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Toward a needs based mechanism for capitation purposes in Italy: the role of socioeconomic level in explaining differences in the use of health services

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Abstract The paper investigated differences in the use of hospital care, out-patient care and pharmaceutical care in Piemonte, a region of northern Italy with 4,000,000 inhabitants, taking into account factors of need and supply, for capitation purposes. The study used a geographical design, with the municipalities as statistical units, and was based on integrated data from health and health service information systems, the population census and on the geographical distances among municipalities. Hierarchical regression models were fitted with the utilisation of services as the outcome variable and a set of direct and indirect factors of need and supply indicators as covariates. Higher health service consumption rates were observed for the most disadvantaged employment categories, in addition to the elderly. Distance from hospital was inversely correlated with the hospitalisation rate. A formula for determining capitation can be developed using age and indirect factors of need as weights.

Keywords Health care financing · Capitation · Hierarchical models · Socioeconomic level

JEL Classification I11 · I18

Introduction

The main objective of a universalistic healthcare system is to guarantee equal access to adequate care in relation to the distribution of health needs, which is also the conceptual basis for allocating health resources (Williams and Wright 1998; Wright et al. 1998; Ferris et al. 1998; Sassi et al. 2001; Oliver and Mossialos 2004; Carr-Hill 1994). Health resource allocation varies greatly when comparing Western countries because of differences in the individual healthcare systems, in the quality of information on the population's health status and in

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the methods for deriving allocation criteria. Nonetheless, it is generally accepted that health resources must be allocated on the basis of the population's actual need, which is closely related to its health.

Various allocation formulas have been developed on the basis of health need and the characteristics of the health system, although the complexity of these formulas depends heavily on the quality of the information used (Rice et al. 2000; Gravelle et al. 2003; Hauck et al. 2002; Glover 1999). One important factor in allocation is the extent to which health need is measured (Bradshaw 1972) and how the relationship among use, need and supply is modelled and analysed (Congdon 2001). The most important studies have hypothesised that, taking into account a "physiological" level of variability in the use of health services (mainly attributable to "supplier-induced demand"), great variations that cannot be justified by need indicate levels of inequity in the healthcare system, which can be addressed through equalising funding mechanisms (Waters 2000). In some countries, allocation is based exclusively on the population's age structure, whereas others consider an extensive series of indicators of use, need and supply, analysing their relationship using multivariate statistical models (Baines and Parry 2000; Begaud et al. 2002). The need for healthcare services is commonly approximated with the use of the services, which can be measured in terms of volume of care, length of hospital stay (for hospital care), or costs (standard or estimated) (Morgan et al. 1987). The demand for healthcare obviously differs from actual need because of factors that limit access to healthcare and because of inappropriate care. Thus "needs adjustment" models are used to control the effects of need and supply on the use of services. In the most advanced experiences, these models consist of multivariate statistical models that consider the use of services as an outcome variable and indicators of need and supply as covariates. The coefficients of the models can thus be used to derive weights to apply to population subgroups to calculate capitation under the assumption that the population average could represent the standard of need.

In Great Britain, need is classified as either "direct" or "indirect" when allocating health resources (Carr-Hill et al. 1994). All western countries that base resource allocation on evidence-based empirical models must address the limitations of morbidity as a direct indicator of need, which can only be accurately measured for certain pathologies (and rarely with sufficient coverage, Sutton 1999; Gibson 2002; Asthana 2004). In actual fact, mortality, the only extensively available direct measure of need, only partially reflects the variations in a population's health status. For this reason demographic factors, the main determinants of health, are largely used as direct indicators of need; the relationship among aging, health status and consumption of healthcare resources is well known. Moreover, socioeconomic characteristics can influence the demand for healthcare (Smith 1994). The most deprived groups (ceteris paribus) tend to have worse health and thus to consume more resources, provided there are no factors limiting access to healthcare (Goddard and Smith 2001). Among the socioeconomic indicators educational level, income and occupation play a role, at least in part, independent of socioeconomic conditions (Petrelli 2006), whereas other aspects of material deprivation (e.g., living conditions) and social networks (e.g., living alone and social capital) can constitute potential covariates (Lynch and Kaplan 2000). These factors may be considered indirect indicators of need.

