municipalities. Furthermore, Joye et al. (1988) included aspects of the municipalities such as affluence, tourist functions and institutions, as well as the socio-economic structure of the municipalities in their model. The classification of 22 municipality types has been updated based on the 1990 Swiss Census (Schuler & Joye, 2000). The spatially homogenous 106 "mobilité spatial" (MS) regions mainly mirror patterns of spatial commuter mobility to socio-economic centres (Schuler et al., 1997).

The three language regions, the 106 MS regions and the 22 municipality types have usually been the basis for health research in Switzerland (Bopp, 1997; Bopp & Gutzwiller, 1999; Gass, 1979; Schüler & Bopp, 1997). In Europe, at the beginning of the 1950s, Swiss all-cause mortality rates were average; currently they are among the lowest worldwide (Bopp & Gutzwiller, 1999). For ischemic heart disease standardized by age, Gass (1979) found a higher mortality rate for Swiss men in the German speaking areas than in the French speaking areas. The differences are more pronounced for large cities than for rural locations. For Switzerland, Bopp (1997) found regional mortality disparities that correspond with life expectancy. High mortality rates were revealed for French-speaking regions and large cities. Schüler and Bopp (1997) analysed mortality rates for the 106 MS regions from 1970 to 1990, showing a difference of 26-28% between MS regions with the highest and MS regions with the lowest all-cause mortality rates. The ranking of the regions altered between 1970 and 1990, but the risk differences between the best- and the worst-off group of regions remained stable. These findings suggest a relatively high area effect on Swiss residents' health perception.

In comparison with all other European countries, since 1999 Switzerland has had the highest life expectancy at birth and appeared among the highest rated countries in terms of the number of years spent in good health. Since 1992, over 80% of the respondents in the Swiss Health Survey as well as in the Swiss Household Panel, reported their health to be excellent or good. This proportion of a population with health perception rated as good or excellent is amongst the highest worldwide (Zimmermann & Burton-Jeangros, 2004).

Preliminary results derived from SHS97 uncovered regional differences in self-reported health (Koller, 2000). Based on SHS97, general health assessment, measured by the question of health-related well-being (how healthy respondents felt at the time of asking: excellent, good, moderate, poor or very poor) as well as socio-demographic factors and municipality typology have been investigated (Keller-Lengen, 2005a). A good health-related well-being is associated with young and well educated people, and with high socio-professional status; poor health-related well-being is associated with low education, low social status and relatively high age. Furthermore, affluent municipalities, tourist and semi-tourist municipalities, as well as semi-rural municipalities were associated with good health-related well-being. In contrast, peripheral municipalities with population decline and large cities tended towards poor health-related well-being (Keller-Lengen, 2005a).

Study design

Health data

General health surveys often include a broad spectrum of different health concepts, which attempt to be appropriate for groups differing by disease, severity of symptoms and co-morbidity (McHorney, 1999). The health data used in this study are drawn from the Swiss Health Survey collected in 1997 (SHS97) by the Swiss Federal Statistical Office. The Swiss Health Survey is a well-established generic assessment based on comprehensive and dynamic approaches including self-reported individual health, lifestyle and environmental data. According to the WHO definition of health being a state of complete physical, psychological and social well-being, a complex

and dynamic concept of measuring health forms the background of the SHS97 (Calmonte et al., 2000).

The dataset contains a random sample of 13,004 interviews collected mainly by a telephone survey representing all the cantons of Switzerland. The response rate was relatively high (69%). The sample was collected in a two-step procedure: first, a random sample was drawn representing all Swiss geographical areas, whereby areas with a low population density have been over-sampled to allow for firm analyses of them. Second, within the areas, households were randomly selected and within the households the target people. Since we are interested in the structure of the health perception and want to consider areas with low population densities, we did not use the weighting factors included in the dataset. For more details on field characteristics, see (Calmonte et al., 2000).

Based on a frequency analysis, we selected a set of 16 health indicators covering self-reported mental and physical health, recent symptoms and medication. For mental health, six items measuring "moods" were chosen: feeling lonely; depressive and moody; not calm or well-balanced; nervous and strained; pessimistic and unmotivated, and fearing illness. The ordinal ordered categories of these mental symptoms comprised "nearly every day", "on three or four days of the last week", "on one or two days of the last week" and "not during the last week". For physical symptoms, ten items were included: weak, tired and lacking energy; headache and facial pain; sleep disorders; abdominal pain and pressure; backache; fever; cardiac dysrhythmia such as cardiac palpitation and tachycardia; thoracic pain and pressure, articular pain as well as diarrhoea or constipation or both. All questions on physical

symptoms referred to the last four weeks, giving the categories "not at all", "a little bit" and "strongly".

