

Trends in hospitalizations for primary care sensitive conditions following the implementation of Family Health Teams in Belo Horizonte, Brazil

Claunara Schilling Mendonça,^{1,2*} Erno Harzheim,² Bruce B Duncan,² Luciana Neves Nunes³ and Werner Leyh⁴

¹Departamento de Atenção Básica, Secretaria de Atenção à Saúde, Ministério da Saúde, Brasília, DF, Brazil, ²Graduate Studies Program in Epidemiology, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil, ³Statistics Department, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil and ⁴Coordenação de Monitoramento e Avaliação da Atenção Básica, Departamento de Atenção Básica, Secretaria de Atenção à Saúde, Ministério da Saúde, Brasília, DF, Brazil

*Corresponding author. Serviço de Saúde Comunitária. Grupo Hospitalar Conceição. Av.Francisco Trein, 596. Bloco H, 3º andar, 91350.200. Porto Alegre/RS Brazil. Tel: +055 51 85410168. Fax: +055 51 33572442. E-mail: claunara@uol.com.br; claunara@ghc.com.br

Accepted	14 March 2011
Objectives	How to provide effective and efficient care to the burgeoning and aging populations of the major cities of low- and middle-income countries constitutes one of the principle public health issues of our times. We evaluated the Family Health Strategy, the Brazilian national health system's public approach to primary health care, in the major city of Belo Horizonte, describing trends and factors associated with hospitalizations for primary care sensitive conditions following the implementation of 506 family health teams, most of which were established in 2002.
Methods	We conducted an ecological study covering 2003 to 2006, using mixed models to investigate time trends in public system hospitalizations as well as their association with social vulnerability and primary care team characteristics.
Results	Sensitive conditions accounted for 115 340 (26.4%) hospitalizations. Over the 4-year period, hospitalizations for sensitive conditions declined by 17.9%, vs only 8.3% for non-sensitive ones ($P < 0.001$). Hospitalization for sensitive conditions declined 22% for women in areas of high social vulnerability vs 9% for women in areas of low vulnerability ($P < 0.001$); for men, 17% vs 10% ($P = 0.11$).
Conclusions	Though the ecologic nature of our study limits the confidence with which conclusions can be affirmed, the Family Health Strategy appears to have contributed to a major reduction in hospitalizations due to primary care sensitive conditions in this large Brazilian metropolis, while at the same time promoting greater health equity.
Keywords	Primary health care, primary care sensitive conditions, hospitalization, equity, Brazil

KEY MESSAGES

- Primary care sensitive hospitalizations decreased approximately 18% over the 4 years immediately following large-scale implementation of Brazil's innovative primary health care team approach in Belo Horizonte, a major metropolis.
- Declines were largest in areas of greatest social risk, leading to a notable reduction in the social gradient of these hospitalizations.

Introduction

Primary health care has been emphasized in the provision of health care to populations since the 1978 Declaration of *Alma-Ata*, and in a particularly pronounced way in recent years. The World Health Organization (WHO), in its 2008 annual report, reinforced the importance of primary care as a co-ordinator of health systems (WHO 2008). Nevertheless, in many low- and middle-income countries the emphasis is still placed on vertical programmes directed toward reducing the burden of specific diseases. Over the last 15 years, Brazil has effected major change in its approach to health care. The country has created over 31 000 primary health care teams within its Family Health Strategy (FHS) (Ministério da Saúde 2007), thus placing primary health care at the centre of its universal and decentralized national health care system (Sistema Único de Saúde, SUS), currently the sole source of health care for approximately 51% of Brazilians.

The FHS offers a multi-professional team composed of a general practitioner, a nurse, a dentist, nursing and oral health assistants and several community health agents (Ministério da Saúde 2007). Each team is responsible for a population of approximately 3500 people living within a geographically defined area. The Strategy seeks to fulfill primary care principles by providing first contact with health activities and services, making universal and continuous access to effective, quality health services possible, offering comprehensive care in its various aspects, as well as co-ordinating care of users within the service network (Starfield 2002).

How to respond to the growing demand for health services in large metropolitan areas has become a major health care dilemma for developing countries. As the rapidly aging population of these cities frequently suffers from a triple burden of illnesses—infections, malnutrition and reproductive health problems; chronic illnesses; and those resulting from violence and other external causes (Mendes 2009)—the provision of adequate health care threatens to overwhelm hospitals and available resources.

In 2002, in order to increase access to the FHS in large urban centres, the Brazilian Ministry of Health implemented the Family Health Expansion and Consolidation Project (Projeto de Expansão e Consolidação da Saúde da Família, or PROESF) with the support of the International Bank for Reconstruction and Development (IBRD). Though widespread variation existed in FHS implementation, by September 2009, 85% of the 226 municipalities with more than 100 000 inhabitants had increased their population coverage and average coverage had increased from 24% to 40% (Ministério do Planejamento 2001).

As part of this effort, in 2002, the Municipality of Belo Horizonte initiated a macro-structural change in its health system, replacing its traditional primary care models with FHS

teams while expanding access to primary care coverage to over 70% of the population (Turci 2008).