The role of supply must also be considered, in that it influences the use of services in various ways. In particular, there is the well-documented effect of "supplier-induced demand", where the use of services tends to be greater in areas with more availability and ease of access and where the perceived supply determines the demand (e.g., a general practitioner may steer a patient towards a given treatment based on the expected waiting time for receiving that treatment). On the other hand, the health system, through the supply of healthcare,

influences the population's health status, and thus the need, but also responds to demand by increasing or decreasing the intensity of services. In other words, the relationship between supply and demand is extremely complex and tends to be two-directional. Supply should thus be measured in terms of both amount of resources and access (Rice and Smith 2001). The question of access is particularly important in areas where orography can greatly influence access to care, as is the case in vast areas of Italy.

In Italy, the funding of the National Health Service works on three levels: the National Health Fund is first allocated to the country's 21 regions; the Regional Health Funds are then allocated to the Local Health Units (LHUs); lastly, the healthcare services are funded by the LHUs. Since 1992, the National Health System has been undergoing a process of decentralisation, with the regions becoming more autonomous. This has resulted in an increasing responsibility of the regions (and of their public companies, the LHUs) for negotiating with the state in order to obtain a health fund proportional to need, and for balancing their own budgets. The need to control the costs in a context of limited resources has thus brought about the problem of how to allocate funds. Since 2003, the regions have been funded on the basis of "essential levels of care", which define the services that the health system must guarantee to safeguard the population's health. For hospital care, out-patient care and pharmaceutical care, funding is by capitation formulas, based on the population's age structure; infant mortality (direct indicator of need) and population density (indirect indicator of need), are also taken into consideration as corrective factors (Toniolo 2003).The distribution of regional funds to LHUs is of particular importance, in that they are responsible for ensuring the same care for the same need, taking into account the variability in need among LHUs. Each region can autonomously establish the criteria for funding, though until recently in most of the regions the LHUs were funded ex-post on the basis of production factors. Thus, despite the fact that the introduction of principles of equity of allocation in this part of the process of financing Italy's healthcare system is mandatory, the population's healthcare needs were not systematically considered and formulas that take into account the relationship among use, supply and need have not been developed in any region.

Lastly, financing health services is a particularly important issue for LHUs, which, being responsible for the funding of hospitals and out-patient facilities, enjoy autonomous decision-making power and can establish the modality of remuneration of the health services provided.

The objective of the present study was to estimate weights for capitation funding of the LHU's in a large region of Italy (Piemonte) by modelling the use of hospital care, out-patient care and pharmaceutical care, as a function of factors of direct need, indirect need and supply.

Materials and methods

The study focused on hospital care, out-patient care and pharmaceutical care, both because of their importance in terms of the consumption of resources (25%, 8%, and 33% of the Regional Health Fund, respectively) and given the availability of accurate data from existing information systems.

Since indicators of need at individual level were not available, a geographic approach was adopted, using the municipality of residence as the statistical unit of analysis. This kind of methodology is also called 'ecologic'. The study was carried out in Piemonte (a region in north-western Italy with a population of ~4,200,000), which has a large number of municipalities varying greatly in population size. Piemonte covers 8% of Italy's surface area. There are 1,206 municipalities, constituting 15% of the national total. Approximately 80% of

the municipalities have fewer than 3,000 inhabitants; 5% have more than 5,000 inhabitants (compared to 30% for Italy as a whole). There are also a limited number of mid-to-large sized cities, which consist of the eight capitals of the region's provinces and of the suburbs of Turin, the region's capital (population of ~900,000). In Turin, the historical population register has collected demographic and socioeconomic information on all residents since 1971; it is updated on a yearly basis with information on changes of residence within or outside the city, and it allows data to be aggregated at various sub-urban levels. To reduce the ecologic bias, i.e. the bias in estimating an association due to the use of aggregated data, the data for the city of Turin were disaggregated at the neighbourhood level ($n = 23$; mean population of 38,660; SD: 10,927). The analyses were thus conducted on 1,228 units of statistical analysis (1,205 municipalities in the region and 23 neighbourhoods in Turin).