Geographical data

To study area effects on the perception of health we use the following Swiss classifications of regions and areas (see Table 1): three Swiss language areas (LAN) – German, French and Italian, seven statistical regions (REG) following the European Nomenclature of Territorial Statistical Units (referred to as NUTS 2-level), eight classes of municipalities by population size (POP), 22 municipality types (MUT), and 106 "mobilité spatial" regions (MSR).

The MUTs differentiate between the approximately 3,000 Swiss municipalities following a centre-periphery model for describing the spatial organisation of Switzerland. The classification is based on the 1980 Swiss Census (updated in 1990), which include characteristics about individual, household, residence and building. Large centres, middle-sized centres and small centres as well as centres of peripheral regions were segregated (Joye et al., 1988; Schuler & Joye, 2000). The characteristics of the suburban municipalities were defined regarding the density of jobs, the number of commuters, the housing structure and the income of the inhabitants. The characteristics of the municipalities outside the suburban area were based on the dominant economic structure of the inhabitants as well as the migration rate (Joye et al., 1988).

The 106 MSRs have been used as an important small area level of regional analysis. They differentiate between mountain, urban and regional planning regions. This classification reflects spatial mobility patterns and small labour market areas with

functional orientation towards centres, and depicts regions of homogeneous socio-economic conditions and commuter coherences (Schuler et al., 1997).

Method

Principal Component Analysis (PCA) is a well-known technique of displaying relationships between cases associated through a set of variables. With (ordered and unordered) categorical variables, PCA is not immediately available, although these variables are often treated as being numerical. In the case of ordered categorical data, for example, three, four and five point scales, the more appropriate technique to use is Categorical Principal Component Analysis (CatPCA, or Nonlinear PCA), in which the category values are replaced by optimal scores (Gifi, 1990; Heiser & Meulman, 1994). The distances between the optimal scores reflect the similarities of the successive categories, the further two successive categories are away from each other, the more dissimilar they are; the closer they are, the more similar. The order of the categories is always retained or at least not disrupted, with a minimum value of zero; in this case the categories are tied. In contrast to PCA, CatPCA solutions are not nested, i.e. the number of dimensions has to be determined in advance (usually the number of dimensions is two). As in PCA, the mean values of the subject scores in CatPCA are standardized to zero, the variances to one.

CatPCA also provides quantifications of the variable categories within *r* dimensions. The process of finding co-ordinates of points in a lower-dimensional space is the concern of biplots (Gabriel, 1971, 1981), which may be interpreted just like other co-ordinate axes (Gower & Hand, 1996). Comparing the biplot-axes provides the response structure (Blasius, 2001).

In the first step of the multivariate analysis, we apply CatPCA and use the biplot methodology for visualizing the structure of the 16 individual active health variables. In the second step, we calculate for all categories of all area typologies their position in the "health space". Calculating the means on both axes (ANOVA), for each geographical area it is possible to estimate whether their inhabitants have (on average) health symptoms above or below the average for all respondents.

Results

Applying CatPCA to the 16 items of perceived health provides a two-dimensional space that explains 33% of the total variation (Fig. 1). The first dimension explains 23% of the total variation ($\lambda_1 = 3.686$), discriminating between good and poor general health. All 16 biplot axes are directed from the left, which symbolises the worst perception of certain symptoms, to the right (Fig. 1). The axes on the right are much shorter than on the left, reflecting the fact that more people have no symptoms than those reporting symptoms of any degree.

The second dimension, which explains an additional 10% of the total variation ($\lambda_2 = 1.598$), distinguishes between two kinds of health indicators: mental and physical symptoms. The nearer the top a respondent is located in the health space, the higher is the share of mental symptoms compared to physical symptoms; the nearer the bottom a respondent is located in the health space, the higher is the share of physical symptoms compared to mental symptoms. The contrast between mental and physical health could be emphasized by superimposing two bisectional dimensions in the health space (as done in Fig. 2).

Within the poor general health field, three clusters of symptoms are distinguishable: the first cluster reflects poor mental health, the second cluster – opposite in terms of the composition of symptoms – reflects poor physical health, and the third lies in between. This intermediate cluster is formed by four of the physical symptoms: "fearing illness", "weak, tired and lacking energy", "headache and face-ache", and "sleep disorders" (Fig. 1).

In the next step we include the Swiss area typologies in the health space. All area positions are relatively close to the centroid of health space, which is symbolized by the cross of the axes (Fig. 1). With the exception of the Italian speaking area (LAN3), the canton Ticino (REG7) and municipalities with large population decline (MUT22), most of the area types of LAN, REG, POP, MUT (see Fig. 1) are positioned close to the centroid of the health space, i.e. they are close to the average of the whole sample.

