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Defining a typology of primary care practices: a novel approach

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Abstract

Objective: To define a typology of primary care (PC) practices based on a mixed inductive/deductive approach that uses a large number of variables describing organizational and demographic characteristics of practices and *a priori* hierarchical structuring of the data.
Design: Secondary analysis of the Swiss part of the QUALICOPC study using a multiple factor analysis approach incorporating 74 variables hierarchically structured and including information on infrastructures, clinical care, workforces, accessibility and geographic location of PC practices.
Setting: Switzerland.
Participants: Two hundred randomly selected PC practices.
Main Outcome Measures: Typology of PC practices based on axes identified through the multiple factorial approach.
Results: The factorial analysis extracted two uncorrelated axes summarizing 17% of the global variance. The first axis is mainly associated with two dimensions related to the comprehensiveness of services, namely 'clinical care provided' (Pearson's $r = 0.73$) and 'available infrastructures' ($r = 0.78$). The second axis is mainly associated with the workforce in the practice such as the number of general practitioners or other health workers ($r = 0.69$). Swiss PC practices were mapped using these two axes.
Conclusions: This innovative approach allows defining a global typology of PC practices. Based upon Swiss data, two axes were identified to globally describe PC organization: comprehensiveness of services and workforces development. This exploratory study demonstrates a promising way, first to characterize globally one or several PC models that emerge from complex features, second to compare more accurately PC organization between countries and finally to assess how these models might be associated with patients' outcomes.

Key words: typology, organization, primary care, factorial analysis, general practice Swiss

Introduction

It is recognized that a strong primary care (PC) system improves the overall health of the population [1]. However, the complexity, diversity and multiplicity of factors that should be taken into account to characterize PC organizations or models pose a challenge in terms of methodological approach.

Traditional approaches to compare health systems

Different approaches are traditionally used to describe, compare and eventually assess the impact of PC systems or health systems in general. First, health systems can be summarized to one specific feature that is predefined and allow the comparison between countries. A classical example is the financial scheme (fee-for-service,

payment-for-performance, salaries, …) that is often used to differentiate PC systems [2]. It is, however, difficult to measure the impact on physicians' behaviors or patients' outcomes on this basis. Organizational features such as the use of electronic medical records, size of practice or multidisciplinary teams within practices are also used as *a priori* hypothesis to differentiate PC models at the practice level [3]. Varabyova and Müller pointed out, however, in a recent systematic review the methodological limitations of current approaches to compare the efficiency of health systems. For example, they showed low correlations between country ranking, which can be attributable to a lack of internal validity [4]. Another recent study by Pineault *et al.* showed also that using size of practices as a single proxy for organizational characteristics can be misleading [5].

More sophisticated approaches to compare PC systems consist in using multiple indicators grouped in *a priori* defined dimensions. Classical dimensions described are comprehensiveness (scope of services provided), first-contact (entry point to the health system), continuity of care, coordination of care or patient/family-centeredness [6]. The variables or indicators used to describe each dimension are sometimes summarized in scores. This approach is extensively used to compare the strength of PC systems between countries, for example, by Starfield [6] and Starfield and Shi [7] and Kringos *et al.* [8, 9]. However, depending on the indicators used to construct the scores and rank countries according to their performance, results can be substantially different from one study to another [9, 10]. Finally, the variables grouped by dimension in scores as described above are also sometimes used to evaluate their impact on some patients' outcomes like in a recent study by Kringos where dimensions (continuity, coordination,…) are assessed for correlation to admission rates for specific diseases or self-rated health [1].