The goal of this study is to evaluate this change. A series of approaches utilizing hospitalization data have been applied as a measure of the effectiveness of primary care. Among them is that of Ambulatory Care Sensitive Conditions, developed by John Billings and collaborators in the 1990s, stemming from the concept of avoidable deaths (Billings *et al.* 1993; Fleming 1995; Caminal *et al.* 2001; Malta *et al.* 2007). Studies show that high rates of hospitalizations for these conditions, deemed avoidable through quality primary care, in a population or subgroup(s) of the population may indicate problems of access or performance in the health system (Bindman *et al.* 1995; Casanova and Starfield 1995; Brown *et al.* 2001; Bermudez-Tamayo *et al.* 2004). Better access to primary care has been associated with the reduction of these hospitalizations (Fleming 1995; Shah *et al.* 2003; Saha *et al.* 2007).

Few studies have, however, analysed changes in the rates of these hospitalizations in response to the policies and programmes that aim to provide greater access to health care, such as the FHS (Saha *et al.* 2007). In order to investigate the relationship of the presence and quality of the FHS with the reduction of hospitalizations for primary care sensitive conditions within the SUS in a large metropolis, we evaluated temporal trends in public hospital hospitalizations in Belo Horizonte, Minas Gerais (MG), Brazil, immediately after the period of large-scale implementation of the FHS, as well as the relationship of these hospitalizations with organizational characteristics of the teams and socio-economic factors of the population.

Methods

Study design

At the time of the study, the Municipality of Belo Horizonte had recently implemented a network of primary care services consisting of 139 health centres, with 506 family health teams and 2229 community health agents. These services, in geographical terms, cover 76% of the estimated 2 412 937 population of the municipality; and 436 420 families with 1 539 987 individuals, 64% of the population, were formally registered with the teams.

Specialized care was composed of six medical specialty services, six medical clinic services, a pre-hospital emergency network and a public and contracted hospital network composed of more than 40 hospitals (Turci 2008).

Belo Horizonte was chosen for this analysis given: (1) its choice to organize health care delivery based on family health teams (Turci 2008), with implementation of this change in large part during 2002; (2) the quality and completeness of its

data in national health information systems; and (3) the fact that 100% of its hospitalizations are regulated through a central system which suffered no reduction in the number of available beds for those presenting with primary care sensitive conditions over the period of study.

This ecological study is based on the analysis of secondary data over the period from 2003 to 2006. To study the factors associated with changes in the hospitalization rate, we used census tracts as the units of observation. Of the total of 2563 census tracts, 1909 had family health teams (74.5% of the total), thus constituting the universe under analysis. Census tracts not covered by family health teams have a large proportion of residents covered by private insurers and no public provision of primary care. These tracts were thus excluded from the analyses, as hospitalizations through private insurers would not be registered in available databases.

To characterize the socio-economic conditions, we employed a Health Vulnerability Index (Índice de Vulnerabilidade à Saúde), created for the Municipality of Belo Horizonte (Gerência de Epidemiologia e Informação 2003). This index is composed of sanitation, habitation, education, income and health indicators obtained from the year 2000 Brazilian national census, and labels geographic areas as socio-economic environments in which residents are at low, medium, high or very high vulnerability for adverse events. We also evaluated organizational aspects of the family health teams obtained from the municipal health care information systems: total months of team existence within the study period, size of the registered population, physician consultations/inhabitant/year, the existence of multiple team physicians over the period and maximum length of continuity of a given physician with the team.

We obtained data regarding hospitalizations within the SUS for the resident population, by year of hospitalization, from the Hospital Information System (Sistema de Informações Hospitalares). The classification of primary care sensitive hospitalizations was made following a list of such conditions designed specifically for use in evaluating primary care actions in Brazil (Ministério da Saúde 2008; Alfradique *et al.* 2009).

Geocoding of residencies of hospitalized patients to the census tracts was done by the Municipality Health Office, using the Municipal Technical Registry (Cadastro Técnico Municipal), which utilizes street address codes and real estate property numbers. Five hospitals in Belo Horizonte, managed by the Minas Gerais State Health Department rather than the Municipality, did not furnish the addresses to the Hospital Information System. To geocode these events, we applied the Geobase Nacional Plus database (GSE Soft 2010) to data obtained at time of hospitalization to generate zip codes for residences. From these, we georeferenced hospitalizations for sensitive conditions for these hospitals. As address data were not always sufficiently specific, we incurred a total loss of 2.7% of all addresses. Geocoding of FHS team characteristics was facilitated by the fact that geographic coverage of FHS teams is based on census tracts.

Statistical analysis

Annual hospitalization rates of the census tracts were standardized using the age and sex distribution of the year 2000 Census for the population of Belo Horizonte as a standard, and

are expressed per 10000 inhabitants. We applied Pearson's chi-square to test differences in secular trends between hospitalizations for sensitive and for non-sensitive conditions. We evaluated correlates and the relationship of temporal trends of adjusted hospitalization rates for sensitive conditions with a mixed model (Brown and Prescott 2006), also known as the random coefficient model. In this model, the upper hierarchy unit of observation was the census tract; the lower, the calendar year.