To interpret the position of the area types within the health space in more detail and in comparison to well-known socio-demographic factors, we change the scale and zoom into the centre of the health space to examine the area typologies (LAN, REG, POP, MUT, MSR, Fig. 2.1-2.5). Additionally, age and gender are included to provide a comparative measure for interpretation of the relationship between health space and area typologies.

The successive age categories are almost on a straight line along the second health space's dimension, running with increasing age from mental to physical symptoms (Fig. 2). The younger the respondents are, the higher the impact of mental symptoms. In contrast, the older the people are, the higher the impact of physical symptoms. Furthermore, in contrast to the four middle age groups, the five youngest and the three

oldest age groups show a tendency towards poor general health. Compared to age, gender tends to be a weak discriminator within the health space, especially on the second axis. The profiles of men and women are relatively closely positioned at the centroid. Nevertheless, women report on average a poorer general health than men. This is predominantly caused by physical symptoms (Fig. 2).

The Swiss Language Areas (LAN)

The German and French areas are relatively close to the centroid of the health space (Fig. 2.1). This solution was expected because both areas together cover approximately 90% of the sample size (Table 1); for this property they have to be close to the centroid. The Italian language area is shifted towards poor mental health; their self-reported general health is close to that of the females – and this difference is meaningful. According to the composition of health, females reported a relatively high share of physical symptoms whereas the inhabitants from Italian speaking areas reported an above average share of mental problems.

Seven Swiss Regions (REG)

Except for the Ticino (REG7), all regions are located within a relatively narrow circle around the centroid of the health space (Fig. 2.2). The outlying position of the Ticino towards poor mental health corresponds to the position of the Italian language area. Zurich (REG4) shows a slight tendency towards poor general health, whereas Central Switzerland (REG6) and Geneva (REG1) tend towards good general health. Although these differences are smaller than age and gender effects, there are at least differences in the perception of health by the seven regions that are not explained by sample bias.

Eight Classes of Municipalities by Population Size (POP)

The differences between the eight classes of population size form a clear pattern. Whereas the large municipalities (POP1-POP4) have a tendency towards poor general health, municipalities with less than 5,000 inhabitants (POP6-POP8) tend towards good general health (Fig. 2.3). The observations concerning the regions confirmed as the metropolitan areas (POP1) show almost the same position as Zurich, the largest Swiss metropolitan region (REG4), and the smallest municipalities (POP8) mirror the position of Central Switzerland, a predominantly alpine-rural region (REG6).

Twenty Two Types of Municipalities (MUT)

Similar to the larger municipalities (POP1-POP4), large centres, middle-sized centres and small centres (MUT1-MUT3) of the municipality typology show the same tendency towards poor general health (Fig. 2.4). Most of the metropolitan municipality types (MUT2, MUT3) share the position in the health space with the peripheral rural municipality type as well as with the municipality type with large population decline (MUT21, MUT22). MUT22 has only a small sample size (n = 48), and therefore the outlying position might be explained by sample bias. The disadvantaged, suburban and employment municipalities of metropolitan regions (MUT9, MUT10) tend also towards poor general health, and unlike MUT1, MUT2 and MUT3 as well as MUT21 and MUT22 they are located in the poor mental health part of the health space. In contrast to suburban municipalities, the group of the more affluent semi-rural commuter municipalities of metropolitan and non-metropolitan regions (MUT11, MUT14) as well as tourist and semi-tourist municipalities (MUT6, MUT7) are located in the good general health part of the health space.

One Hundred and Six Mobility Spatial Regions (MSR)

To avoid interpretations based on small area samples (i.e. to avoid solutions that might be coincidental), we restricted the graphical solution to areas that contain at least 20 respondents (see also Table 1). Furthermore, to simplify the intelligibility of the figures, areas that are close to the centroid (± 0.25 units on both dimensions) are excluded from the graphical representation.

In correspondence with the Italian language area (LAN3) and Ticino (REG7) the three Ticino MS regions (MSR81-83; Bellinzona, Lugano and Mendrisio) belong to the poor health cluster (Fig. 2.5). From the Ticino, only Tre Valli (MSR79) is located in the sector of poor mental health. Two other MS regions (MSR46, MSR76; Solothurn and Thurtal) share this location in the health space. Along the base of the Northern Alps, four non-coherent MS regions, Entlebuch, Glarner Unterland, Werdenberg and Aigle (MSR29, MSR36, MSR55, MSR64), incline towards poor physical health. Most of the 12 MS regions that tend toward good general health can be found along the Northern Alpine crest line: Glâne/Veveyse (MSR43), Saanen/Obersimmental (MSR21), Oberland-Ost (MSR23), Uri (MSR30), Nidwalden/Engelberg (MSR35), Sarganserland (MSR56), Mutschellen (MSR73), Domleschg/Hinterrhein (MSR65), Prättigau (MSR61), and Davos (MSR62).