Limitations of current approaches

The traditional approaches described above have in common that they rely on theoretical conceptual frameworks [11]. One or several variables or indicators are *a priori* gathered under dimensions, then sub-dimensions, leading to an array of PC models according to the framework. This refers mostly to a deductive approach. In brief, this means that observations are interpreted according to a predefined theoretical construction [12]. This has the advantage to be clear with concepts that are observed, but on the other hand, it provides an arbitrary and often simplified vision of PC systems. This is well illustrated in a recently published analysis by F. Toth who pointed out, referring the classification of health systems using classical deductive approach, that 'Grouping countries on the sole basis of the prevalent model thus risks producing simplistic descriptions of the national systems that are quite far from the actual state of affairs' [13].

Another example of the limitation of the current approach is the comparison of PC systems based on the Primary Health Care Active Monitoring for Europe (PHAMEU) study, which ranked European countries for different predefined dimensions (access, coordination, …) according to scores built on selected variables. The main limitations of using scores in this way are that each variable included in the scores is giving the same weight. Finally, this rends also the interpretation of inferential analysis to measure the impact of health systems on patients' outcomes difficult [9].

New approach

In order to address these shortcomings, an empirical strategy that integrates many organizational characteristics at a time stemmed from collected data, weighted for contribution to the model and hierarchically structured according to a conceptual framework, may provide a more powerful and comprehensive description of PC models. In other words, by this approach, the model will emerge from the data while the original predefined structure of the data will guide its interpretation. This approach integrates thus an inductive process, which means to start with observations to generate hypothesis. By itself, the discussion about complementarities between deductive and inductive approaches is not new in sciences and advantages and disadvantages of each approach is debated for long, like in clinical decision-making [12]. However, inductive approach is now considered to be especially useful in fields where uncertainties exist in classification categories like in health systems comparison [13, 14].

Rational of the study

In line with what is mentioned above, we propose using in this study a mixed inductive/deductive method called multiple factor analysis (MFA) to draw a multidimensional typology of PC practices in Switzerland. The typology will be thus based upon a survey collecting standardized organizational and demographic characteristics (the Quality and Cost in Primary Care study, QUALICOPC) [15, 16].

The aim is to integrate all potential contributing organizational elements to describe one or more distinct PC models that might coexist within a health system. Like multivariate data analysis techniques, the MFA is an inductive approach since based on observations, however, this technique is also partly deductive as it takes into account the hierarchical structure of the questionnaire, itself based on a theoretical framework.

This approach might help to better and more finally characterize PC practices and identify the main factors that differentiate practice types between themselves. Besides the illustration using Swiss data, this work could provide also a new methodological approach for the international comparison of PC models and a more global assessment of health system performance.

Methods

Context and setting

In 2012, an European Union funded study on quality and cost (QUALICOPC; coordinated by the Nivel in the Netherlands) was launched [16]. Switzerland participated in this study, and a random sample of 200 general practitioners (GPs) was enrolled. This study is based on data collected using the GP questionnaire.

The questionnaire to GPs included 60 questions investigating broad aspects of demographic characteristics of GPs, contextual features of their practice, infrastructure and organization of practice, and comprehensiveness of care. The QUALICOPC questionnaire's structure was largely developed based on the theoretical framework developed by Kringos *et al.* [17]. This framework was developed along the PHAMEU project which aimed to be a standardized instrument to compare PC systems.

The sample of 200 GPs used for this study is considered representative of Swiss GPs on several key demographic characteristics such as age, sex and rural/urban distribution (when compared to national statistics) [18].

Statistical procedures

Out of ~150 variables, 74 were retained. Variables were excluded either because their content did not apply to Switzerland (i.e.

capitation mode of remuneration does not exist in Switzerland) or because too few variations were observed in the GPs' answers (low variance).

The data reduction was thus performed on the selected variables using an MFA to identify axes or latent variables. In this method, the particularity is that the selected variables are first gathered in groups based on the theoretical framework used to create the questionnaire (see above). Five groups were thus defined: infrastructures, clinical care, workforce distribution, accessibility and geographical location. This hierarchy is summarized in Table 1. Some groups have only 1 variable, while another have 28 variables. In a traditional factorial analysis, this would lead to a severe unbalance toward the concepts described with a great number of variables. Through the creation of groups, the MFA gives the same weight to the different groups in the construction of the axis and consequently balances the weight of the different variables; variables in large groups having lower final weight in the analysis.

