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TITLE

Measuring the impact on the healthcare of a 10-year social programme in Trieste (Italy): a retrospective cohort study.

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ABSTRACT

Objectives

Poor social conditions are strong determinants of poor health but positive health and healthcare changes caused by social interventions are difficult to demonstrate. In Trieste (Italy), in 2006, in eight deprived neighbourhoods, a social intervention known as “Habitat Microaree” (HM) project was started. In 2016, an observational study was launched to assess the impact of the HM project on healthcare.

Design

Retrospective cohort study.

Setting

The Eight geographically defined neighbourhoods of Trieste involved in the HM project in 2006, which accounted for a total of 11,380 residents.

Participants

Participants were all residents in the intervention areas. By means of a propensity score based on deprivation index, age, sex, Charlson index and drug utilization, a non-participating, comparison group was defined.

Intervention

The community-based intervention consisted of facilitating access to social services and outpatient healthcare facilities, coordinating intersectoral public services and specifically planning hospital discharge. These services were not provided in other areas of the city.

Outcome measures

Hospital admissions and Emergency Department access.

Results

We followed 16,256 subjects between 2008 and 2015. Living in microareas was associated with a hazard ratio (HR) for 1st hospital admission, for all causes, of 0.95 (95% CI: 0.91 – 0.99); while the HR for urgent admissions in females was 0.91 (95%CI 0.87 – 0.97). The HR for psychiatric disorders, in females, was 0.39 (95%CI 0.18 – 0.32); in particular, the HR for psychosis was 0.15 (95%CI 0.05 – 0.51). The HR for for acute respiratory diseases in females was 0.44 (95% CI: 0.21 – 0.95). In males, the HR for genitourinary diseases and heart diseases, were 0.65 (95% CI: 0.42 – 1.01) and 0.72 (95% CI: 0.54 – 0.97). Concerning multiple admissions, the odds ratio (OR) in females for fractures was 0.75 (95% CI: 0.57 – 0.97).

Conclusion

In the study period, the effects on healthcare appear evident, especially in females.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- This study involved two wide cohorts for a long follow-period and the use of administrative databases, as a data source, provided a complete picture of subjects' access to health care facilities, diagnosis, therapies and treatments in the study period.
- To our knowledge, this is one of few studies that evaluate the effectiveness of a social intervention in terms of impact on health service.
- Our data derive from the administrative databases through an anonymous identifier, therefore, although not all residents were directly involved by the HM project, for our analysis all residents in the selected microareas were considered as participants in the HM project.

- Between 2009 and 2012 the HM project was extended to three other microareas and, therefore, among whom we considered not participants, there were residents who were actually involved by the intervention.
- Our results suggest that the HM project was more effective among females this represents a limit in terms of results generalizability.

ARTICLE

Introduction

Material deprivation is an outcome-based measure of material well-being, the material deprivation rate is an indicator in the European Union statistics on income, and living conditions (EU-SILC), adopted by the Social Protection Committee and used by the European Commission to set targets for the Member States. [1-2] Indeed, there is mounting evidence of an association between material deprivation and poor health conditions, regarding particularly chronic diseases which risk increases over life course. [3] A Spanish nationwide small area study aimed to investigate the excess of mortality, by first 10 leading causes, associated to deprivation indexes, found that the higher the deprivation levels the higher the mortality risks, although this relation varied by gender and region. According to the authors, these findings support the idea that material deprivation causes health inequality through two mechanisms: by increasing the general susceptibility to diseases that lead to an excess of mortality for a wide range of causes; and through a set of more specific factors that lead to an excess of mortality for gender-specific causes. [4,5]

Furthermore, it has been showed that there is an increasing trend in annual access to emergency and urgent care in developed countries.[6] Studies from the United States, Canada, the United Kingdom, and Australia consistently reported demand for emergency department (ED) care increased from 3% to 6% per year. Between 1996

and 2006, in the United States, accesses to ED rose up from 34.1% to 40.5% while in United Kingdome demand has more than doubled from 6.8 million ED accesses in 1966 to 14.3 million in 2012. [7-10] However, according to the available studies, this phenomenon is attributable mainly to people with primary care problems who improperly use emergency and urgent care services to access care. Relevant proportions of patients, ranging from 10% to 60%, could be managed using services with lower and more appropriated care and more accessible primary care may reduce unplanned secondary care use. [6, 11] Material deprivation is one of the factors that affect the way health services are used; in a population-based cohort study, Brokamp et al. [12] found that a 10% increase in the deprivation level caused a 1.03-fold increase (95% CI 1.03-1.04) in hospitalization length of stay and 1.02-fold increase (95% CI: 1.01-1.04) in risk for hospital utilization.