The study was conducted separately for hospital care, out-patient care and pharmaceutical care, each of which, according to Italian legislation, is considered as a different "level of essential care", that may be differently related to the need, and, consequently, which must be funded separately. The use of health services was measured using the 2003 crude rates. As direct indicators of need we used the crude mortality rate for all causes, taken from the Regional Registry of Mortality (2001) and age, taken from the 1991 population census (four variables were derived expressing, for each municipality, the percentages of people in the following age groups: 0–4; 15–64; 65–84; and 85 years and older). As indirect indicators of need the socioeconomic indicators were selected according to their predictive capacity for health status (Daly 2002). The following indicators were taken from the population census (and from Turin's historical population register): percentage of the population with a low level of education ($\leq$5 years), index of household crowding (mean number of persons per room), percentage of manual workers in the occupied population, unemployment rate among the active population and percentage of elderly people living alone.

Three more indicators of indirect need were taken from the Istituto Centrale di Statistica (the National Census Bureau, 2001 data): percentage of foreign immigrants (2001, related to the amount of irregular migrants), per capita expenses for non-food consumption (in Euro; an income indicator) and population density (number of inhabitants per square kilometre). For Turin, given that information disaggregated by neighbourhood was not available, we considered the median income of the neighbourhood (taken from the tax register starting with the median income per census tract) as the indicator of economic resources.

On the supply side, we selected indicators of both the amount of supply and access, according to the availability of data. The register of health services in the Piemonte Region (updated in 2003) collects information on all the Region's healthcare services, including the number of hospital beds, the number of out-patient facilities and disciplines that provide out-patient care within each out-patient facility. With regard to the amount of supply, we used the number of acute hospital beds (per 1,000 inhabitants) as the indicator of the amount of resources for the analysis of hospital care and the number of disciplines (per 1,000 inhabitants) for the analysis of out-patient care, in which a facility was counted as many times as the number of disciplines providing care within the facility itself.

For the analysis on pharmaceutical care, no data are actually available on the prescribing habits of general practitioners and specialists. We thus adopted the same indicator used for the analysis of out-patient care, hypothesising the following: (1) the amount of disciplines for out-patient care is a proxy of the prescribing habits of specialist practitioners; (2) the prescribing habits of general practitioners and specialists were geographically collinear.

To measure accessibility, we used a matrix of regional distances, which includes time needed to travel (in seconds, under normal traffic conditions), among all of Piemonte's municipalities. Thus as an indicator we used the distance from the nearest municipality with

a "supply unit" (hospitals for the analysis of hospitalisations and specific discipline for the analysis of out-patient and pharmaceutical care). Given that it was not possible to disaggregate the data at the sub-municipality level, the distances among healthcare services in Turin were considered as zero.

Statistical analysis

The relationship among the use of services, need and supply was investigated with hierarchical linear regression models, using the crude rate of the utilisation of healthcare services as the outcome.

The municipalities (and the neighbourhoods in Turin) were considered as level 1 units, whereas the LHUs were considered as level 2 units. Although this is an ecologic study, hierarchical models were deemed necessary to control for the clustering of data within the LHUs, which consist of aggregations of municipalities or, for Turin, sub-municipalities. It can, in fact, be hypothesised that the use of services has a structure of correlation that differs among individual LHUs both for the greater homogeneity in the resident population's socio-demographic characteristics and for the effect that political choices have on the intensity of demand.

The utilisation rate, which has an asymmetrical distribution, was entered in the models in logarithmic form.

Statistical models were estimated individually for hospital care, out-patient care and pharmaceutical care. A first set of models was estimated entering age and mortality only; we then estimated models that also took into account, alternatively, covariates of socioeconomic level and of supply. Finally, we estimated saturated models taking into account all the covariates. We also tested the interactions between age and socioeconomic covariates.

The models were compared using the likelihood ratio test to evaluate the relative role of the single blocks of covariates, whereas the evaluation of the significance of the intercept variance provided indications of the predictive capacity of the single blocks of covariates in explaining the variability among LHUs.