Model

$$\begin{aligned} \text{Hospitalizations}_{ij} = & (\alpha_0 + \alpha_1 \text{TeamTime}_i + \alpha_2 \text{MDTime}_i \\ & + \alpha_3 \text{Vun_Med}_i + \alpha_4 \text{Vun_High}_i + U_{1i}) \\ & + (\beta_0 + \beta_1 \text{Vun_Med}_i + \beta_2 \text{Vun_High}_i + U_{2i}) \\ & * \text{Years}_{ij} + \varepsilon_{ij} \end{aligned}$$

where

$i = 1, \dots, n$, where n is the number of census tracts;
 $j = 1, \dots, n$, where n is the number of years since 2002;
 Hospitalizations_{ij} is the standardized rate of hospitalizations for primary care sensitive conditions of tract i in year j ;
 TeamTime _{i} is the time (months) of operation of the FHS of tract i ;
 MDTime _{i} is the maximum time (months) of permanence of the same FHS physician of tract i ;
 Vun_Med _{i} is an indicator variable for medium social vulnerability of tract i (1 if the vulnerability index is medium, and 0 otherwise);
 Vun_High _{i} is an indicator variable for high social vulnerability of tract i (1 if the vulnerability index is high, and 0 otherwise);
 Years_{ij} is the period of time since 2002 for tract i in year j ;
 U_{1i} and U_{2i} are random effects for each tract, U_{1i} measures how much the intercept of the straight line of the i -th tract digresses from the intercept of the average straight line, and analogically, U_{2i} measures this digression in terms of the slope;
 ε_{ij} is the random error.

Models were stratified by sex.

We used SPSS (Statistical Package for the Social Science) for descriptive analysis and chi square calculations, and the software R (R Development Core Team 2004; Brown and Prescott 2006) for mixed model analyses. To evaluate the presence of multicollinearity of the independent variables included in the model, we calculated the *Variance Inflation Factor* (VIF). Multicollinearity was highly improbable, as the variance inflation factors obtained were always below 2.

Results

A total of 435 253 hospitalizations, excluding childbirths, occurred within the SUS for residents of Belo Horizonte living in census tracts covered by the FHS from 2003 to 2006. Of these, 115 340 (26.4%) were due to primary care sensitive conditions (Figure 1). Of this latter total, 58 405 (50.6%) occurred in women. Hospitalizations for sensitive conditions were concentrated at the extremes of age, with 43 778 (38%) being in those less than 20 years of age and 35 743 (31%) in those above 60 years of age.

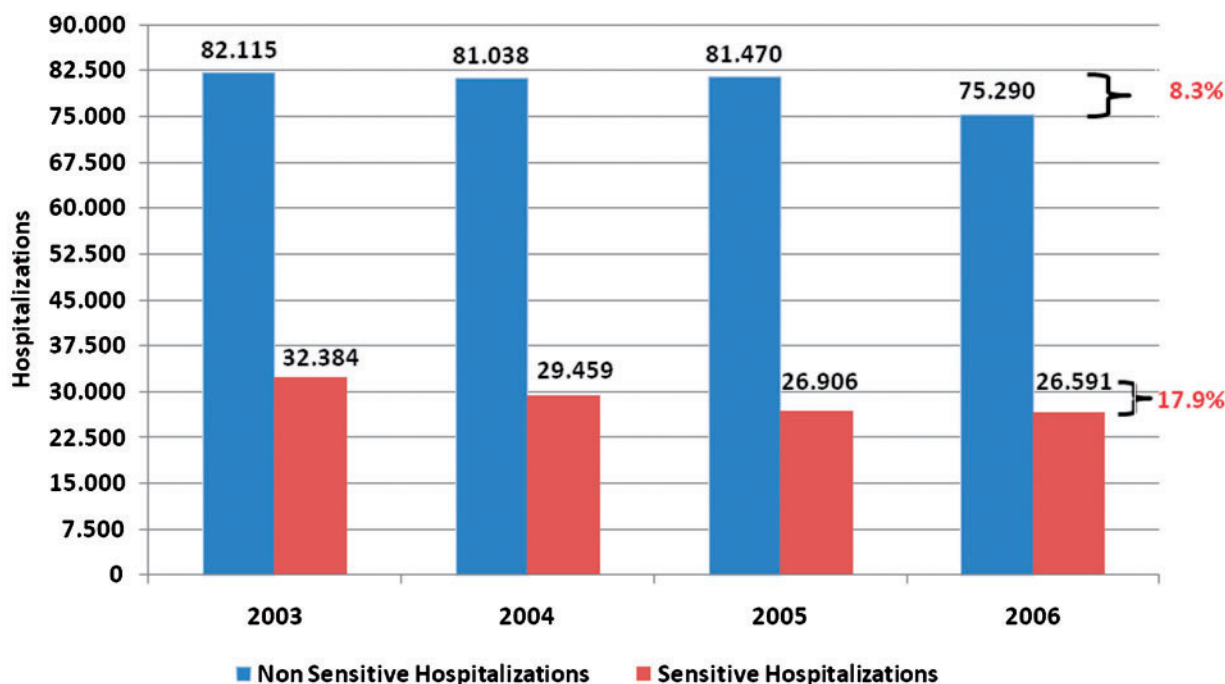


Figure 1 Total number of hospitalizations (except for childbirth) due to conditions sensitive (light columns) and not sensitive (dark columns) to primary care by year, Belo Horizonte, MG, Brazil, 2003–2006

The decline in hospitalizations for sensitive conditions over the 4-year period was 17.9%, while the decline for hospitalizations for non-sensitive conditions was only 8.3% ($P < 0.001$).