Despite the magnitude of the evidence on the social determinant of health, very few large community interventions have been conducted worldwide. A comprehensive approach to these issues, along with mental and paediatric health, have been the landmark health initiatives conducted in Trieste in the past 50 years. [13-15] Trieste lies at the extreme northeast of Italy, close to the borders with Austria and Slovenia. The area is mostly urban (inhabitants: 234,493; area: 212 km^2; density: 1,107/km^2; age over70: 22.2%; foreign nationality: 10% in 2019). [16] The city has been and still is rich in contrasts and it owes an important proportion of its affluence to the port that brought over the centuries a rich tradition of multilingualism and multiculturalism, although concurrently social inequalities in the physical and social environment and in health. In particular, in the beginning of the new millennium, the increase in population aging, prevalence of chronic conditions and polypharmacy, and inequalities in risk factor distribution and welfare reliance, including public housing, impacted in uncontrolled access to care that was explained more by social determinants and unorganized medical supply than by acute clinical progression

demand. In particular, there are well defined neighbourhoods of Trieste, known as "Microaree", with 500 up to 2500 inhabitants characterized by high prevalence of social housing, economic and social hardship and a poor environment.

To improve the health status and the social capital of these deprived communities, in 2006, the health authorities together with the voluntary sector, the public social housing and citizens started in eight "Microaree" a proactive joint intervention program called "Habitat Microaree" (HM). The HM project started on 1 January 2006 in eight "Microaree", which accounted for a total of 11,380 residents. The project was set to act at the individual level, by helping the access to health facilities, social services and also improving the coordination of different services; and at the community level, supporting hospital discharges. The HM project was designed as a joint intervention set in people's life contexts and planned to act on multiple levels, health, social and housing, through a paradigm shift: services no longer as a set of a-priori defined activities, but co-built with people in order to engage them. To achieve this goal, eight multi-professional teams were set up, one for each microrarea, consisting of experts of care pathways from the local health district, social workers from Trieste municipality and agents from social housing agency. More details about the HM project are reported elsewhere. [17]

To evaluate the effectiveness of this community based social intervention, in 2016, the University of Udine started a retrospective cohort study to measure the impact on the local health service. At the same time, in a coordinated way, the University of Turin began the analysis of the social capital generated by the intervention and the relationship with the health status. Here we presents the results of the retrospective cohort study.

Methods

The study cohort and the associated variables of interest were extracted through record linkage with the administrative databases of the Regional Repository of MicroData (RRMD) of Friuli Venezia Giulia region, using an anonymous identifier. The general population was made up by subjects who had lived in Trieste continuously in the four years preceding 2006. Based on the address of each subject on 1 January 2006, the general population was categorized as: 1) 'resident in a microarea (M)' and therefore, for the study purposes, considered as participant in the HM project; 2) 'not resident in a microarea (NM)' and considered as not participant. In order to make the two groups comparable, each M subject was matched with a NM subject through propensity score [18, 19]. We used the Nearest Neighbour Matching method with a greedy algorithm without replacement. [20-22] The matching variables were: sex, the 2001 deprivation index by Caranci, [23] age at 1 January 2006, the Charlson index [24] constructed using hospital admissions in the four years preceding 01/01/2006, use of selected drugs in the year prior to 1 January 2006, identified according to the Anatomical Therapeutic Chemical classification system (ATC). [25] We considered hypertension drugs (ATC: 'C02', 'C03', 'C04', 'C07', 'C08'), diabetes drugs (ATC: 'A10A', 'A10B', 'A10X') and ulcer drugs (ATC: from 'A02BC01' to 'A02BC05', 'A02BA', 'A02AA', 'A02AB', 'A02AC', 'A02AD', 'A02AF', 'A02AG', 'A02AH', 'A02AX', 'A02X', from 'A02BD01' to 'A02BD07', 'A02BB', 'A02BX'). At the end of the matching process we obtained 2 cohorts: the Microarea Cohort (MC) and the Not Microarea Cohort (NMC). Trying to maximize differences between these two cohorts, we focused our analysis only on stable residents, and thus we excluded individuals who alternated periods living in a microarea with periods living in a non-microarea, and, furthermore, we considered the first two years as latency time. The follow up of the resulting cohorts lasted, therefore, from 1 January 2008 to 31 December 2015.

The study outcomes were 1st admission in a regional hospital, 1st admission to a local Emergency Department (ED), multiple admissions to a regional hospital and to a local

ED, during the follow-up period. The 1st admission in a regional hospital was identified as the earliest hospital admission for all causes, for each International Classification of Diseases 9th edition (ICD9-CM) diagnosis blocks, and for each specific diagnosis (ICD9-CM defined), during the study period. The date of admission was defined as 'index date' and each comorbidity was identified.The 1st admission to the ED was defined as the earliest ED admission for all causes occurring during the follow-up period, with date of admission as 'index date'.