We tested the hypothesis of random slopes among the LHUs; nonetheless, the models did not provide statistically significant parameters.

Moreover, considering the hypothesis of a possible strong linear correlation between certain socioeconomic covariates, we also evaluated multicollinearity, using variance inflation factor (VIF) and the eigenvalues obtained through a principal component analysis conducted on the matrix of the covariates. All analyses were performed with the SAS System (SAS Institute 1999).

Results

Table 1 shows the distribution of indicators of need and supply. As shown, Piemonte, compared to Italy as a whole, has a higher percentage of the population belonging to the oldest age group, a higher mortality, a higher percentage of immigrants, a higher percentage of manual workers, a higher household crowding and a higher percentage of elderly people, whereas for the other indicators the values obtained were lower than the national average.

Tables 2, 3 and 4 show the results of the multivariate hierarchical models for, respectively, hospital care, out-patient care and pharmaceutical care. Since one of the objectives was to evaluate the supplementary effects of indirect need (in particular, the indicators of socioeconomic level) for each level of care, we show the results for the models in which the

Table 1 Regional and national average values of need and supply indicators

Variables	Piemonte	SD	Italy
Population 0–4 (%)	4.12	1.22	4.59
Population 65–84 (%)	18.83	5.32	16.50
Population 85+ (%)	2.62	1.91	2.18
Crude mortality rate (per 100,000 inhabitants)	1120.47	773.41	980.00
Foreign immigrants (%)	3.08	1.87	2.34
Population with a low level of education (%; ≤5 years)	37.95	8.93	46.90
Manual workers among occupied population (%)	43.20	10.57	34.57
Index of household crowding (mean number of persons per room)	0.72	0.09	0.67
Expenses for non-food consumption (per capita in Euro)	836.8	401.21	716.1
Population density (number of inhabitants per square kilometre)	168.12	1668.49	192
Unemployed (%)	14.08	3.52	17.80
Elderly living alone (%)	13.06	5.91	10.78
Acute hospital beds (per 1,000 inhabitants)	4.11	7.78	5.10
Number of disciplines (per 1,000 inhabitants)	6.54	59.12	– [d]
Distance to hospital[a]	18.21[c]	13.81	– [d]
Distance to out-patient facility[b]	17.9[c]	13.95	– [d]

[a] Distance between municipality of residence and the nearest municipality with hospital
[b] Distance between municipality of residence and the nearest municipality with out-patient facility
[c] Mean value of normalised distribution
[d] Data not available

covariates age, mortality and supply were entered (Model A), and the models in which all of the covariates were entered (Model B).

Regarding hospital care (Table 2), consumption rates were significantly higher in the age class between 65 and 84 years. The estimated parameter shows that for each expected increase of 1% in this age group, the expected hospitalisation rate increased by 0.148 (95% CI: 0.090–0.207). Among the socioeconomic level indicators, there was a direct association between the percentage of manual workers and hospitalisation (coefficient 0.014; 95% CI: 0.002–0.025). Among the indicators of supply, when controlling for other factors, we found that the hospitalisation rate decreased as the distance between the municipality of residence and the location of the nearest hospital increased.

In terms of out-patient care (Table 3), an age of between 65 and 84 years was confirmed as the principal determinant of seeking health care (coefficient 0.160; 95% CI: 0.096–0.225), whereas among socioeconomic factors, consumption increased with the unemployment rate (coefficient 0.038; 95% CI: 0.002–0.074). Moreover, we found an inverse association with the percentage of the population with a low educational level: in areas with a greater percentage of people with a higher level of education, there was greater consumption of out-patient care. Among the indicators of supply, distance showed an inverse linear association.

The use of pharmaceutical care (Table 4) was instead greater in areas with a higher percentage of people over 64 years of age. In this case, the age class of more than 84 years was also positively associated with greater consumption. Of the socioeconomic factors, the percentage of manual workers, the unemployment rate and the percentage of elderly persons living alone were positively associated.

