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Health Care Atlases: Informing the General Public About the Situation of the Austrian Health Care System

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Abstract. There is a great number of complex data concerning the Austrian Health Care System. The goal was to process this data and present it to the general public on an easily accessible information platform. The platform focuses on data about the burden of disease of the Austrian Population, the available medical care and the services provided by the physicians. Due to the vast differences in the underlying source data, the methods used for the data acquisition range from statistical linkage over web scraping to aggregating data on the reimbursed services. The results are published on a website and are mainly displayed with interactive graphics. Overall, these dynamic and interactive websites provide a good overview of the situation of the Austrian Health Care System and presents the information in an intuitive and comprehensible manner. Furthermore, the information given in the atlases can contribute to the health care planning in order to identify distinctive service provision in Austria.

Keywords. atlas, delivery of health care, data aggregation

1. Introduction

Issues concerning the health care system are mentioned by the Austrian media on a regular basis. Recent keywords include the reformation of the Social Security System and the imminent retirement of a large number of general practitioners in rural areas. However, the media reports always focus only on a small aspect of the health care system and fail to describe the complex overall situation.

Therefore, the Main Association of Austrian Social Security Institutions launched the Health Care Atlases. The goal is to provide the public with a neutral, data driven information platform which gives a good overview of the current situation of the health care system and presents the complex data in a well comprehensible and intuitive manner. The project was implemented by DEXHELPP, a research association developing methods, models and technologies in order to support the analysis, planning and controlling of the health care system.

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The information in the atlases covers three main issues of the health care system: the burden of disease of the Austrian Population, the medical care available in different regions of Austria and the services provided by the physicians in their respective field. Considering the big difference in available source data, the Health Care Atlases have not been implemented in one single project. Instead, they were split into three smaller projects, which have been implemented independently: the Epidemiology Atlas, the Care Atlas and the Services Atlas.

Similar projects have been implemented by other countries, e.g. the UK, the US and Germany. The *Environment and Health Atlas for England and Wales* [1] [2]is a collection of interactive maps depicting the relative risks for a total of 14 health conditions, averaged over a 25-year period. The *Dartmouth Atlas Project* [3]–[7] presents a variety of maps and charts displaying various information ranging from surgical procedures to medical discharges, all based on data from Medicare, a national health insurance program in the United States. Finally, the German *Versorgungsatlas* [8]–[12] is a library of many smaller projects involving health care. These projects include information about the number of resident physicians, vaccination rates, a selection of health indicators, etc.

2. Methods

The implementation of the different atlases consisted of two parts:

1. data acquisition and processing
2. data visualization

For the first part, different methods were applied for each of the three atlases, due to a vast difference in the source data in terms of quantity and quality. These methods range from statistical linkage (Epidemiology Atlas) over web scraping (Care Atlas) to aggregating existing data on the billed services (Services Atlas). For the second part, mainly all three atlases used the same graphical representation of the data.

2.1. Epidemiology Atlas

The Epidemiology Atlas aims to provide information on the burden of disease of the Austrian population. This information can only be collected by indirect means, since there is no standardized diagnostic coding in the outpatient sector in Austria. Diagnoses are only available in relation to sick leaves or hospital stays. In this project, the following three methods have been evaluated in order to derive disease information indirectly:

- ATHIS Austrian Health Interview Survey 2006/2007
- ATC-ICD predicting the ICD code (*International Classification of Diseases)* from the ATC code (*Anatomical Therapeutic Chemical Classification System*)
- Methods of Diagnosis Assignment by experts

One of these methods (Methods of Diagnosis Assignment) only considers the prevalence of diabetes, the two other methods (ATHIS and ATC-ICD) consider multiple diseases. In the first instance, all of these three methods were applied to diabetes in order to compare their performance. Additionally, in the finalized Epidemiology Atlas, ATC-ICD has been used to compute the prevalence of multiple diseases.

In ATHIS [13], a representative sample of about 15 000 Austrian residents aged 15 and over have been surveyed. The participants have been asked about their overall health status. The questionnaire included, among others, inquiries about a past or present manifestation of diabetes and about treatment or antidiabetic medication received within the past twelve months. The results considering diabetes were then extrapolated to the Austrian population.

ATC-ICD is a statistical method calculating prevalence probabilities. In a first step, hospital and sick leave diagnoses, as well as data on received medication are used to determine assignment probabilities. In a second step, these assignment probabilities are applied to the prescription data of all persons who have used social insurances services, giving an estimate of the diabetes prevalence in the Austrian population. The underlying data source is the research database GAP-DRG[14] (Grundlagenforschung für ambulante, personenbezogene "Diagnoses related Groups") of the Association of Austrian Social Security Institutions. It contains reimbursement data of all social health insurance funds as well as the diagnostic data of hospital admissions and sick leaves for the years 2006 and 2007. It is the only available data source containing information on both the inpatient and the outpatient sector. The ATC-ICD method developed by Weisser et al. [15] is based on the idea of Chini et al. [16] to estimate the prevalence of certain conditions based on pharmacy data.