Admissions in regional hospitals were stratified in two groups: Ordinary (Planned+Day hospital) and Urgent, while ED admissions were analysed according to triage priority codes: white (not urgent conditions), green (minor injuries or illnesses), yellow (potentially life threating conditions) and red (life threating conditions) codes. In our analysis we accounted also for multiple hospital admissions and for multiple ED admissions. Multiple admissions were defined as more admissions of the same patient in the study period. We categorised multiple admissions in three classes: 0 admissions, 1 admission, ≥2 admissions.

Participants and not participants in the HM project intervention were compared in terms of 1st hospital admission and 1st access to ED, using Cox regression models. Person-time was calculated as difference between index date and beginning of follow-up. Multiple hospital admissions and ED accesses were analysed using ordered logistic regression models setting as reference the 0-category. All models were adjusted by age at the start of follow-up, by Charlson index and by the 2001 deprivation index, and stratified by sex. The statistical software used for the analysis was the SAS software, Version 9.4 (SAS Institute Inc., Cary, NC, USA). This study was conducted in accordance with the 1964 Helsinki declaration and its later amendment.

Patient and Public Involvement statement

Anonymised patient data, from administrative databases, were used in this study; neither patients nor the public were personally involved.

Ethics approval

This study did not require ethical approval since data were extracted from the administrative databases of the Regional Repository of MicroData by using an anonymous identifier.

Results

Subjects belonging to the MC, at the enrolment, were 10,588 and a corresponding number of matching subject from the NMC was found. The steady residents at the beginning of the follow-up period were a total of 16,256 (Table 1).

Table 1. Steady residents in Microarea cohort (MC) and Not Microarea cohort (NMC)

	MC cohort (n. 6963)		**NMC cohort** (n. 9293)	
	Females	**Males**	**Females**	**Males**
n. (%)	3793 (54.5%)	3170 (45.5%)	5020 (54.0%)	4273 (46.0%)
Mean age (sd)	57.7 (19.7)	53.6 (19.8)	54.5 (22.3)	50.3 (20.6)

The total amount of the follow-up time was equal to 80325.19 years, while the mean value was 4.90 years (median=5.5 years; Q1=1.9 years; Q3=8 years). The Hazard Ratio (HR) that compares MC with NMC for 1st hospital admission for all causes was 0.95 (95%CI 0.91 – 0.99) while HRs for planned and urgent 1st admissions were, respectively, 0.97 (95%CI 0.91 – 1.02) and 0.95 (95%CI 0.90 – 1.01) (Figure 1). Stratifying by gender, while in MC and NMC males hazards for 1st admissions seemed to be fairly the same, in females the HR for 1st planned admission was 0.95 (95%CI 0.88 – 1.02) and for urgent admission was 0.91 (95%CI 0.87 – 0.97) (fig. 2). When the analysis focused on specific causes of hospitalization, i.e., by ICD9-CM diagnosis blocks, the HR of 1st urgent admission for mental disorders in females was 0.39 (95%CI 0.18 – 0.82). Instead, an increased, albeit not statistically significant, HR for planned

admissions for mental disorders was also seen [HR 1.51 (95%CI 0.76 – 2.96)] (Figure 3). Again in females the HR for 1st urgent hospitalization caused by diseases of the genitourinary system was 0.74 (95%CI 0.49 – 1.11), whereas for planned admissions the HR was 1.03 (95%CI 0.82 – 1.31). Analysis regarding hospitalizations for diseases of the circulatory system and respiratory system showed a different pattern: HRs for circulatory system diseases were 1.15 (95%CI 0.98 – 1.35) for urgent hospitalization and 0.91 (95%CI 0.70 – 1.81) for planned admissions. HRs for respiratory system diseases were 0.95 (95%CI 0.74 – 1.21) for urgent and 0.63 (95%CI 0.42 – 0.94) for planned hospitalizations, respectively.

In males, the most relevant results refer to hospitalizations for diseases of the genitourinary system with the HR for 1st urgent admissions equal to 0.65 (95%CI 0.42 – 1.01) and for diseases of the circulatory system with the HR for 1st urgent hospitalization equal to 0.91 (IC95% 0.77 – 1.08) and for planned admissions equal to 1.37 (95%CI 1.08 – 1.74) (fig. 4).

Focusing on specific diagnosis, some relevant results emerged: in females, the HR for 1st urgent admission for psychosis (n.27; ICD9-CM 290-299) was equal to 0.15 (95%CI 0.05 – 0.51) while for acute respiratory infections (n.34; ICD9-CM 460-466) was 0.44 (95%CI 0.21 – 0.95). In males, the HR for 1st urgent admission for psychoses (n.21) was equal to 0.49 (95%CI 0.19 – 1.27), for other forms of heart disease (n. 197; ICD9-CM 420-429) was 0.72 (95%CI 0.54 – 0.97).