Table 2 Results of hierarchical models for hospital care: hospitalisation rate (per 100,000 inhabitants mean: 18498.46 SD: 3512.54)

Covariates		Model A			Model B		
		Coefficient	95% CI lower	95% CI upper	Coefficient	95% CI lower	95% CI upper
Direct need							
Population 0–4 (%)		−0.042	−0.140	0.056	−0.039	−0.139	0.060
Population 65–84 (%)		0.081	0.054	0.109	0.148	0.090	0.207
Population 85+ (%)		0.007	−0.061	0.075	0.043	−0.034	0.120
Crude mortality rate (per 100,000 inhabitants)		1,400E-04	−1,270E-05	2,900E-04	1,200E-04	−3,720E-05	2,700E-04
Indirect need							
Population with a low level of education (%, ≤5 years)		–	–	–	0.001	−0.017	0.019
Manual workers among occupied population (%)		–	–	–	0.014	0.002	0.025
Unemployed (%)		–	–	–	0.001	−0.031	0.034
Elderly living alone (%)		–	–	–	0.040	−0.023	0.103
Household crowding		–	–	–	−0.869	−2.883	1.144
Foreign immigrants (%)		–	–	–	0.034	-0.023	0.091
Expenses for non-food consumption		–	–	–	−5,570E-05	−3,000E-04	1,800E-04
Population density		–	–	–	−4,790E-05	−1,000E-04	3,956E-05
Population 65–84 (%)* elderly living alone (%)		–	–	–	−0.003	−0.005	−0.001
Supply							
Acute hospital beds		0.006	−0.007	0.018	0.006	−0.006	0.019
Distance to hospital		−0.029	−0.037	−0.021	−0.028	−0.037	−0.020
Variance	Level	Coefficient	95% CI lower	95% CI upper	Coefficient	95% CI lower	95% CI upper
Intercept	LHU	0.006411 ($p=0.0025$)	0.003544	0.01495	0.005154 ($p=0.0030$)	0.002818	0.01229
Residual		0.02779 ($p<0.0001$)	0.0257	0.03016	0.02753 ($p<0.0001$)	0.02544	0.02988

* Indicates the interaction term among population 65–84 and elderly

Table 3 Results of hierarchical models for out-patient care: utilisation rate (mean: 10.87 SD: 2.38)

Covariates		Model A			Model B		
		Coefficient	95% CI lower	95% CI upper	Coefficient	95% CI lower	95% CI upper
Direct need							
Population 0–4 (%)		−0.100	−0.217	0.017	−0.033	−0.143	0.077
Population 65–84 (%)		0.074	0.042	0.107	0.160	0.096	0.225
Population 85+ (%)		−0.039	−0.120	0.043	0.049	−0.036	0.133
Crude mortality rate (per 100,000 inhabitants)		−3,000E-04	−5,000E-04	−1,000E-04	−9,310E-05	−3,000E-04	7,561E-05
Indirect need							
Population with a low level of education (%, ≤5 years)		–	–	–	−0.020	−0.040	0.000
Manual workers among occupied population (%)		–	–	–	0.004	−0.009	0.017
Unemployed (%)		–	–	–	0.038	0.002	0.074
Elderly living alone (%)		–	–	–	0.001	−0.068	0.071
Household crowding		–	–	–	−0.459	−2.715	1.798
Foreign immigrants (%)		–	–	–	−0.053	−0.116	0.009
Expenses for non-food consumption		–	–	–	7,256E-05	−2,000E-04	3,300E-04
Population density		–	–	–	9,889E-05	−3,930E-06	2,000E-04
Population 65–84 (%)* elderly living alone (%)		–	–	–	−2,400E-03	−5,000E-03	2,000E-04
Supply							
Acute hospital beds		0.001	−0.001	0.003	0.001	−0.001	0.003
Distance to out-patient facility		−0.058	−0.067	−0.049	−0.050	−0.058	−0.041
Variance	Level	Coefficient	95% CI lower	95% CI upper	Coefficient	95% CI lower	95% CI upper
Intercept	LHU	0.01148 ($p=0.0014$)	0.006545	0.02518	0.009991 ($p=0.0015$)	0.005681	0.02199
Residual		0.03951 ($p<0.0001$)	0.03653	0.04287	0.03359 ($p<0.0001$)	0.03111	0.03654