Discussion

Based on perceived health characteristics, we have constructed a health space using categorical principal correspondence analysis. Differing from Gatrell et al. (2004) who "mapped localities" in a social space constructed on the basis of social survey variables and correspondence analysis, we mapped area types as "localities" in our health space. Subsequently, we explored the inter-relationship between the health

space and five different Swiss area typologies as well as for age and gender. Analogous to age and gender, the „locations“ of most Swiss area types are relatively close to the centroid of the health space, i.e. the strong explanatory power of the association between the health space and area types is similar to that between the health space and socio-demographic factors. We can conclude, that, for Switzerland, the area effect on health perception has the same dimension as the effect of age and gender on health.

Creating a health space and mapping positions of area types within this health space does not appear to have been done before. Bourdieu's classical analysis of socio-cultural life in France (Bourdieu, 1979, 1984) and Gatrell's reconstruction of social space, based on a British social survey, focused the social space and social inequalities. After constructing social space, Gatrell et al. (2004) investigated the relationship between social space and "localities" as well as the relationship between social space and, subsequently, loneliness and long-standing illness. However, we focused our attention directly on the health perception of the Swiss Health Survey respondents, who may be assumed to be especially attuned to health perception. Health space visualizes their collective health perception. Thereby the first, horizontal dimension of health space has been interpreted as "general health", extending from "poor general health" to "good general health". The second, vertical dimension reflects the composition of mental and physical health. Our findings support similar results of Hays & Stewart (1990) and Cella et al. (2005) who report a mental and physical dimension in their health survey data. We added two bisectional axes to emphasise physical and mental health (Fig. 2).

The construction of our health space is similar to the construction of Bourdieu's social space. Bourdieu's (1979, 1984) dimension "capital volume" in social space is comparable with "general health" in health space; and "composition of economic and cultural capital" can be compared to "composition of mental and physical symptoms". According to the purpose, the implemented indicators differ; whereas Bourdieu used life-style indicators, we applied indicators of perceived mental and physical symptoms. While the social space has often been constructed to describe social relationships, the health space has been created to describe differences in the perception of health.

The methodology used in this paper can be compared to that of Bourdieu (1979, 1984) and Gatrell et al. (2004). They used mainly nominally scaled variables, and therefore applied CA for constructing the social space. In contrast, our data is ordinal, and is on three, four or five point scales, respectively. Therefore, we use CatPCA to include this ordinal information and to avoid a methodological bias when applying CA to this data (De Leeuw, 2006; Gifi, 1990).

The advantage of using CA or CatPCA is the possibility of visualizing complex structures in a low-dimensional space, usually within two dimensions. Applying these data reduction techniques allows for a geometrical interpretation of the data. Whereby Bourdieu (1979, 1984) and Gatrell et al. (2004) constructed a social space on the basis of life-style indicators, we constructed a health space on the basis of health perception indicators. CatPCA gave us the opportunity to include a major set of health perception variables, not aiming at data reduction, but to depict health perception more appropriately based on 1-2 self-reported or composite indicators of a regression model, and with respect for its multi-faceted character.

In accordance with Ecob and Macintyre (2000) who noticed that the influence of area on health-related behaviour varies according to the way it is measured, we may conclude the same for measuring and analysing health perception. This might contribute to the understanding of different results concerning area effects related to "objective health indicators" - standardised mortality rates (SMR), disability adjusted life years (DALY) and potential years of life lost (PYLL), and our area effects related to self-reported health. For Switzerland (Bopp, 1997; Bopp & Gutzwiller, 1999) as well as for Sweden (Malmström et al., 2001; Sundquist et al., 1997c) and Britain (Boyle et al., 2004) and the U.S.A. (Wilkinson, 1996), differences of SMR related to area classifications or regions have been shown. In Switzerland, at the regional level Wanner et al. (2001) reported cantonal SMR differences of up to 50% for men aged 35 to 64 – reflecting a regional difference in the mean life expectancy of up to two years. At the regional level (MS regions), Bopp (1997) detected SMR differences of 75% to 100%, which correspond to regional differences in mean life expectancy of up to four years. The regional differences between Wanner's and Bopp's results are probably to be ascribed to a small number problem for the MS regions, which we also find in our results. The MSR types are more dispersed over the health space than the types of any other area typology. It is worthwhile noting that we analysed the mean scores of the area types. Had we shown the positions of the individual respondents, they would spread out over the whole health space (Fig. 1), as can be seen in the example given by Gatrell et al. (2004, Fig.2, p.252).