For what concerns multiple admissions for all causes (Table 2),

Table 2. Frequency distribution of all multiple hospital admissions (urgent+planned) by cohort and gender

MULTIPLE ADMISSIONS	COHORT	SEX	FREQ	%
≥ 2 admissions	MICROAREA	F	1318	23.9
		M	1103	20.0
	NOT MICROAREA	F	1732	31.4
		M	1357	24.6

in females, the Odds Ratio (OR) was 0.93 (95% 0.89 – 0.98); in males was 0.98 (95%CI 0.93 – 1.03). For urgent hospitalizations (Table 3)

Table 3. Frequency distribution of multiple urgent hospital admissions by cohort and gender

MULTIPLE ADMISSIONS	COHORT	SEX	FREQ	%
≥ 2 admissions	MICROAREA	F	681	23.7
		M	607	21.2
	NOT MICROAREA	F	886	30.9
		M	695	24.2

in females, the OR was 0.95 (95%CI 0.90 – 1.00); in males it was 1.03 (95%CI 0.96 – 1.09). Particularly relevant resulted the OR for multiple urgent admissions for fractures (ICD9-CM 800-829), in females, that was equal to 0.75 (95%CI 0.58 – 0.97). Analysing hazards for 1st access to ED, a slight reduction emerged for white codes, both in females and in males; the HRs were respectively 0.97 (95%CI 0.89 – 1.05) and 0.94 (95%CI 0.86 – 1.03). This reduction was found also for green codes but only in females: HR 0.94 (95%CI 0.87-1.00). For other priority codes, no risk differences emerged (data not shown). For what concerns multiple accesses to ED, again a minor reduction emerged for white codes, both in females and in males, the ORs were respectively equal to 0.97 (95%CI 0.91 – 1.02) and 0.97 (95%CI 0.92 – 1.03) and for green codes only in females results showed a risk reduction: OR 0.95 (95%CI: 0.91-1.00). No further significant results emerged for other priority codes (data not shown).

Discussion

We focused hazards of 1st hospitalization, as main measurable outcomes, under the hypothesis that after the 1st hospital access patients are more likely to be involved in a controlled clinical follow-up and, therefore, the following hospital admissions may not be independent events. Our results show a slight reduction of 1st hospitalization hazard for all causes in MC and for urgent admissions in females, this reduction

appears to be more relevant. Coherently, hazards for 1st access to ED for the lowest priority access code, both in females and in males seem to be slightly decreased for white codes. This reduction was found also for green codes but only in females while for other priority codes, no risk differences emerged. In literature interventions such patient education, needs assessment, telephonic support and follow-up have effectively reduced hospital admissions. [26] A meta-analysis from Panagioti et al. [27] showed that interventions aimed to improve self-management support, reduced health service utilization, with no negative impact on patient health outcomes; robust evidence was found for respiratory and cardiovascular disorders. Coherently with these results, in our study, females belonging to the MC, showed a lower risk for acute respiratory infections, while in males of MC, a lower risk was found for 1st urgent hospitalization due to other forms of heart disease. However, it's for psychosis that we actually found our strongest evidence, particularly in females. The longitudinal SMILE study in the Netherlands (Groffen et al. 2008) [28] showed that those reporting material deprivation had a higher risk of physical and mental dysfunction. Randal et al [29] in a meta-analysis of the effect of early interventions for Psychosis found a positive effect in terms of hospitalization reduction. McFarlane and colleagues, [30] noted that admission rates for psychotic episodes were reduced by a community-wide program of early identification and intervention initiated in 2001.

Beyond the 1st hospitalization, multiple admissions represent a patient safety issue other than a public cost. [26] Socioeconomic status is strongly associated with hospital outcome measures and the available evidence shows that some multifaceted interventions were successful in reducing hospital readmissions. [31] In a randomized control trial, Naylor and colleagues [32] studied the effectiveness of nurse–centered discharge planning and follow-up intervention for subjects at higher risk of readmission, between 1992 and 1996. 24 weeks after hospital discharge, readmission was more frequent in the control group than in the intervention group of patients.

Our results suggest that the HM project was effective in reducing multiple admissions for all causes (Table 2), in females, and particularly for fractures.

For what concern the ED care services, there is an increased demand that affects countries where the population aging leads to individuals with different and more complex care needs. [33] Factors such as lack of access to other care or lack of awareness of available services or diagnostic and therapeutic pathways play a role and explain why demand for these services is persistently increasing. In addition, patients of low socioeconomic status do prefer hospital care, instead of primary care, because hospital cares are perceived as higher quality care and more convenient and accessible. [34] Our results show that during the multifaceted HM project, the hazards of 1st access to ED for white codes slightly decreased, both in females and in males.