* Indicates the interaction term among population 65–84 and elderly

Table 4 Results of hierarchical models for pharmaceutical care: utilisation rate (mean: 7.23 SD: 1.54)

Covariates		Model A			Model B		
		Coefficient	95% CI lower	95% CI upper	Coefficient	95% CI lower	95% CI upper
Direct need							
Population 0–4 (%)		0.010	−0.101	0.121	0.048	−0.062	0.159
Population 65–84 (%)		0.160	0.129	0.191	0.339	0.274	0.404
Population 85+ (%)		0.188	0.111	0.266	0.278	0.192	0.363
Crude mortality rate (per 100,000 inhabitants)		−6,810E-05	−2,000E-04	1,000E-04	−6,250E-05	−2,000E-04	1,100E-04
Indirect need							
Population with a low level of education (%, ≤5 years)		–	–	–	−0.014	−0.035	0.006
Manual workers among occupied population		–	–	–	0.015	0.002	0.028
Unemployed (%)		–	–	–	0.063	0.027	0.099
Elderly living alone (%)		–	–	–	0.132	0.061	0.202
Household crowding		–	–	–	0.291	−1.965	2.547
Foreign immigrants (%)		–	–	–	0.001	−0.062	0.064
Expenses for non-food consumption		–	–	–	−1,310E-05	−3,000E-04	2,500E-04
Population density		–	–	–	−6,680E-05	−2,000E-04	3,039E-05
Population 65–84 (%)* elderly living alone (%)		–	–	–	−0.007	−0.010	−0.005
Supply							
Acute hospital beds		−0.002	−0.004	0.000	−0.002	−0.004	0.000
Distance to out-patient facility		−0.028	−0.037	−0.019	−0.025	−0.034	−0.016
Variance	Level	Coefficient	95% CI lower	95% CI upper	Coefficient	95% CI lower	95% CI upper
Intercept	LHU	0.007405 ($p=0.0019$)	0.00416	0.01672	0.006368 ($p=0.0027$)	0.003504	0.01499
Residual		0.03563 ($p<0.0001$)	0.03294	0.03866	0.03419 ($p<0.0001$)	0.0316	0.03711

* Indicates the interaction term among population 65–84 and elderly

To conduct a more detailed investigation of the actual relationships among the elderly population, who showed the highest consumption rates, we tested the interaction between the 65 and 84 years age group and socioeconomic characteristics. The coefficient relative to the interaction between the percentage of elderly persons who live alone and the percentage of the population in the 65- to 84-year-old group is negatively and significantly associated with hospitalisation and pharmaceutical care. Therefore, although the use of healthcare services is greater among the elderly, it is lower among elderly persons who live alone. This is possibly explained by the limited access to health services of people whose need for healthcare does not thus translate into demand. For each level of care, there is statistically significant residual heterogeneity around the intercept (Tables 2, 3, 4). Figure 1 shows the level 2 residuals of the hierarchical models both with (red lines) and without (blue lines) the covariates of indirect need. In some LHUs, consumption significantly exceeds the regional average, whereas in others it is significantly lower. Thus there are LHUs with an unexplainable residual variability, even after controlling for all of the covariates. The comparison of the models shows that for many (though not all) LHUs, variability around the intercept tends to decrease when socioeconomic factors are introduced into the models.

Furthermore, the geographic pattern follows different trends depending on the level of care. Some LHUs for which the residual consumption of hospital care is lower than the regional average show higher residuals, whereas the use of out-patient and pharmaceutical care increases, and vice versa.

Finally, the empirical evaluation of the maximum value of VIF (3.1, corresponding to the percentage of people in the 65–84 year age group), of the absence of very small eigenvalues and of low condition-index values suggests that there are problems of multicolinearity that are negligible or, at most, slight and thus have no important effect on the stability of the estimate of the parameters.