When standardized, rates of hospitalizations from sensitive conditions decreased throughout the period, from 182/10 000 inhabitants in 2003 to 154/10 000 inhabitants in 2006, corresponding to a reduction of 15.6%. Among men, the reduction was 12.7% (from 163 to 142/10 000 inhabitants), while among women, it was 18.4% (from 199 to 162/10 000 inhabitants).

In terms of the distribution of the socio-economic variables of the census tracts, 255 (12.3%) of the hospitalizations for sensitive conditions occurred for residents of census tracts with low social vulnerability, 902 (47.2%) for residents of tracts with medium vulnerability and 772 (40.4%) for residents of tracts with high vulnerability.

With regard to FHS team organization, the team operated from the beginning of 2003 in 1909 tracts (74.5%), and the same physician remained with the same team throughout the whole period in 463 tracts (24%). In relation to the size of the registered population, teams were responsible for up to 2500 inhabitants in 301 tracts (16%), for between 2501 and 3500 inhabitants in 795 tracts (42.2%), and for more than 3501 inhabitants in 790 tracts (41.9%). The average number of physician consultations/inhabitant/year in the FHS ranged from 0.7 to 1.8 in the period under analysis. The average number of physician consultations/inhabitant/year and the size of the registered population, whether tested in continuous or categorical forms, were not significantly related to hospitalization rate for either men or women. These variables were thus not included in the final model.

In 2003, women residents of census tracts of medium vulnerability, in comparison with those of low vulnerability

tracts, had 110 more hospitalizations per 10 000 inhabitants; whereas the inhabitants of high vulnerability tracts had 204 additional hospitalizations/10 000 inhabitants (Table 1). Men residing in the medium vulnerability tracts had 70 additional hospitalizations/10 000 inhabitants when compared with those in low vulnerability tracts; men residing in high vulnerability tracts had 104 additional hospitalizations/10 000 inhabitants ($P < 0.001$).

The mixed model analysis also showed significant reduction in the hospitalizations for sensitive conditions over the 4 years for both men and women (Table 1). Yet, as may be verified by the 'year since 2002*social vulnerability' interaction terms of Table 1, the standardized rate of hospitalizations in tracts of greater vulnerability declined at a considerably greater rate. These interaction term beta coefficients express the greater average decline in hospitalizations, per calendar year, among residents of census tracts of greater social vulnerability. Summed over the whole period, for women residents of low vulnerability tracts, the fall in yearly hospitalizations was only 5.9/10 000 inhabitants, while for those of middle vulnerability tracts it was 34.8/10 000 inhabitants and for those of high vulnerability tracts, 55.9/10 000 inhabitants ($P < 0.001$). For men, a similar fall among residents of the more socially vulnerable tracts was also seen; a decline in hospitalizations, over the period, of 21/10 000 inhabitants in the medium vulnerability tracts, and of 31/10 000 inhabitants in the high vulnerability tracts, as opposed to only 9/10 000 inhabitants in the low vulnerability tracts ($P = 0.11$). The estimated adjusted straight line graph (Figure 2) derived from the models demonstrates this marked reduction in inequality of hospitalization rates for sensitive conditions across the social strata.

Table 1 Association of Family Health Strategy characteristics, social vulnerability and calendar year with the rate of hospitalization for primary care sensitive conditions. Mixed model analysis, Belo Horizonte, MG, Brazil, 2003–2006

	Women			Men		
	Difference ^a	95% CI	P-value	Difference ^a	95% CI	P-value
(Intercept)	45.2	1.01 – 89.4	<0.001	67.9	33.3 – 102.5	<0.001
Existence of the Family Health Team (months) ^b	1.00	0.15 – 1.86	<0.001	0.78	0.10 – 1.46	0.001
Maximum time of one physician with the team (months)	–0.53	–1.03 – –0.04	<0.001	–0.22	–0.62 – 0.16	0.023
Time since 2002 (years) ^c	–1.95	–9.60 – 5.69	<0.001	–2.95	–9.49 – 3.59	<0.001
Social vulnerability			<0.001			<0.001
Middle risk	110.3	80.6 – 140.0		70.27	47.5 – 93.0	
High risk	203.9	173.3 – 234.5		103.5	80.0 – 127.0	
Interaction (Time since 2002 × Social vulnerability) (yrs)			<0.001			0.11
Middle risk	–9.65	–18.2 – –1.07		–3.94	–11.3 – 3.40	
High risk	–16.7	–25.5 – –7.86		–7.53	–15.1 – 0.02	

Notes:

^aDifference in the annual rate of hospitalizations/10 000 inhabitants associated with a one unit change in the variable.

^bTotal months of operation during the study period.

^cFor example, for 2005 the value here would be 3 (years).