The procedure then computes partial axes which are the results of separate analysis for each different group. This reintroduces an art of confirmatory approach in this exploratory method. This approach does not, however, try to test hypotheses about the existence of latent variables behind each group of variables as in the case of confirmatory factor analysis.

In concrete terms, in each group, a separate factor analysis is performed (principal component analysis, PCA, if the variables are quantitative, multiple correspondence analysis, MCA, if the variables are qualitative). Within a group, the first eigenvalue is used to weight the variables. All the weighted variables are then gathered in a single data set on which a global non normalized PCA is performed. A complete description of this method can be found elsewhere [19, 20]. In order to overcome the limitation due to missing values (as a great number of cases could be not taken into account due to missing values from one or another variable), they were imputed in a preliminary step with a regularized iterative MFA algorithm [21].

In order to have axes that include a small number of variables, and thus facilitate the interpretation of the axes as latent variables, a varimax rotation was performed using a new procedure developed specifically for its use with the results of MFA [22, 23]. This procedure works in a similar manner as the 'traditional' varimax rotation [24] for factorial analyses [25, 26]. The main difference is that, for qualitative variables, the correlation ratio is used instead of the squared correlation (for quantitative variables). As rotation procedure is not included in the traditional R package (FactoMiner or Ade4) used to perform MFA, we used another derived package of FactoMineR: MFAmix in which the rotation is already implemented.

In the end, the axes identified using this analysis represent the main global features to characterize PC practices' models in our Swiss representative sample of PC practices. Interpretation of the axes focused on the association between the variables and the axes. In the case of nominal variables, interpretation was made both at variable and modalities levels.

The numerical values of the factors' scores must not be interpreted for themselves as those values are different between categorical and continuous variables. Moreover, according to the way of calculating the coefficients, the results are proportional between the two methods [20].

Based on the defined axes and the resulting factorial plan, we could develop a schematic typology of GP practices in Switzerland to illustrate the method.

Table 1 Organization and group of variables according to the QUALICOPC questionnaire developed

Groups and sub-groups of variables	Number of variables
1. Infrastructure	
1.1 Technical equipment	28
1.2 Access to X-ray and laboratory	2
2. Clinical care	
2.1 Orientation of care (proxy : GP as first healthcare provider)	19
2.2 Medical and/or surgical act	10
3. Workforce distribution	
3.1 Physician workforce distribution	3
3.2 Other workforce	4
4. Accessibility	
4.1 Access to (non-emergency) medical services during evening, nights and weekends	3
4.2 Accessibility for new patients	2
5. Geographic location of the practice	
5.1 Type of area (urban/rural)	1
5.2 Distance to PC facilities	2

Results

Global results of the MFA

According to Cattell's recommendations [27], the screeplot (Fig. 1) suggests that either two or four principal components (or axes) are above, respectively, a first or a second 'elbow' (slope break in the screeplot) and should thus be retained. However, a closer look at the third and the fourth axes shows a typical Guttman effect [28], distinguishing middle values for both extreme values in ordinal variables. This effect is commonly found in MCAs and, by extension, in MFA. Only the two first axes were, therefore, retained.