Discussion

The study shows that both need and supply influence the use of healthcare services. In particular, socioeconomic level, as a proxy of indirect need, is a statistically significant determinant of hospitalisation, out-patient care and pharmaceutical care. Occupation seems to be the most important factor: higher unemployment was found to be positively associated with the use of out-patient and pharmaceutical care, whereas excesses in hospitalisation were found where the percentage of manual workers was higher. Although the use of health services is significantly greater in areas with more elderly inhabitants, we found lower consumption rates where there was a higher percentage of elderly persons living alone, even when the elderly made up the same percentage of the population. Moreover, residual differences in the use of health services in Italy were observed after taking into account a number of factors related to need and supply (Fig. 1). The results suggest that the relationships among use, need and supply can be used to develop funding mechanisms that include principles of allocative equity. Following the experience in the UK, the coefficients of the models can be considered as indexes of variability of need that can be used as weights in order to calculate capitation.

Although the results contribute to the search for appropriate funding mechanisms, certain critical aspects of this approach need to be emphasised. In Italy, the main objective of an allocative formula for the LHU's is the allocation of current funds, essentially regarding healthcare costs. Investments on the development, reorganisation or construction of healthcare facilities take the form of capital funding, distributed on the basis of budgets mainly related to short-term factors. Within this framework the role of parameters of need is essen-