Our study presents some limitations: our data derive from the administrative databases through an anonymous identifier, therefore, although not all residents were directly involved by the HM project, for our analysis all residents in the selected microareas were considered as participants in the HM project. This could have introduced a certain degree of misclassification with a likely underestimation of the effectiveness of the intervention. Moreover, between 2009 and 2012 the HM project was extended to three other microareas and, therefore, among whom we considered not participants, there were residents who were actually involved by the intervention. Again this could have contributed to underestimate the effectiveness of the intervention. Our results suggest that the project was more effective among females; according to what multi-professional teams reported, one possible explanation may be that it was easier to involve and females rather than males. However, this represents a limit in terms of results generalizability.

Our study presents also some strengths: it involved two wide cohorts for a long follow-period and the use of administrative databases provided a complete picture of

subjects' access to health care facilities, diagnosis, therapies and procedures done in the study period. To our knowledge, this is one of few studies that evaluate the effectiveness of a social intervention in terms of impact on health service. In our view, this study may represent a starting point for a more comprehensive evaluation aimed to determine the impact of the HM project on the healthcare even in terms of costs, which represent a hot topic since sustainability of the public health service is matter of concern.

Conclusions

Our results show that working on social determinants of health the burden on the health service can be controlled and reduced. There is evidence that during the follow-up period, there was a reduction of 1st urgent hospital admissions in the social intervention area, especially in females and for specific diagnosis such as psychosis. Also multiple admissions in the intervention group were decreased, again mainly in females and for specific diagnosis such as fractures.

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Competing interests declaration

All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: this retrospective cohort study was supported by a fund allocated by the local health authority of Trieste "Azienda Sanitaria Universitaria Integrata di Trieste" on 31st August 2016 (CUP E97B16000340002); no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

Contributors

LC, FB, MGCD and FP conceived, designed and coordinated the study. MS, EA CE and FP collected data. MG, LC, VR defined the statistical analysis plan and performed the analysis. LC, MG, FB, MGCD and FP interpreted the results. LC and MG drafted the paper. FB, MGCD, MS, EA CE, FP and VR critically revised the manuscript.

Transparency statement

All authors declare that this manuscript is an honest, accurate, and transparent account of the study being reported; no relevant aspects of the study have been omitted. The study has been conduct as it was planned, with no relevant discrepancies.

Role of the funding source

This retrospective cohort study was supported by a fund allocated by the local health authority of Trieste "Azienda Sanitaria Universitaria Integrata di Trieste" on 31st August 2016 (CUP E97B16000340002) through an *ad hoc* agreement with the University of Udine. Researchers acted independently from the funder and all authors had full access to all data (including statistical reports and tables) in the study and can take responsibility for the integrity of the data and the accuracy of the data analysis.

Data sharing statement

All data relevant to the study are included in the article. No additional data available.

Dissemination declaration

The results of this retrospective cohort study were presented to public healthcare authorities, non-profit organisations, social housing, and citizens, during an *ad hoc* conference held in Trieste on 14 and 15 June 2018.

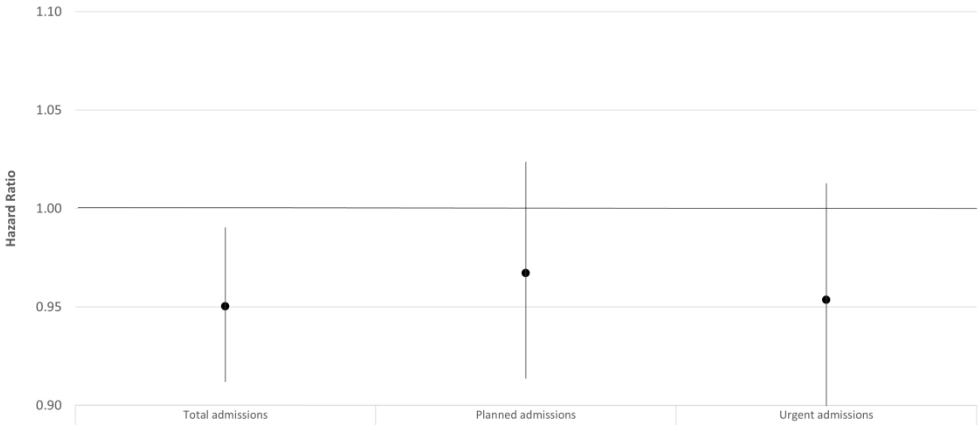
Figure legends

Figure 1. HRs for 1st hospital admission; MC vs NMC. Analysis adjusted for age, Charlson and deprivation indexes