Traditionally, in factorial analysis, the quality of the projection on the different axes is evaluated with the inertia ratio. In the case of the MFA, this evaluation is conservative due to both the inclusion

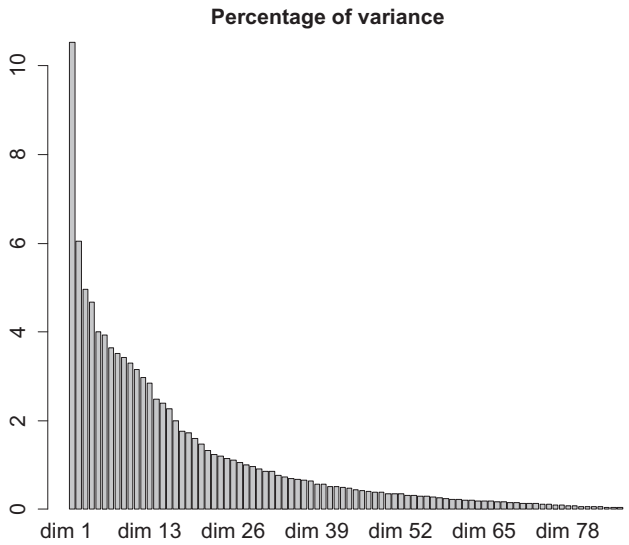

Figure 1 Screeplot of all axes identified and their variance. The first two axes were retained to create the typology. Both together explain 17% of the total variance of all variables.

of categorical variables in the analysis and the performing of distinct analysis PCA or MCA on the different groups of variables before performing the global PCA [20]. Given this, the inertia ratio of 17% of the two first axes in our case (respectively, 11% and 6% for the first and second axes) should be interpreted as a good quality of projection.

Description of the retained axes

The first (horizontal) axis mainly corresponds to two dimensions related to the comprehensiveness of services, namely 'clinical care' and 'infrastructures' (see Fig. 2). The dimension 'clinical care' includes two main components. The first is 'orientation of care', which is approximated with the questions 'To what extent will patients in your practice population contact you as the first healthcare provider?' for a wide range of medical conditions, from psychosocial and psychiatric problems (e.g. anxiety) to internal medicine (e.g. chest pain or first convulsion) and surgical problems (joint pain). A Likert scale is used to answer these questions. The more often that practices answered '(Almost) always' or 'usually' to questions concerning somatic medicine and/or 'Occasionally' or 'Seldom or Never' to questions about psychosocial and psychiatric problems, the more likely those practices have high values for the first axis, and *vice versa*. The medical conditions with the strongest positive association with the comprehensiveness of services axis are summarized in Table 2. Only one condition ('Anxious man, aged 45') was inversely correlated with this axis, which is consistent with the identified 'psychosocial direction'. The second component of the dimension 'clinical care' is 'medical or surgical procedures', which is covered with the generic question 'To what extent PROCEDURE X is carried out in your practice population by you (or your staff) and not by a medical specialist' for a wide range of medical or surgical procedures. Table 2 shows the five procedures that were the more strongly correlated with axe (i) the second dimension of 'comprehensiveness of services' is 'infrastructures' with the first component 'technical equipment'. Table 2 shows the equipment that was typically available in practices offering a wide range of services. For X-ray and laboratory equipment, GPs were asked if they own such equipment and/or if they have easy access outside their practice.

The second (vertical) axis is mainly associated with the available workforce in the practices. This axis incorporates both the number of physicians (GPs and/or specialists) and the presence of other professionals (paramedical and/or managerial). The number of physicians (GPs and/or specialists) in the practice, as well as the number of full-time equivalent positions, is strongly correlated with the second axis (respectively, correlation of 0.75 and 0.71, *P*-value 10^{-38} and 10^{-31}). This axis thus distinguishes between (large) group and solo practices.

Practices with a manager of the center or practice and/or with a physiotherapist tended to have high values on this axis. These practices tended to have higher patient turnover (see Table 3). The size of the practice was not correlated with the availability of equipment. The combination of these different aspects (workforce, multidisciplinary teams and patient turnover), when present, was typical of large urban polyclinics (see Fig. 2).

In Fig. 2, a schematic overview of some variables that contribute to each axis is presented. The double arrows (in the case of oppositions) or ellipses (in other cases, such as ternary relations) correspond to the sub-dimensions specified in Table 1, some of them summarizing up to 28 variables.