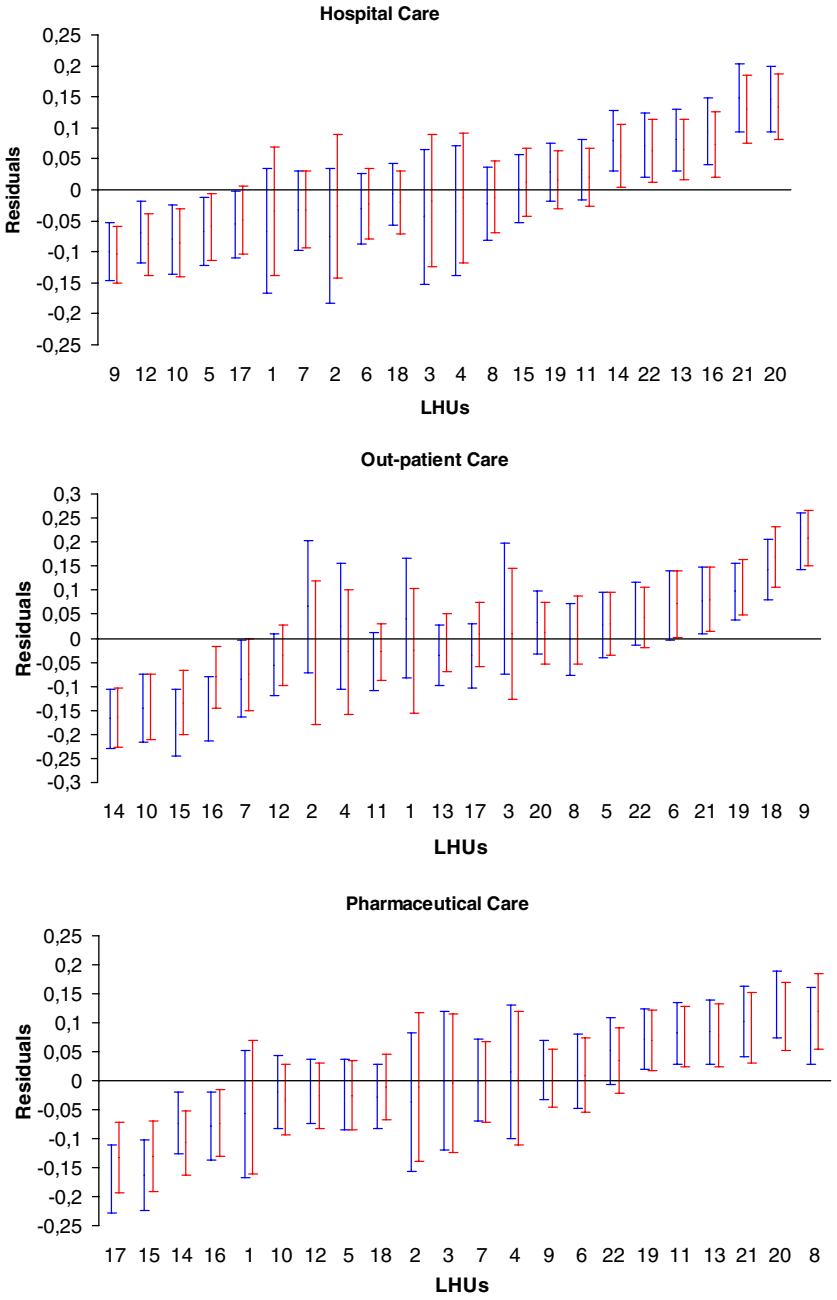

Fig. 1 Level 2 residuals of hierarchical models for hospital care, out-patient care and pharmaceutical care

tial for an equity oriented allocation of current funds; while supply parameters need to be interpreted more clearly. Our models show a statistically significant effect of distance on the use of healthcare. In Italy distances from hospitals or specialist out-patient facilities are,

on average, small enough to exclude that the observed relationship is due to the costs of transport in order to reach the healthcare facility constituting a deterrent to demand. It is therefore reasonable to state that the distance from the healthcare facility is a good indicator of supplier-induced demand. For these reasons the estimated coefficient for supply should be considered in the model, as a factor that strongly influences the consumption of services, but not included as a weighting factor for capitation-based allocation of current resources, as this would inevitably result in inequalities in the yearly distribution of resources.

A determinant of demand not measured in the model is the cost of production and distribution of services, which can be heterogeneously distributed in a given area. For instance, there could be marked differences in the costs of managing emergencies, because of the orography of a given area (especially in Piemonte, which has many mountainous areas), or in the costs of providing certain services (e.g., cleaning and catering). There is actually a special equalisation fund, to compensate for differences in production costs; however, including this in a statistical model would be justified if the aim was focused on estimating the determinants of cost, in a model using the economical value as the outcome, rather than on the determinants of utilisation of services, as in our case. The observed residual variability could be attributable to both the influence of the professional and organisational appropriateness of health care, and the misclassification of parameters of need, supply and production cost factor.

Moreover certain methodological criticisms have to be mentioned. The major international studies that have investigated the differences in the use of healthcare services, though based on sound conceptual models, have had to deal with a lack of individual information and have opted for empirical models based on ecologic studies. This was also the case in our study: the capacity to measure the effect of the variables of need on the use of health services was greatly limited by the absence of individual socioeconomic data, in the databases that collect information on the use of services. Using geographically aggregated variables to make inferences at the individual level is subject to a risk of bias (Carr-Hill and Rice 1995). The heterogeneity in the size of the individual municipalities should also be taken into account as a potentially bias-creating factor. Studies investigating the intensity of ecologic bias in the relationship between socioeconomic factors and health (Soobader 2001; Geronimus and Bound 1998) at different levels of geographic aggregation have shown that the regression coefficients in the aggregated analyses are overestimated when compared to those in individual analyses and that stability varies with geographic granularity, whereas the effect of geographic heterogeneity on the estimates is as yet unclear.

Moreover, the underlying mechanism in the transformation of need into demand is not completely represented in the model. In this regard, it would be useful to introduce complex indicators capable of measuring propensity towards the use of health services, taking into account the multidimensionality of the concept of health, which should consider both the objective and the perceived component; these indicators should also take into account environmental and cultural factors. Unfortunately, in Italy, the only combined data available on objective and perceived health are those provided by the sample studies on the health status of Italy's population conducted every 5 years by the National Census Bureau.

The potential effect of using retrospective associations should also be mentioned. Given that population censuses are conducted every 10 years and that additional time passes before the data are actually available, socioeconomic covariates that pre-date the indicators of the use of healthcare services have to be used. However, according to the international literature, there is a negligible sensitivity in the association between health status and socioeconomic level using covariates with different retrospective lag times (Soobader 2001).

In conclusion, the results of this study on need estimation could be useful to derive weights for an allocative formula for distributing current regional health funds to LHU's in Italy.

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