Figure 2. HRs for 1st hospital admission; MC vs NMC by gender. Analysis adjusted for age, Charlson and deprivation indexes

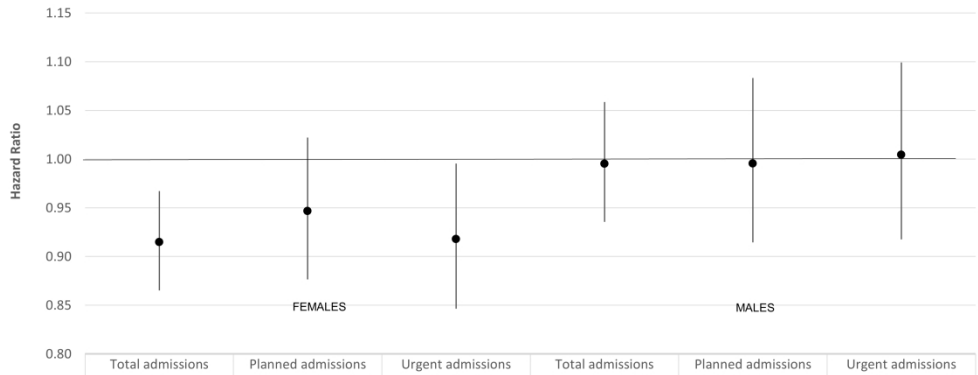
Figure 3. HRs for 1st hospital admission by ICD-9-CM blocks of diagnosis; MC vs NMC (females). Analysis adjusted for age, Charlson and deprivation indexes

Figure 4. HRs for 1st hospital admission by ICD-9-CM blocks of diagnosis; MC vs NMC (males). Analysis adjusted for age, Charlson and deprivation indexes



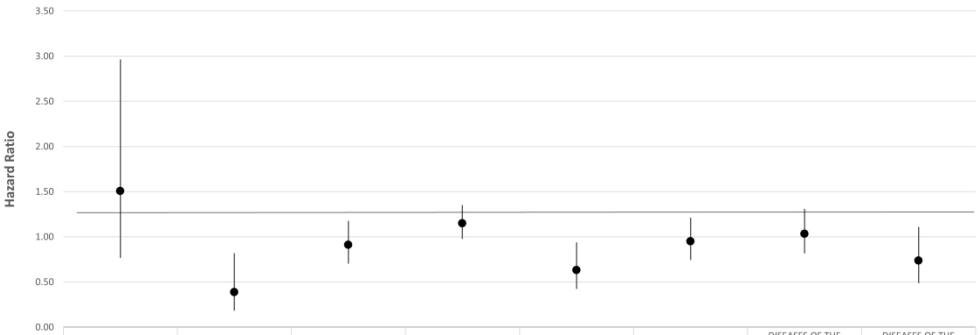
	Total admissions (n. 9237)	Planned admissions (n. 4898)	Urgent admissions (n. 4339)
Hazard Ratio	0.95	0.97	0.95
HRLowerCL	0.91	0.91	0.90
HRUpperCL	0.99	1.02	1.01

338x190mm (300 x 300 DPI)



	Total admissions (n. 5102)	Planned admissions (n. 2691)	Urgent admissions (n. 2411)	Total admissions (n. 4135)	Planned admissions (n. 2207)	Urgent admissions (n. 1928)
Hazard Ratio	0.91	0.95	0.92	1.00	1.00	1.00
HRLowerCL	0.87	0.88	0.85	0.94	0.91	0.92
HRUpperCL	0.97	1.02	1.00	1.06	1.08	1.10

338x190mm (300 x 300 DPI)



	MENTAL DISORDERS (ICD9-CM 290-319) planned (n. 34)	MENTAL DISORDERS (ICD9-CM 290-319) urgent (n. 37)	DISEASES OF THE CIRCULATORY SYSTEM (ICD9-CM 390-459) planned (n. 240)	DISEASES OF THE CIRCULATORY SYSTEM (ICD9-CM 390-459) urgent (n. 593)	DISEASES OF THE RESPIRATORY SYSTEM (ICD9-CM 460-519) planned (n. 112)	DISEASES OF THE RESPIRATORY SYSTEM (ICD9-CM 460-519) urgent (n. 268)	DISEASES OF THE GENITOURINARY SYSTEM (ICD9-CM 580-629) planned (n. 286)	DISEASES OF THE GENITOURINARY SYSTEM (ICD9-CM 580-629) urgent (n. 100)
Hazard Ratio	1.51	0.39	0.91	1.15	0.63	0.95	1.03	0.74
HRLowerCL	0.76	0.18	0.70	0.98	0.42	0.74	0.82	0.49
HRUpperCL	2.96	0.82	1.18	1.35	0.94	1.21	1.31	1.11