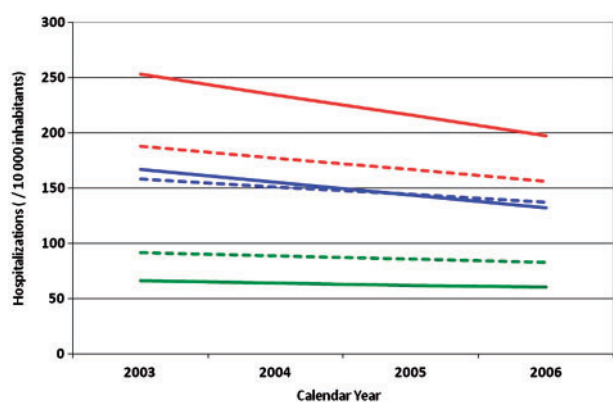


Figure 2 Adjusted decline in the standardized hospitalization rates for primary care sensitive conditions in women (solid lines) and in men (dashed lines), respectively, according to social vulnerability (black = high; grey = medium; light grey = low), Belo Horizonte, MG, Brazil, 2003–2006

Only two aspects of the team organization were associated with the number of hospitalizations for sensitive conditions: the duration of operation of the FHS and the maximum length of continuity of the team physician. For each additional month of team operation, the number of hospitalizations increased by 1/10 000 inhabitants/year for women and by 0.7/10 000 inhabitants/year in men (both $P < 0.001$). For each additional month of permanence of the same physician on the team, the number of hospitalizations reduced by 0.5/10 000 inhabitants/year for women ($P < 0.001$) and 0.2/10 000 inhabitants/year for men ($P = 0.02$).

The most frequent hospitalizations for primary care sensitive conditions were due to bronchial pneumonia (15.4%), asthma (13.7%), cardiac insufficiency (11.7%), cerebrovascular diseases (9.5%) and gastroenteritis (9.2%); these five diagnostic groups representing 59.5% of the total hospitalizations for sensitive conditions in the period under consideration. In percentile terms, the greatest reduction corresponded to hospitalizations

for inflammatory disease of the female pelvic organs (71%), vaccine preventable diseases (58%) and hypertension (49%), while hospitalizations for bacterial pneumonia and stroke did not show reductions over the period. In absolute terms, the greatest reductions were in hospitalizations for asthma (25.6% of the total), cardiac insufficiency (21.9% of the total) and gastroenteritis (19.1% of the total) (Table 2).

Discussion

In Belo Horizonte, an 18% reduction in hospitalizations for sensitive conditions occurred over a 4-year period soon after the large-scale implementation of the FHS. This reduction was most notable in communities with greater social vulnerability. Most of the limited range of specific FHS team characteristics available for evaluation showed little or no association with hospitalization rates.

Diverse evaluations of the Brazilian Family Health Strategy have shown positive results in relation to evaluations of users, managers and health professionals (Macinko *et al.* 2004; Brown and Prescott 2006; Harzheim *et al.* 2006b; Guanais and Macinko 2009), to the availability of health care and to access and use of services (Elias 2006; Facchini 2006; Harzheim *et al.* 2006a; Piccini 2006; Viana 2006). Favourable results have also been shown for reduction of infant mortality (Macinko *et al.* 2006; Aquino *et al.* 2009) and for increased labour supply and employment, increased school attendance and decreased fertility among the registered populations (Rocha and Soares 2009). These findings, together with the fact that hospitalizations for sensitive conditions are more prevalent in populations of greater socio-economic risk, advanced age, women, ethnic minorities and in individuals in areas with fewer primary care physicians (Bindman *et al.* 1995; Fleming 1995; DeLia 2003; Shah *et al.* 2003; Ansari *et al.* 2006; Valenzuela Lopez *et al.* 2007), reinforce the importance of offering effective primary care services to the population.

Table 2 Crude annual incidence of hospitalizations (10 000/inhabitants) for primary care sensitive conditions (ACSC) according to International Classification of Diseases (ICD-10) groups, Belo Horizonte, MG, Brazil, 2003–2006

	2003		2004		2005		2006		Absolute reduction ^a	Relative reduction ^b
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%		
Immunizable conditions	66	0.2	65	0.2	39	0.1	28	0.1	38	57.6
Preventable conditions	505	1.6	450	1.5	397	1.5	330	1.2	175	34.7
Gastroenteritis	31 083	9.8	2756	9.4	2599	9.7	2078	7.8	1105	34.7
Anaemia	147	0.5	135	0.5	94	0.3	87	0.3	60	40.8
Nutritional deficiencies	247	0.8	278	0.9	218	0.8	210	0.8	37	15.0
Ear, nose and throat infections	110	0.3	111	0.4	129	0.5	98	0.4	12	10.9
Pneumonia	4288	13.2	3985	13.5	4411	16.4	5114	19.2	−826	−19.3
Asthma	4542	14.0	4447	15.1	3713	13.8	3060	11.5	1482	32.6
Lower respiratory tract diseases	2113	6.5	1933	6.6	1655	6.2	1848	6.9	265	12.5
Hypertension	1364	4.2	999	3.4	699	2.6	701	2.6	663	48.6
Angina pectoris	1888	5.8	1594	5.4	1481	5.5	1522	5.7	366	19.4
Congestive heart failure	4201	13.0	3480	11.8	2852	10.6	2934	11.0	1267	30.2
Cerebrovascular diseases	2516	7.8	2782	9.4	2753	10.2	2918	11.0	−402	−16.0
Diabetes mellitus	1391	4.3	1239	4.2	1124	4.2	1185	4.5	206	14.8
Epilepsy	611	1.9	622	2.1	532	2.0	495	1.9	116	19.0
Kidney/Urinary tract infection	2693	8.3	2371	8.0	2427	9.0	2297	8.6	396	14.7
Skin and subcutaneous tissue infection	596	1.8	523	1.8	447	1.7	457	1.7	139	23.3
Pelvic inflammatory disease	717	2.2	572	1.9	322	1.2	211	0.8	506	70.6
Gastrointestinal ulcer	1081	3.3	1020	3.5	905	3.4	906	3.4	175	16.2
Prenatal and birth related diseases	125	0.4	97	0.3	109	0.4	112	0.4	13	10.4
Total hospitalizations for ACSC	32 384	100.0	29 459	100.0	26 906	100.0	26 591	100.0	5793	17.9

Notes:

^aDifference in number of hospitalizations 2003 vs 2006.