Mapping of Swiss practices

The above-defined axes were used to build the first 'factorial plan' on which the different practices can be mapped (see Fig. 3). This highlights a high concentration of practices in the lower right quadrant and two tails, one parallel to the axis 1 and the other to axe 2. The concentration of practices in one quadrant may indicate the existence of a common model in Swiss PC (predominant model), with two deflection axes from this model, one associated with axis 1

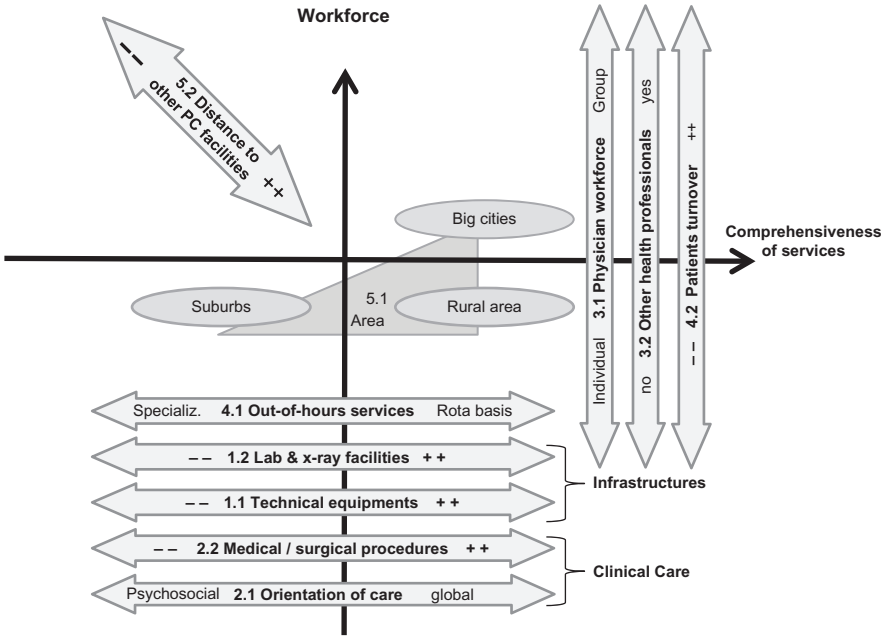

Figure 2 Schematic representation of some organizational and access variables that contribute to both axes. This figure is in line with Fig. 3 of the mapping. This helps to characterize the practices which fall in one of the quadrant. Categories of variables (3.1,…) refer to Table 1.

Table 2 Variables that are the most contributive to the axis 'comprehensiveness of services'[a]

	Correlation with the axis[b]	*P*-value
Clinical care/orientation of care		
Child with severe cough	0.65	9×10^{-26}
Child aged 8 with hearing problems	0.64	2×10^{-24}
Man aged 28 with a first convulsion	0.53	3×10^{-16}
Man aged 35 with sprained ankle	0.48	4×10^{-13}
Physically abused child aged 13	0.39	6×10^{-9}
Woman aged 60 with acute symptoms of paralysis	0.33	1×10^{-6}
Anxious man aged 45	−0.24	2×10^{-3}
Clinical care/procedures		
Wound suturing	0.73	6×10^{-35}
Removal of sebaceous cyst	0.66	3×10^{-27}
Strapping an ankle	0.64	4×10^{-25}
Setting up an intravenous injection	0.56	5×10^{-18}
Wedge resection of ingrown nail	0.51	2×10^{-14}
Technical equipment		
Urine catheter	2.50	6×10^{-26}
Set for minor surgery	2.85	1×10^{-26}
Suture set	3.00	7×10^{-17}
Hemoglobinometer	2.87	4×10^{-16}
Defibrillator	1.79	2×10^{-15}
Laboratory equipment		
Laboratory in practice and no easy outside access	2.88	7×10^{-15}
Laboratory in practice and easy outside access	1.59	4×10^{-05}
No laboratory in practice but easy outside access	−4.48	2×10^{-13}
X-ray equipment		
X-ray in practice and no easy outside access	1.85	3×10^{-11}
X-ray in practice and easy outside access	0.98	4×10^{-03}
No X-ray in practice but easy outside access	−2.83	2×10^{-16}

[a]The higher the correlation is, the stronger the contribution is.