How strong is the area effect related to health space and health perception, respectively? The „locations" of most Swiss area types are relatively close to the

centroid of the health space. We used the individual socio-demographic variables age and gender as comparative measures. On the first dimension, the dispersion of area types is similar to the dispersion of gender and age groups. Our results are in line with the results of previous work showing that health is differentiated by age (see Ware & Sherbourne, 1992) and gender (see Calmonte et al., 1998). As we found a similar differentiation for area typologies in health space as for age and gender, we may conclude that area effects on health perception are of similar dimension to that of age and gender effects on health perception. However, if we consider Gatrell's (2004) findings concerning gender, which was not retained as a significant covariate for psychological morbidity, we have, analogously, to be careful about ascribing area types too strong an association to health perception.

One clear area effect is detected for the Italian-speaking region, the Ticino, and especially the MS regions Bellinzona, Lugano and Mendrisio, which are all positioned in the poor mental health part of health space. According to Walter-Busch (1997) who in a non-health-related quality of life study reported a more negative assessment by respondents from the Ticino, we have to take into consideration that our result may indicate a cultural difference in the interpretation of questions about health and quality of life. For different social groups (ethnic groups, unemployed, students), different cultural biases were also detected by Boyle et al. (2001). They also suggested "that cultural factors may influence the likelihood of a positive answer to the question on limiting long-term illness [...] have been shown to be higher in Wales than would be expected from the mortality rates" (Boyle et al., 2001, p. 798).

In a previous study, Keller-Lengen (2005a) detected coherence between health-related well-being and municipality types (MUT). In the present study we found that the

municipality types are also related to the perception of physical and mental symptoms. Both studies confirm that in semi-rural and affluent areas, including tourist and semi-tourist destinations, people frequently assess their health as good or excellent. People living in city centres (MUT1, MUT2) and in the rural periphery (MUT21, MUT22) feel less healthy. It could be shown that health-related well-being is highly related to the general health dimension (see Keller-Lengen and Blasius, submitted). Thus, our results verify Koller's (2000) conclusion that people who live in the Swiss rural and mountain areas have better health-related well-being than people in other areas. People in the most remote periphery and in the large centres seem to share a tendency towards poor health perception. They reported on average more negative moods and physical symptoms. Despite the lower socio-economic status and less affluent living conditions that people more frequently experience both in the centres and in the periphery, does social isolation of anonymous cities and depopulated peripheries have an effect on health perception? To thoroughly address this question, within the Swiss health inequality debate, aspects of people's home, neighbourhood and area environment, which might affect physical and mental health perception as well, should not be neglected.

Conclusions

To cope with the complexity of health perception, we have introduced a more sophisticated, multidimensional health concept. This methodology proved to be appropriate to investigate and visualise the variation in health perception by areas.

For Switzerland, a health space based on 16 self-rated health variables turned out not to be very strongly associated with area typologies, as well as age, gender, individual

income and education (Keller-Lengen and Blasius, submitted). In contrast to Gatrell et al. (2004), who focused on the "context of social space", we focus on the individual self-rated health space, a space of individual, internal (intrinsic) health perception. Self-rated health variables form the core of our investigation. It is not surprising that we found a discrepancy between subjective health perception and "objective", however one-dimensional or compositional, health indicators such as SMR, DALY and PYLL. Developing a health space by using multidimensional scaling methods not as a reductive method, but as a tool for analysis and mapping a multidimensional space, may give a substantial input for a more holistic conceptualization of health and health perception and their realization.