In the third method, experts used the GAP-DRG database to evaluate the number of people who had at least one prescription for a diabetes related medication or who had a hospital stay with the diagnosis diabetes.

The prevalence estimates of all three methods are normalized to the Statistics Austria population per 10 000 inhabitants and can be filtered by age, gender and federal state.

Apart from the method comparison based on the prevalence of diabetes, the Epidemiology Atlas also provides prevalence estimates for all diseases classified by ICD, more precisely, the 9th and 10th revision of ICD [17]. The estimates have been calculated by extending the ATC-ICD method to these diseases. The results were calculated for both a normalized and a standardized population[18] and have been processed to answer the following questions:

1. What is the prevalence of a given disease for a specific federal state, age group and gender?
2. How are the prevalence estimates for a given disease affected by the chosen cut-off-point?
3. What are the most common diseases, ranked by their total prevalence?

For the first question, a person is considered to be affected by the disease if the calculated probability is greater than 0.75. The influence of this threshold value (= cut-off-point) of 0.75 on the calculated prevalence estimates is examined in the second question.

2.2. Care Atlas

The aim of the Care Atlas is to provide an overview of the available medical supply in Austria to the public population. Furthermore, this Care Atlas can contribute to and support the general planning process of medical services by identifying distinctive service provision in the Austrian health care sector. Consequently, this might have an impact on improving the overall structural health care quality in the future. The underlying data is publicly available on the websites of the Austrian Provincial Chambers of Physicians (Landesärztekammern). For every physician, the website contains an entry,

providing information on the medical specialty, the type of social security contract, the gender and the opening hours. Selenium, a framework which automates tasks performed within a browser, was used to visit the single websites and to collect this information. Regular expressions were then used to identify the information on the opening hours provided by the physicians. The collected opening hours were stored in a database.

The collected data were subsequently processed to comply with the following indicators:

- What is the number of available practices for a given federal state, medical specialty, contract type and gender of the physician?
- What is the number of available weekly hours for a given federal state, medical specialty, contract type and gender of the physician?
- What is the number of open practices by time and day of the week for a given federal state, medical specialty, contract type and gender of the physician?

For the evaluation of the time dependent results, only those practices were included in the data set for which the opening hours indicated a specific start and end time.

All results are expressed both in absolute values and in relation to the population.

2.3. Services Atlas

The goal of the Services Atlas was to provide information on the services provided by the physicians. The underlying data consists of the services billed to the social health insurances by resident physicians in the years 2016 and 2017 and was provided by the Association of Austrian Social Security Institutions. This database contains information about the nature and number of services provided by each contracted physician, as well as additional information on the contracted physician (i.e. insurance provider, medical specialty, address). Each individual service is classified by an alphanumeric code, in which the first two characters assign the service to a specific body region [19]. It is the only data source providing a uniform encoding of the services provided in every federal state.

It is important to notice, that neither services provided by non-contracted physicians nor by physicians employed in a hospital or a similar institution are represented in this data set.

Considering the good quality of the underlying data, only the standard data preprocessing had to be applied and the data could be aggregated to comply with five different indicators:

- What is the spectrum of the services provided: How many different services are provided by the individual medical specialties in a given year and federal state?
- What are the most billed services (grouped by the corresponding body region) for a given medical specialty, federal state and year?
- What are the most billed individual services for a given medical specialty, federal state and year?
- What is the distribution of the individual services: What percentage of the most billed services is provided by what group of medical specialties in a given year and federal state?
- How many individual services are billed in the different federal states in relation to the population in a given year?

During the data processing, privacy laws have been taken into consideration, more specifically k-anonymity has been respected for k equals 3 [20]. Hence, every

information concerning a federal state where there are less than three contracted physicians for a given medical specialty, is not displayed in the final results.

2.4. Visualization

Since the targeted audience of the Health Care Atlases is the general public, the information is predominantly given in graphical form, allowing a quick and intuitive comprehension of the presented data.

The type of chart is chosen depending on the underlying data: Regional information is displayed in a choropleth map of Austria depicting the different federal states. A single hue progression is used to illustrate the magnitude of the values represented on the map. Categorical data, which do not represent regional information, are mostly displayed using bar charts, allowing a quick comparison of the depicted values. The 3-dimensional information on the number of open practices by time and day of the week is represented using heat maps. As in the choropleth maps, a single hue progression illustrates the magnitude of the values.

All charts and maps have been implemented in the form of interactive graphics. This way, the user can single-handedly browse through the results and apply several filters. Furthermore, a number of different tooltips and popovers display more detailed information.