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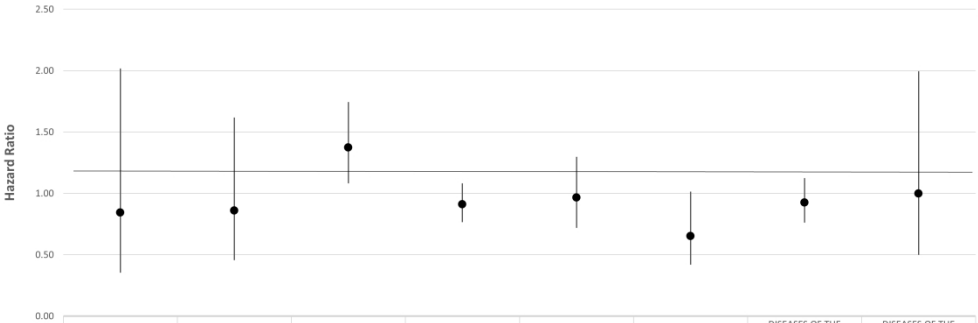

	MENTAL DISORDERS (ICD9-CM 290-319) planned (n. 22)	MENTAL DISORDERS (ICD9-CM 290-319) urgent (n. 40)	DISEASES OF THE CIRCULATORY SYSTEM (ICD9-CM 390-459) planned (n. 272)	DISEASES OF THE CIRCULATORY SYSTEM (ICD9-CM 390-459) urgent (n. 539)	DISEASES OF THE GENITOURINARY SYSTEM (ICD9-CM 580-629) planned (n. 182)	DISEASES OF THE GENITOURINARY SYSTEM (ICD9-CM 580-629) urgent (n. 89)	DISEASES OF THE MUSCULOSKELETAL SYSTEM AND CONNECTIVE TISSUE (ICD9-CM 710-739) planned (n. 420)	DISEASES OF THE MUSCULOSKELETAL SYSTEM AND CONNECTIVE TISSUE (ICD9-CM 710-739) urgent (n. 33)
Hazard Ratio	0.84	0.86	1.37	0.91	0.97	0.65	0.93	1.00
HRLowerCL	0.35	0.46	1.08	0.77	0.72	0.42	0.76	0.50
HRUpperCL	2.02	1.62	1.74	1.08	1.30	1.01	1.12	2.00

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STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract Page 1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found Page 2
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported Page 3
Objectives	3	State specific objectives, including any prespecified hypotheses Pages 5-6
Methods		
Study design	4	Present key elements of study design early in the paper Pages 6-8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection Pages 6-7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up Pages 6-7
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed Page 6 for matching criteria and *Results*, page 8 for number of exposed and unexposed (participants and not participants)
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable Page 7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group Pages 6-8
Bias	9	Describe any efforts to address potential sources of bias Pages 7-8
Study size	10	Explain how the study size was arrived at Page 6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why Pages 7-8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding Pages 7-8
		(*b*) Describe any methods used to examine subgroups and interactions Pages 7-8
		(*c*) Explain how missing data were addressed Not applicable
		(*d*) If applicable, explain how loss to follow-up was addressed Not applicable
		(*e*) Describe any sensitivity analyses Not applicable
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially

		eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed Page 8
		(b) Give reasons for non-participation at each stage Not applicable
		(c) Consider use of a flow diagram Not applicable
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders Not applicable
		(b) Indicate number of participants with missing data for each variable of interest Not applicable
		(c) Summarise follow-up time (eg, average and total amount) Page 8
Outcome data	15*	Report numbers of outcome events or summary measures over time Tables 2 and 3 pages 9 and 10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included See page 8, for list of confounders and Figures 1 to 4 for adjusted estimates and confounders
		(*b*) Report category boundaries when continuous variables were categorized Not applicable
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period Not applicable
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses Not applicable
Discussion		
Key results	18	Summarise key results with reference to study objectives Pages 10-13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias Page 12
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence *Discussion*, pages 12 and *Conclusions*, page 13.
Generalisability	21	Discuss the generalisability (external validity) of the study results Page 12
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based *Role of the funding source*, page 14

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

BMJ Open

Measuring the impact of a social programme on healthcare: A 10-year retrospective cohort study in Trieste, Italy

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Keywords:	PUBLIC HEALTH, EPIDEMIOLOGY, SOCIAL MEDICINE

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TITLE

Measuring the impact of a social programme on healthcare: A 10-year retrospective cohort study in Trieste, Italy

CORRESPONDING AUTHOR

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ABSTRACT

Objectives

Poor social conditions are strong determinants of poor health but positive health and healthcare changes caused by social interventions are difficult to demonstrate. In 2006, in Trieste (Italy), a social intervention known as “Habitat Microaree” (HM) project was implemented in eight deprived neighbourhoods. In 2016, an observational study was launched to assess the impact of the HM project on healthcare.