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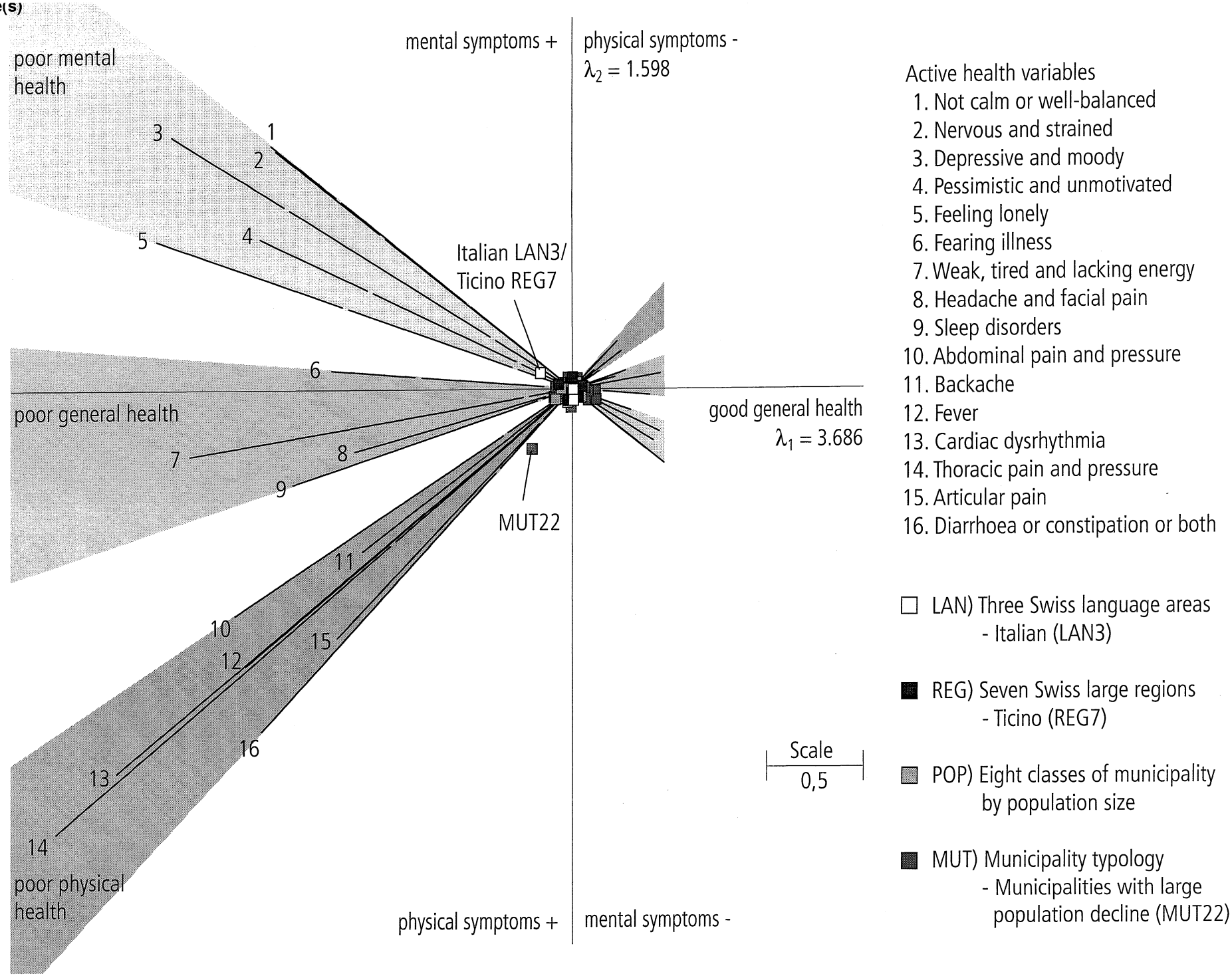
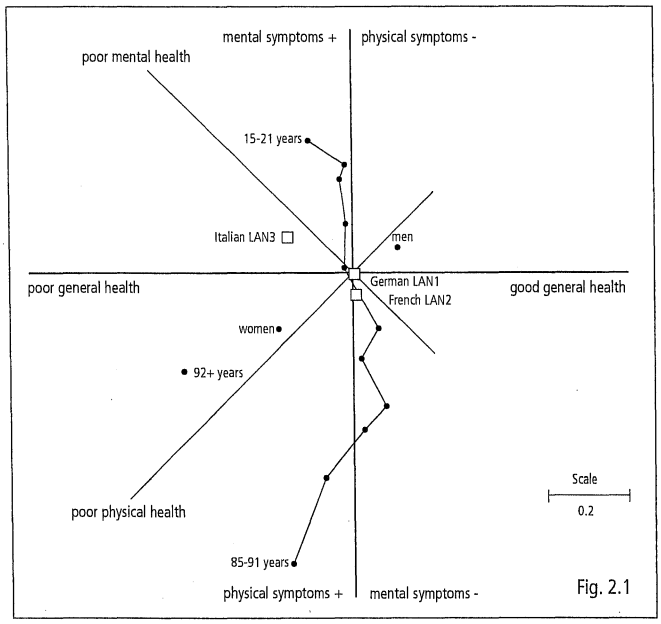