3. Results

The Health Care Atlases are publicly available on the DEXHELPP-website[2]. For each atlas, the information is divided into several chapters and subchapters. Every chapter or subchapter contains an explanation of the data presented, as well as some operating instructions for the interactive features of the chart. Furthermore, every atlas also provides detailed background information, additional links and the source of the underlying data.

Since the goal of this project was to provide a neutral information platform, the Health Care Atlases do not make an assessment on the current situation and do not draw any conclusions from the data. However, they can be used to make some interesting observations. These atlases provide a good overall overview of the Austrian health care system and its service provision. By providing these data in an aggregated manner, contributions can be made regarding the identification of distinctive service provision in various regions in Austria. For example, a comparison of two heat maps displaying the number of practices by time and day of the week is incorporated in the Care Atlas. By using a dropdown menu, the user can filter the available data and compare the number of open practices of general practitioners in an urban and a rural area. Figure 1 shows the results in relation to 100 000 inhabitants. In the capital city of Austria (Vienna), the number of practices which are open in the morning is almost equal to the number of practices with opening hours in the afternoon. In contrast to this, in Carinthia, which is the federal state with the lowest population density, there are much more open practices in the period between 8:00 and 12:00 o'clock.

[2] http://www.dexhelpp.at

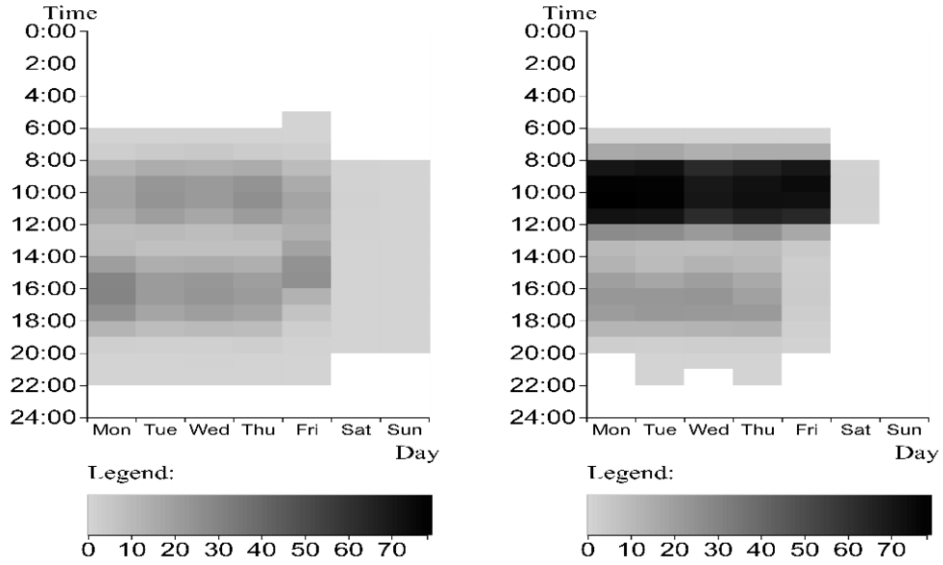

Figure 1. Two heatmaps comparing the number of open practices of general practitioners per 100 000 inhabitants. Vienna is displayed on the left and Carinthia on the right.

Easily accessible data like this may provide additional information regarding the public debate on the health care system: is there a general lack of physicians in a given federal state? Is there only an apparent lack due to a temporal clustering of the opening hours? How does the need of health care provision vary within different federal states and regions?

4. Discussion

The three Health Care Atlases give a broad overview of the current situation of the Austrian health care service. They give an insight on the burden of disease of the population and the availability and type of treatment. Simply put, the three atlases answer the following questions:
What diseases does the Austrian population suffer from?
Where and when is a treatment available?
How is the Austrian population treated?

However, the atlases do not depict the complete Austrian health care system. The information displayed in the Epidemiology Atlas depends on estimations and the Care Atlas and the Services Atlas only contain information on registered physicians in the outpatient sector. The Services Atlas is even further limited to registered physicians with a contract with the Social Security Institutions.

5. Future Work

Being aware of the limitations mentioned in chapter 4, additional projects and further analyses regarding the Health Care Atlases have already been launched. For the Epidemiology Atlas, a new approach of the ATC-ICD-method is already under investigation and for the Care Atlas, it is planned to also include the opening hours of outpatient departments. Currently, there are no plans to expand the information of the Services Atlas to non-contracted physicians, since there is no data available on this subject matter.

Furthermore, it is planned to equip each atlas with the visualization of the temporal change of the data. Currently, it is possible to change the considered year in the Epidemiology and in the Service Atlas. However, it may also be interesting to see the temporal change of the data during the whole investigated period in one single chart.

Finally, it is intended to monitor anonymous usage behavior of the visitors of the atlases. Thus, it can be investigated, how often the atlases are visited, and which is the most popular one. This will give an insight into the public interest in the project.