[b]This data set contains all the quantitative variables and the 'Burt table' for the qualitative variables (like for the traditional MCA).

(horizontal) and the other to axis 2 (vertical). Very few practices have high values on the second axis, suggesting a strong effect of outliers. We performed the same analysis without those outliers and extracted axes in the same direction. These outliers are large practices (see below), which remain rare in Switzerland.

We also observed that in rural areas, almost all practices belong to the predominant model, namely a small structure (one or two physicians) with a wide range of services. These practices provide mostly out-of-hours services on a rota basis and have a low turnover of patients. If in rural areas practices are more homogenously organized in line with the predominant model, in urban areas, more diversity exists and practices might be quite different from the predominant model. First, some practices are going in the direction of reducing the range of services they provide, relying more on other specialty medical care providers for and for emergencies as well as for medical imaging and laboratory. Second, they are more oriented toward psychosocial care. Last, they are less likely to provide out-of-hours services.

Table 3 Variables that are the most contributive to the second axe 'workforces'[a]

	Coordinate of the barycenter[b]	*P*-value (*t*-test)
Location big (inner) city	2.42	3×10^{-19}
Patient's turnover above average	3.06	4×10^{-18}
Physiotherapist	2.37	1×10^{-15}
Manager of the center	1.72	5×10^{-7}

[a]The higher the correlation is, the stronger the contribution is.

[b]The coordinate of a modality of a categorical variable corresponds to the centroid of the practices with this modality and may be displayed on the factorial plane showing the distribution of practices.

Another model that emerges is the one that meets the needs of a more mobile population in urban centers with larger facilities. There are large practices, usually providing a wide range of services and are located in the centers of major cities. These practices tend to have an above-average rate of patient turnover. Figure 4 attempts to provide a schematic typology of practices in Switzerland defined according to the two axes based on our defined random sample of 200 GPs.

Discussion

In this study, we used a multiple factorial analysis to develop a global typology of PC practices. This analysis was based on a large amount of organizational variables hierarchically structured according to the questionnaire's construction of the Swiss QUALICOPC data. Through this approach, it was possible to define the most relevant dimensions (axes) that allow to characterize each of the practices compared to the others and thus to draw a detailed typology. One single PC model appears to be predominant in Switzerland that represents relatively small practices offering a wide range of services.

Interest of the method

This approach is interesting in several ways. First, it allows to empirically highlight the organization of practices based on hierarchically *a priori* structured data and to produce a comprehensive description of PC models by integrating a large number of characteristics without predefined selection. This is likely to provide a more objective and accurate picture of the organization of practices, with simultaneous consideriation of conceptual models. Second, complementary deductive and inductive methods, as advocated by some researchers, can help generate new hypothesis such as in the context of health services research. This is nowadays made easier to perform with new computational methods [29]. If inductive or mixed indicative/deductive methods are extensively used in social sciences or in clinical logic reasoning, it is seldom used to compare health systems. We can, however, find some evidence on the importance to consider a large amount of variables to describe the complexity of PC practice organization. A study by Bobiak *et al.* for example showed how difficult it is to select *a priori* organizational features that make the difference. They indeed included >100 organizational variables in the construction of their tool to measure practice capacity to retain finally 25 items [30]. Last, another potential use of this approach is to assess associations between these axes and patient outcomes. Indeed, through the integration of many different variables (instead of isolated elements) in broad but latent features of PC models, this approach could address the complexity of how an entire system