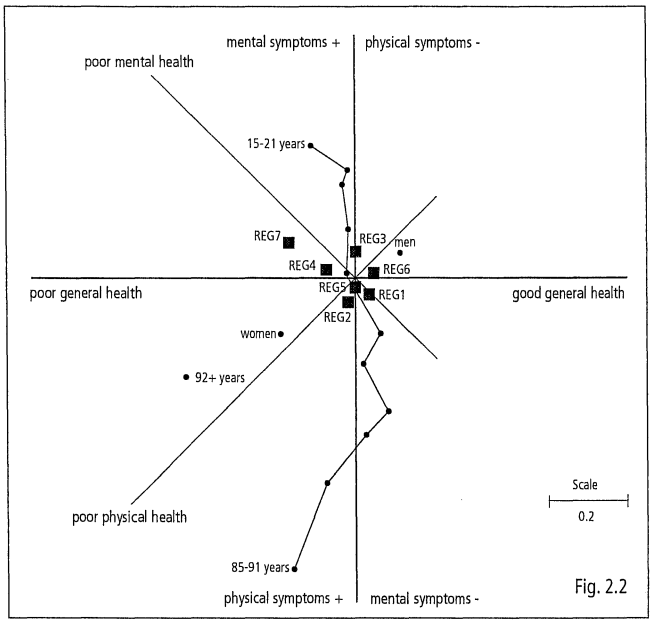
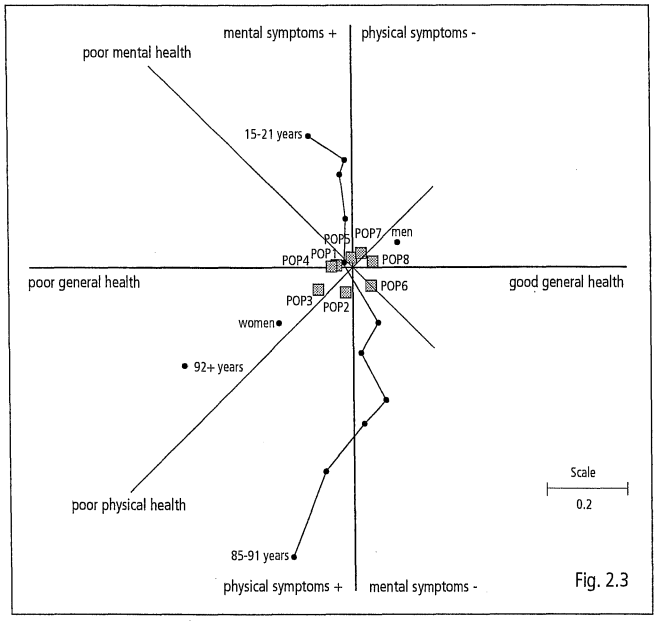
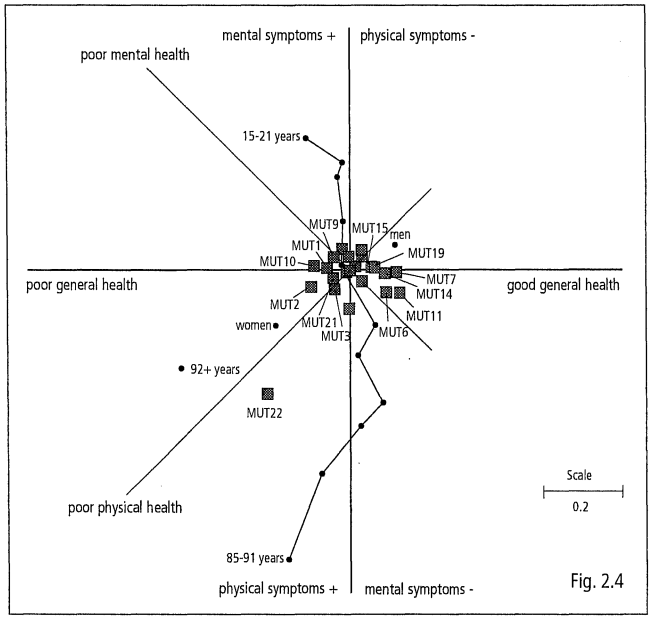
Figure(s)