^b(Difference in number of hospitalizations/number of hospitalizations in 2003)*100.

The greater reduction in sensitive condition hospitalizations for women was also found in studies of three groups of preventable chronic illnesses in Brazil (Guanais and Macinko 2009). Assuming that this difference is at least in part due to the greater contact of the FHS with women, these findings indicate the need for improving access for men to primary care/FHS so that they too may enjoy benefits such as reduction of hospitalizations for complications of chronic diseases.

Our findings with respect to FHS team characteristics are of quite limited scope and merit interpretation. The validity of the results for duration of 'Operation of the FHS team' is questionable. As the great majority of teams were implemented prior to 2003, the interquartile range for the length of operation of the team was extremely narrow (46–48 months), and this range was associated with the trivial difference of 2 hospitalizations for sensitive conditions per 10 000 inhabitants/year for women and less than that for men. Further, residual confounding of this association by social vulnerability cannot be excluded, as teams were implemented initially in areas of greatest social vulnerability.

Continuity of the team physician, when evaluated across the interquartile range (21–40 months, a difference of 19 months), was associated with 11 fewer hospitalizations/10 000 inhabitants/year. This reduction in hospitalizations, although small, is not negligible. In the face of this, results suggest that, in

addition to the use of the FHS in primary care, the maintenance of general practitioners, over time, is important for reducing hospitalizations due to sensitive conditions (Parchman and Culler 1994; Gulliford 2002; Laditka *et al.* 2005). This finding suggests the need for special attention to issues that increase the stability of professionals on the teams.

The lack of association with hospitalization rate of most of the characteristics of FHS team structure and function evaluated suggests that the reduction in hospitalizations may be related to other aspects of the quality of the primary care they offered, for example, the presence of community health workers, the placement of care geographically close to those using it, and aspects such as first contact, continuity, co-ordination, comprehensiveness, and family and community orientation, previously shown to be relevant (Harzheim *et al.* 2006b).

With regard to hospitalizations for specific diseases, reduction in the number of hospitalizations for sensitive conditions was seen in almost all nosologic groups, with the exceptions of bacterial pneumonia and stroke. With regard to hospitalizations for pneumonia, similar results were found for Canadian children: reduction in hospitalizations for asthma, but an increase in hospitalizations for pneumonia, mainly in the quintiles of lowest income (Agha *et al.* 2007). Hospitalizations for vaccine preventable diseases, conditions typically considered as primary care sensitive, were practically eliminated over the

4 years of this study. On the other hand, infectious diseases less preventable through health care, such as gastroenteritis, may have had their complications controlled in primary care, avoiding hospitalizations. The annual rate of hospitalization for gastroenteritis decreased from 18.2 to 11.8 per 10 000 inhabitants.

For chronic illnesses, which are responsible for approximately half of the hospitalizations for sensitive conditions in the Municipality, hospitalizations are generally due to the worsening of a known condition. In these cases, the role of primary care is in reducing hospitalizations for acute complications of the disease, in avoiding re-admittances and in decreasing the time of in-hospital stay (Gill and Mainous 1998; Alfradique *et al.* 2009). Decreases in several of these conditions suggest that the FHS can provide this long-term care.

Limitations of our study merit discussion. Due to its ecological nature, we cannot categorically affirm that hospitalizations were avoided as a result of the better quality of attention provided by the FHS teams. However, our data support this *a priori* hypothesis as reductions were most marked among those living in the areas of greatest social vulnerability. Further, that the principal change in health care provision in Belo Horizonte over the period was, by far, its massive investment in primary care, and that this major decrease in hospitalizations occurred over a very short period of time, coming immediately after the large-scale implementation of the FHS, support our interpretation of the findings.

The lack of a longer time frame, including data on hospitalizations prior to implementation of the FHS, is an additional limitation. However, the availability and quality of data prior to 2003 made this impossible.

Another limitation of our study is in the characterization of aspects of team organization. Attributes of primary care were restricted to those available in the health care information systems in existence in the Municipality, which evaluate a limited range of factors associated with the quality of primary care. The short period of the study may be considered an additional limitation, especially with respect to conditions for which prevention is a task performed over several years. A possible example of this is the contrast between the trend in hospitalizations for stroke, which showed no reduction over the period, and that for hypertension, which suffered a 49% reduction.