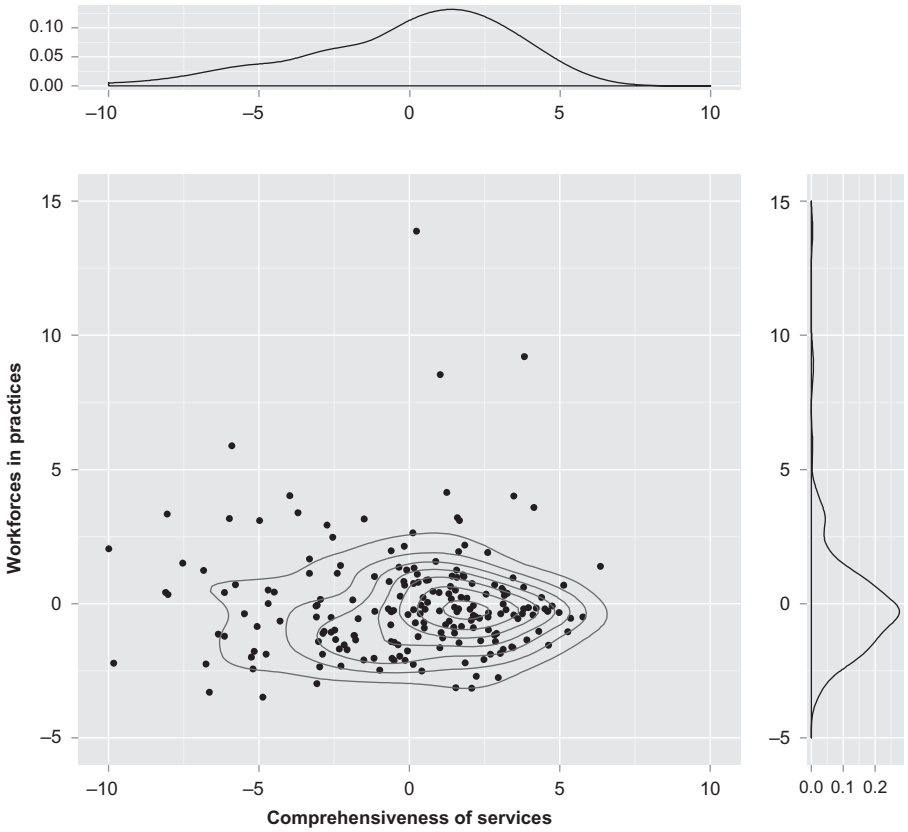

Figure 3 Mapping of the practices with the two defined axes. First factorial plan with marginal densities are also shown on the side of the mapping.

might impact on patient outcomes. The axes are used as a numerical summary of the variables used to construct these axes. This could enable subsequent analysis with methods similar to principal component regression that overcomes multicollinearity problems.

Limitations

A challenge that arises by using this approach is that it requires special attention to the qualitative interpretation of the results in order to give sense to the global and latent characteristics identified (axes and clusters). This might introduce more subjectivity in the interpretation of the results. A qualitative approach with independent experts could be used to refine the interpretation.

Despite the satisfactory representativeness of the GPs sample in terms of age, sex and rural/urban distribution [18], the low response rate (~10%) might introduce some level of bias on other unmeasured characteristics. Second, the limited number of participating physicians (200) might limit the power of the study. However, beside the small number of physicians, a large number of variables can be taken into account, creating a global overview of the practices that was not possible using classical statistical methods.

Finally, some important organizational features, such as the mode of remuneration, might be missing in this analysis. However, these 'macro-level' features are not easy to incorporate at the national level, as most PC physicians are working under the same national framework. For example, in Switzerland, almost all practices are working with a 'fee-for-services' remuneration mode. Therefore, an international perspective comparing countries between themselves is more likely to provide information with regard to such broad characteristics of the health system.