mental symptoms +
physical symptoms -
$\lambda_2 = 1.598$
poor mental health
3
1
2
5
4
Italian LAN3/
Ticino REG7
6
poor general health
good general health
$\lambda_1 = 3.686$
7
8
9
MUT22
11
10
15
12
16
13
14
poor physical health
physical symptoms +
mental symptoms -
Scale
0,5
Active health variables
1. Not calm or well-balanced
2. Nervous and strained
3. Depressive and moody
4. Pessimistic and unmotivated
5. Feeling lonely
6. Fearing illness
7. Weak, tired and lacking energy
8. Headache and facial pain
9. Sleep disorders
10. Abdominal pain and pressure
11. Backache
12. Fever
13. Cardiac dysrhythmia
14. Thoracic pain and pressure
15. Articular pain
16. Diarrhoea or constipation or both
LAN) Three Swiss language areas
- Italian (LAN3)
REG) Seven Swiss large regions
- Ticino (REG7)
POP) Eight classes of municipality
by population size
MUT) Municipality typology
- Municipalities with large
population decline (MUT22)









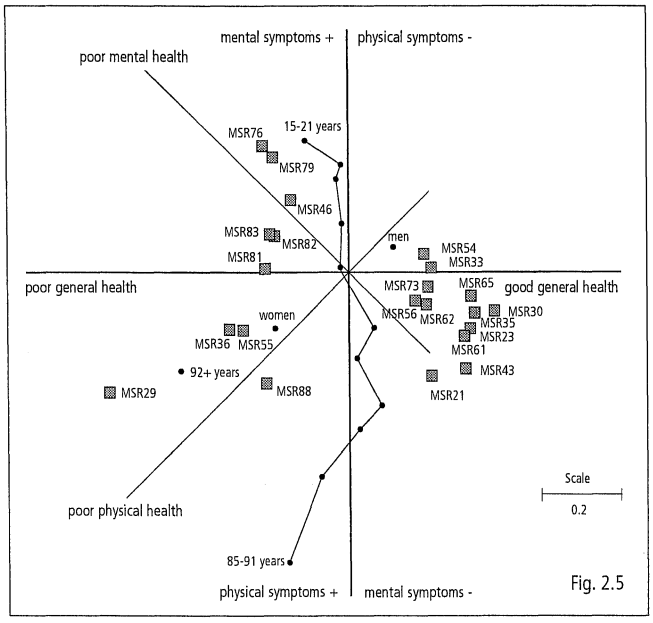


Figure 2: Health space and area typologies

Fig. 2.1: Three Swiss language areas (LAN)

Fig. 2.2: Seven Swiss regions (REG)

Fig. 2.3: Eight classes of municipality by population size (POP)

Fig. 2.4: Municipality typology (MUT)

Fig. 2.5: MS (mobilité spatial) regions (MSR)

Swiss area typologies and Swiss regions	N	*Swiss area typologies and Swiss regions*	N
Three Swiss language areas (LAN)			
1 German	8506		
2 French	3309		
3 Italian	1177		
Seven Swiss regions (REG)		*Eight classes of municipality by population size (POP)*	
1 Lake Geneva region	3862		
2 Swiss Middleland	2689	Population > 100,000	2408
3 North-Western Switzerland	1528	50,000 – 99,9999	1044
4 Zurich	1413	20,000 – 49,999	1135
5 Eastern Switzerland	1210	10,000 – 19,999	1784
6 Central Switzerland	1282	5,000 – 9,999	1756
7 Ticino	1020	2,000 – 4,999	2541
		1,000 – 1,999	1286
		<1,000	1050
Municipality typology (MUT)		*MS regions (MSR, selected)*	
MUT1 Large centres	1871	MSR21 Saanen-Obersimmental	26
MUT2 Middle-sized centres	1555	MSR23 Oberland-Ost	65
MUT3 Small centres	940	MSR29 Entlebuch	24
MUT4 Centres of peripheral regions	395	MSR30 Uri	46
MUT5 Affluent municipalities	604	MSR33 March	105
MUT6 Tourist municipalities	633	MSR35 Nidwalden	67
MUT7 Semi-tourist municipalities	269	MSR36 Glarner Unterland	37
MUT8 M. with a high proportion of institutional inhabitant	266	MSR43 Glâne-Veveye	29
MUT9 Employment municipalities in metropolitan regions	620	MSR46 Solothurn	110
MUT10 Suburban municipalities in metropolitan regions	843	MSR54 Rheintal	40
MUT11 Semi-rural municipalities in metropolitan regions	332	MSR55 Werdenberg	27
MUT12 Employment m. in non-metropolitan regions	857	MSR56 Sarganserland	33
MUT13 Suburban m. in non-metropolitan regions	545	MSR61 Prättigau	29
MUT14 Semi-rural m. in non-metropolitan regions	952	MSR62 Davos	26
MUT15 Allochthonous commuter municipalities	400	MSR64 Mittelbünden	20
MUT16 Autochthonous commuter municipalities	217	MSR65 Hinterrhein/Domleschg	21
MUT17 M. with industrial-tertiary working population	595	MSR73 Mutschellen	72
MUT18 Municipalities with industrial working population	345	MSR76 Thurtal	48
MUT19 M. with agrarian-industrial working population	333	MSR79 Tre Valli	63
MUT20 M. with agrarian-tertiary working population	291	MSR81 Bellinzona	167
MUT21 Municipalities with agrarian working population	93	MSR82 Lugano	443
MUT22 Municipalities with large population decline	48	MSR83 Mendrisio	141
		MSR88 Aigle	27

Table 1: Swiss area typologies, Swiss regions and the sample size (N, SHS97)

Table 2: Characteristics of Swiss Census, Federal Statistical Office, 1993

Individual characteristics	Household characteristics	Residential characteristics	Building characteristics
Date of birth, sex, marital status, nationality, place of residence, place of birth, position in household, number of children, religion, language, education, learned and currant job, currant employment situation, occupational status, place of work, place of education, means of transportation, commute time	People who live in the residence, type of household	Stories, number of rooms, area, kitchen, type of inhabitant, rental cost	Location, type and age of building, renovation, number of stories, heating installation, hot water, ownership of storey, type of property owner-ship

Visualising Areas in "Swiss Health Space"

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