References

[1] "Home page | The Environment and Health Atlas." [Online]. Available: http://www.envhealthatlas.co.uk/homepage/. [Accessed: 23-Jan-2019].

[2] A. L. Hansell *et al.*, *The Environment and Health Atlas for England and Wales*, 1 edition. Oxford: OUP Oxford, 2014.

[3] "Home," *Dartmouth Atlas of Health Care*. [Online]. Available: https://www.dartmouthatlas.org/. [Accessed: 12-Feb-2019].

[4] D. C. Goodman and A. A. Goodman, "Medical care epidemiology and unwarranted variation: the Israeli case," *Isr. J. Health Policy Res.*, vol. 6, no. 1, p. 9, Feb. 2017.

[5] R. Panczak *et al.*, "Regional Variation of Cost of Care in the Last 12 Months of Life in Switzerland: Small-area Analysis Using Insurance Claims Data," *Med. Care*, vol. 55, no. 2, p. 155, Feb. 2017.

[6] D. C. Goodman and G. A. Little, "Data Deficiency in an Era of Expanding Neonatal Intensive Care Unit Care," *JAMA Pediatr.*, vol. 172, no. 1, pp. 11–12, Jan. 2018.

[7] G. P. Westert *et al.*, "Medical practice variation: public reporting a first necessary step to spark change," *Int. J. Qual. Health Care*, vol. 30, no. 9, pp. 731–735, Nov. 2018.

[8] "versorgungsatlas.de - Der Versorgungsatlas." [Online]. Available: https://www.versorgungsatlas.de/der-versorgungsatlas/. [Accessed: 23-Jan-2019].

[9] C. Schmidt *et al.*, "Integration von Sekundärdaten in die Nationale Diabetes-Surveillance: Hintergrund, Ziele und Ergebnisse des Sekundärdaten-Workshops am Robert Koch-Institut," *Bundesgesundheitsblatt - Gesundheitsforschung - Gesundheitsschutz*, vol. 60, no. 6, pp. 656–661, Jun. 2017.

[10] M. K. Akmatov, A. Steffen, J. Holstiege, R. Hering, M. Schulz, and J. Bätzing, "Trends and regional variations in the administrative prevalence of attention-deficit/hyperactivity disorder among children and adolescents in Germany," *Sci. Rep.*, vol. 8, no. 1, Dec. 2018.

[11] H. Burchert, Ed., *Fachbegriffe des Gesundheitsmanagementsh*, 2., überarbeitete und erweiterte Auflage. Herne: nwb STUDIUM, 2018.

[12] S. March *et al.*, "Quo vadis Datenlinkage in Deutschland? Eine erste Bestandsaufnahme," *Gesundheitswesen*, vol. 57, no. 03, pp. e20–e31, Mar. 2018.

[13] Statistik Austria, "ATHIS." [Online]. Available: http://www.statistik.at/web_de/services/publikationen/4/index.html?includePage=detailedView&sectionName=Gesundheit&pubId=457. [Accessed: 23-Jan-2019].

[14] F. Endel, G. Endel, and N. Pfeffer, "PRM34 Routine Data in HTA: Record Linkage in Austrias GAP-DRG Database," *Value Health*, vol. 15, no. 7, p. A466, 2012.

[15] A. Weisser, G. Endel, P. Filzmoser, and M. Gyimesi, "ATC-> ICD–evaluating the reliability of prognoses for ICD-10 diagnoses derived from the ATC-Code of prescriptions," presented at the BMC health services research, 2008, vol. 8, p. A10.

[16] F. Chini, P. Pezzotti, L. Orzella, P. Borgia, and G. Guasticchi, "Can we use the pharmacy data to estimate the prevalence of chronic conditions? a comparison of multiple data sources," *BMC Public Health*, vol. 11, no. 1, p. 688, Sep. 2011.

[17] "ICD-10-GM." [Online]. Available: https://www.dimdi.de/dynamic/de/klassifikationen/icd/icd-10-gm/. [Accessed: 23-Jan-2019].

[18] Y. Dodge, Ed., *The Oxford dictionary of statistical terms*, First published in paperback 2006. Oxford: Oxford Univ. Press, 2006.

[19] "Katalog ambulanter Leistungen (KAL): Entwicklung und Pilotprojekte bis inkl. 2013 | Gesundheitssystem / Qualitätssicherung | Gesundheitssystem | Gesundheit | Sozialministerium." [Online]. Available: https://www.sozialministerium.at/cms/site/gesundheit/dokument.html?channel=CH3958&doc=CMS1240821423857. [Accessed: 23-Jan-2019].

[20] L. Sweeney, "k-anonymity: A model for protecting privacy," *Int. J. Uncertain. Fuzziness Knowl.-Based Syst.*, vol. 10, no. 05, pp. 557–570, 2002.