The Swiss typology of GP practices

One objective of this study was to generate a typology of general practices in order to see if we could identify clusters of practices sharing similar characteristics according to these global and latent characteristics. Instead, what was observed is that most practices are gathered in one single cluster that appears in the lower right quadrant just below the comprehensiveness axis. According to the schematic description of Fig. 4, this corresponds to small practices with a relatively large range of services. In rural areas, this model is even more prevalent than in urban areas. This may be related to the distance from other care providers. This finding is in line with what is known from qualitative descriptions of the Swiss PC system, where almost half GPs remain in solo practice [31]. It is interesting to observe that in an unregulated country such as Switzerland, one single model is largely predominant. Because there are few constraints on the way practices are managed and organized (e.g. regulatory documents), it is likely that macro-level features of the health system such as the remuneration mode, the predominant one in Switzerland being fee-for-service, are the main drivers that define the model of practice. Other factors, related to GP preferences, might also influence the way practices are organized, such as desire to work more part time or to be in smaller groups. We also observed that a high turnover of patients was associated with large practices, maybe reflecting a weaker interpersonal relationship of healthcare

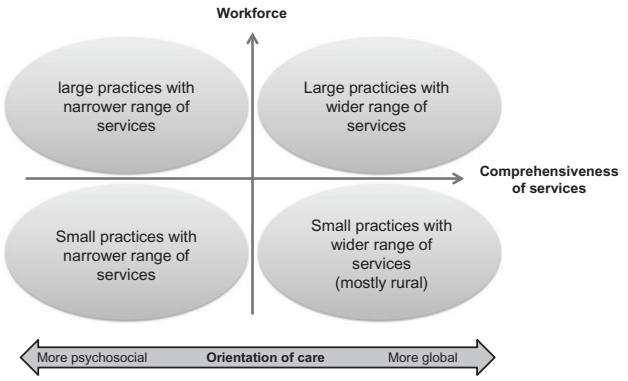

Figure 4 Simplified typology of practices. This figure summaries the information developed in Figs 2 and 3.

professionals with patients and potentially a decreased continuity of care. This observation is of interest as continuity of care is one of the challenges of new model of the PC practices [32, 33].

Interestingly, the comprehensiveness axis is not correlated to the workforce axis. Indeed, and this is probably a specificity of the Swiss PC system, many small practices provide a large range of services, which requires expensive equipments such as laboratory or X-ray facilities.

Finally, from a health services provider perspective, this study can provide useful information on the features that count the most to characterize their own practice. For example, Tables 2 and 3 provide a list of items that are the most contributors to the characterization. Furthermore, and as described in the introduction, the ability to create a typology can help to guide organizational change in the practice by providing clear items that count the most to transform the practice. Ultimately, if the axis would be used to assess the impact on patients' outcomes, it might provide very useful information on what need to be changed. For instance, if a positive correlation is shown between the comprehensiveness axis and patients' satisfaction that might give indications for providers to include items of the comprehensive axis to improve patients' satisfaction.

Conclusions

This exploratory study has provided a proof of concept for this new methodological approach based on a large number of organizational features and opens thus a promising way, first to characterize one or more PC models within one health system, second to compare PC organization between different countries and last to assess how global and latent characteristics of specific PC models might impact on patients' outcomes.

This innovative approach has also provided a global typology of general practices in Switzerland. Two main axes were identified: comprehensiveness of services and workforce in the practice. Less comprehensive practices are generally more oriented toward psychosocial care, while more comprehensive practices are generally more oriented on global care, the latter being more common in rural areas. A single model of practice seems to be predominant in Switzerland, instead of different and distinct clusters of practices as expected. It represents practices with a limited number of GPs offering a wide range of services. This might be explained by the fact that in an unregulated system like Switzerland, there is a natural consensus around one type of model, driven probably by financial considerations as well as personal preferences of living and practicing of GPs.

Authors' note

Part of the results were presented at the NAPCRG conference in Cancun, Mexico, October 2015.

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