Conclusions

Our data suggest that the large-scale implementation of the Brazilian Family Health Strategy in Belo Horizonte improved the quality of primary care services, especially in areas of greater social risk, bringing about an important reduction in the hospitalizations for primary care sensitive conditions and reinforcing the role of public health policies in the reduction of health inequities. Though the ecologic nature of the associations we demonstrate and the lack of control areas without Family Health teams limit the confidence with which we can attribute causality to the declines seen, major positive trends in health and equity in this city are clear. Evidence supporting public health decisions frequently comes from study designs, such as ours, acknowledged to be weak ones.

Nonetheless, these decisions must be taken based on a summary of all existing available evidence. In this context, we believe that the declines demonstrated, coming immediately after a major shift toward publicly provided primary care, are quite relevant to the management of health systems in low- and middle-income countries. In fact, evidence of a better quality to support decisions on the structure of primary care in large urban areas of the developing world is quite limited.

Additionally, the rate of hospitalizations for primary care sensitive conditions appears to be a good indicator for evaluating the access and the quality for health services, especially for primary care.

The more favourable association for women brings to the political arena an important argument for increasing men's access to primary care services.

In relation to the debate regarding the possibility of improving population health without improvement of general social and structural conditions, our results suggests that for a large part of the primary care sensitive conditions, the FHS, especially in conditions permitting stability of its professionals over time, can markedly improve the health of the population. The greater reduction seen in areas of greatest vulnerability will hopefully tend, over the years, to close further the wide gap remaining in preventable hospitalizations between more vulnerable and less vulnerable populations.

Our study adds to a growing list showing benefits, including greater equity, associated with the presence of the Brazilian Family Health Strategy. The findings suggest that the public offering of primary health care as the point of entry to health system services, with a strong component centered on people and on the community, has enormous potential for improving health outcomes in large urban centres of developing countries around the world.

Funding

This research was part of the master's thesis of Claunara Mendonça in the Masters Program in Management of Health Technologies, Graduate Studies Program in Epidemiology, UFRGS, financed by the Brazilian Ministry of Health. It was supported in part by the National Institute of Science and Technology for Health Technology Assessment (IATS) - CNPq/Brazil (Grant No. 573826/2008-0).

Conflict of interest

None declared.

References

- Agha MM, Glazier RH, Guttman A. 2007. Relationship between social inequalities and ambulatory care-sensitive hospitalizations persists for up to 9 years among children born in a major Canadian urban center. *Ambulatory Pediatrics* **7**: 258–62.
- Alfradique ME, Bonolo PF, Dourado I *et al.* 2009. Ambulatory care sensitive hospitalizations: elaboration of Brazilian list as a tool for measuring health system performance (Project ICSAP—Brazil). *Cadernos de Saúde Pública* **25**: 1337–49.

- Ansari Z, Laditka JN, Laditka SB. 2006. Access to health care and hospitalization for ambulatory care sensitive conditions. *Medical Care Research and Review* **63**: 719–41.
- Aquino R, de Oliveira NF, Barreto ML. 2009. Impact of the family health program on infant mortality in Brazilian municipalities. *American Journal of Public Health* **99**: 87–93.
- Bermudez-Tamayo C, Marquez-Calderon S, Rodriguez del Aguila MM, Perea-Milla LE, Ortiz EJ. 2004. Organizational characteristics of primary care and hospitalization for to the main ambulatory care sensitive conditions. *Atencion Primaria* **33**: 305–11.
- Billings J, Zeitel L, Lukomnik J *et al.* 1993. Impact of socioeconomic status on hospital use in New York City. *Health Affairs (Millwood)* **12**: 162–73.
- Bindman AB, Grumbach K, Osmond D *et al.* 1995. Preventable hospitalizations and access to health care. *Journal of the American Medical Association* **274**: 305–11.
- Brown AD, Goldacre MJ, Hicks N *et al.* 2001. Hospitalization for ambulatory care-sensitive conditions: a method for comparative access and quality studies using routinely collected statistics. *Canadian Journal of Public Health* **92**: 155–9.
- Brown H, Prescott R. 2006. *Applied Mixed Models in Medicine*. 2nd edn. Chichester, UK: John Wiley & Sons Ltd.
- Caminal J, Mundet X, Ponsa J, Sanchez E, Casanova C. 2001. Hospitalizations due to ambulatory care sensitive conditions: selection of diagnostic codes for Spain. *Gaceta Sanitaria* **15**: 128–41.
- Casanova C, Starfield B. 1995. Hospitalizations of children and access to primary care: a cross-national comparison. *International Journal of Health Services* **25**: 283–94.
- DeLia D. 2003. Distributional issues in the analysis of preventable hospitalizations. *Health Services Research* **38**: 1761–79.
- Elias PE, Ferreira CW, Alves MC *et al.* 2006. Atenção Básica em Saúde: comparação entre PSF e UBS por estrato de exclusão social no município de São Paulo. *Ciência & Saúde Coletiva* **11**: 633–41.
- Facchini LA, Piccini RX, Tomasi E *et al.* 2006. Desempenho do PSF no Sul e no Nordeste do Brasil: avaliação institucional e epidemiológica da Atenção Básica à Saúde. *Ciência & Saúde Coletiva* **11**: 669–81.
- Fleming ST. 1995. Primary care, avoidable hospitalization, and outcomes of care: a literature review and methodological approach. *Medical Care Research and Review* **52**: 88–108.
- Gerência de Epidemiologia e Informação. 2003. *Índice de Vulnerabilidade à Saúde 2003*. Belo Horizonte: Secretaria Municipal de Saúde de Belo Horizonte, Gerência de Epidemiologia e Informação.
- Gill JM, Mainous AG 3rd. 1998. The role of provider continuity in preventing hospitalizations. *Archives of Family Medicine* **7**: 352–7.
- GSE Soft. 2010. GSE Soft – Base CEP 2010. Accessed online at: <http://www.gsesoft.com/index.html>.
- Guanais F, Macinko J. 2009. Primary care and avoidable hospitalizations: evidence from Brazil. *Journal of Ambulatory Care Management* **32**: 115–22.
- Gulliford MC. 2002. Availability of primary care doctors and population health in England: is there an association? *Journal of Public Health Medicine* **24**: 252–4.
- Harzheim E, Duncan BB, Stein AT *et al.* 2006a. Quality and effectiveness of different approaches to primary care delivery in Brazil. *BMC Health Services Research* **6**: 156.
- Harzheim E, Starfield B, Rajmil L, Alvarez-Dardet C, Stein AT. 2006b. Internal consistency and reliability of Primary Care Assessment Tool (PCATool-Brasil) for child health services. *Cadernos de Saúde Pública* **22**: 1649–59.
- Laditka JN, Laditka SB, Probst JC. 2005. More may be better: evidence of a negative relationship between physician supply and hospitalization for ambulatory care sensitive conditions. *Health Services Research* **40**: 1148–66.
- Macinko J, Almeida C, Oliveira SE, de Sá PK. 2004. Organization and delivery of primary health care services in Petropolis, Brazil. *International Journal of Health Planning and Management* **19**: 303–17.
- Macinko J, Guanais FC, de Fátima M, de Souza M. 2006. Evaluation of the impact of the Family Health Program on infant mortality in Brazil, 1990–2002. *Journal of Epidemiology and Community Health* **60**: 13–19.
- Malta DC, Duarte EC, Almeida MF. 2007. Lista de causas de mortes evitáveis por intervenções do Sistema Único de Saúde do Brasil. *Epidemiologia e Serviços de Saúde* **16**: 233–44.
- Mendes EV. 2009. *As Redes de Atenção à Saúde*. Belo Horizonte: Escola de Saúde Pública, Minas Gerais.
- Ministério da Saúde. 2007. *Política Nacional de Atenção Básica*. 4 edition. Série E Legislação de Saúde, Série Pactos pela Saúde 2006, v. 4. Brasília: Ministério da Saúde, Secretaria de Atenção à Saúde, Departamento de Atenção Básica.
- Ministério da Saúde. 2008. Portaria n° 221 de 17 de abril 2008. Publica em forma do anexo a Lista Brasileira de Internações Hospitalares Sensíveis à Atenção Primária. *Diário Oficial da União*. Brasília: Ministério da Saúde.
- Ministério do Planejamento. 2001. *Comissão de Financiamentos Externos – COFLEX n° 580 de 21/06/2001*. Brasília: Ministério do Planejamento.
- Parchman ML, Culler S. 1994. Primary care physicians and avoidable hospitalizations. *Journal of Family Practice* **39**: 123–8.
- Piccini RX, Facchini LA, Tomasi E *et al.* 2006. Necessidades de saúde comuns aos idosos: efetividade na oferta e utilização em atenção básica à saúde. *Ciência & Saúde Coletiva* **11**: 657–67.
- R Development Core Team. 2004. A language and environment for statistical computing. Vienna: R Foundation for Statistical Computing. Online at: <http://www.R-project.org>.
- Rocha R, Soares RR. 2009. Evaluating the Impact of Community-Based Health Interventions: Evidence from Brazil's Family Health Program. *Institute for the Study of Labor (IZA), Discussion Paper n° 4119*.
- Saha S, Solotaroff R, Oster A, Bindman AB. 2007. Are preventable hospitalizations sensitive to changes in access to primary care? The case of the Oregon Health Plan. *Medical Care* **45**: 712–19.
- Shah BR, Gunraj N, Hux JE. 2003. Markers of access to and quality of primary care for aboriginal people in Ontario, Canada. *American Journal of Public Health* **93**: 798–802.
- Starfield B. 2002. *Atenção Primária: Equilíbrio entre Necessidades de Saúde, Serviços e Tecnologia*. Brasília: UNESCO / Ministério da Saúde.
- Turci MA. 2008. *Avanços e desafios na organização da atenção de saúde em Belo Horizonte*. Belo Horizonte: Secretaria Municipal de Saúde/HMP Comunicação.
- Valenzuela Lopez MI, Gaston Morata JL, Melguizo JM, Valenzuela Lopez MM, Bueno CA. 2007. To identify primary care interventions that reduce hospitalisation of people over 65 due to ambulatory care sensitive conditions. *Atencion Primaria* **39**: 525–32.
- Viana AL, Rocha JS, Elias PE, Ibañez N, Novaes MH. 2006. Modelos de Atenção Básica nos grandes municípios paulistas: efetividade, eficácia, sustentabilidade e governabilidade. *Ciência & Saúde Coletiva* **11**: 577–606.
- World Health Organization. 2008. *The World Health Report 2008. Primary Health Care, Now More Than Ever*. Geneva: World Health Organization.