Design

Retrospective cohort study.

Setting

The eight geographically defined neighbourhoods of Trieste involved in the 2006 HM project, accounting for a total of 11,380 residents.

Participants

Participants were all residents in the intervention areas. By means of a propensity score based on deprivation index, age, sex, Charlson index and drug utilization, a non-participating, comparison group was defined.

Intervention

The community-based intervention consisted of facilitating access to social services and outpatient healthcare facilities, coordinating intersectoral public services and specifically planning hospital discharge. These services were not provided in other areas of the city.

Outcome measures

Hospital admissions and Emergency Department access.

Results

We followed 16,256 subjects between 2008 and 2015. Living in microareas was associated with a hazard ratio (HR) for 1st hospital admission, for all causes, of 0.95 (95% CI: 0.91 – 0.99); while the HR for urgent admissions in females was 0.91 (95%CI 0.87 – 0.97). The HR for psychiatric disorders, in females, was 0.39 (95%CI 0.18 – 0.82); in particular, the HR for psychosis was 0.15 (95%CI 0.05 – 0.51). The HR for acute respiratory diseases in females was 0.44 (95% CI: 0.21 – 0.95). In males, the HR for genitourinary diseases and heart diseases, were 0.65 (95% CI: 0.42 – 1.01) and 0.72 (95% CI: 0.54 – 0.97), respectively. Concerning multiple admissions, the odds ratio (OR) for fractures in females was 0.75 (95% CI: 0.57 – 0.97).

Conclusion

In the study period, the effects on healthcare appear evident, especially in females.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- This study involved a large cohort for a long follow-period and the use of administrative databases as a data source, provided a complete picture of the

subjects' access to health care facilities, diagnoses, therapies and treatments in the study period.

- To our knowledge, this is one of few studies that evaluate the effectiveness of a social intervention in terms of impact on health service.
- Our data derive from the administrative databases through an anonymous identifier, therefore, although not all residents were directly involved in the HM project, in our analysis all residents in the selected microareas were considered as participants in the HM project.
- Between 2009 and 2012 the HM project was extended to a further three microareas. Therefore, a number of residents initially considered as non-participants, were subsequently involved in the intervention.
- Our results suggest that the HM project was more effective among females. This represents a limitation to the generalizability of the results.

ARTICLE

Introduction

Material deprivation is an outcome-based measure of material well-being and material deprivation rate is an indicator in the European Union statistics on income, and living conditions (EU-SILC), adopted by the Social Protection Committee and used by the European Commission to set targets for the Member States. [1-2] Townsend considered the material deprivation as the "inability of living a decent life". [3] He stated "People can be said to be deprived if they lack the types of diet, clothing, housing, environmental, educational, working and social conditions, activities and facilities which are customary, or at least widely encouraged or approved, in the societies to which they belong. They fall below standards of living which either can be shown to be widespread in fact or are socially accepted or institutionalized". [4] Sen,

in 1983, agreed with Townsend on the concepts of “shame” and “inability to live a decent life with dignity” to explain the concept of material deprivation. [5] To date, authors converge towards a definition of material deprivation as “exclusion from the minimum acceptable way of life in one’s own society because of inadequate resources” [6,7,8,9,10,11] or “the lack of socially perceived necessities”. [7,12] Indeed, there is mounting evidence of an association between material deprivation and poor health conditions, in particularly with regards to chronic diseases whose risk increases over the life course. [13] A Spanish nationwide small area study aimed to investigate the excess of mortality by first 10 leading causes associated to deprivation indexes, found that the higher the deprivation levels the higher the mortality risks, although this relation varied by gender and region. According to the authors, these findings support the idea that material deprivation causes health inequality through two mechanisms: by increasing the general susceptibility to diseases that lead to an excess of mortality for a wide range of causes; and through a set of more specific factors that lead to an excess of mortality for gender-specific causes. [14,15]

Furthermore, it has been shown that there is an increasing trend in annual access to emergency and urgent care in developed countries.[16] Studies from the United States, Canada, the United Kingdom, and Australia consistently reported demand for emergency department (ED) care increased from 3% to 6% per year. Between 1996 and 2006, in the United States, accesses to ED rose from 34.1% to 40.5% while in United Kingdom demand has more than doubled from 6.8 million ED accesses in 1966 to 14.3 million in 2012. [17-20] However, according to the available studies, this phenomenon is attributable mainly to people with primary care problems who make improper use of emergency and urgent care services to access care. Relevant proportions of patients, ranging from 10% to 60%, could be managed using services with lower and more appropriate care, and more accessible primary care could reduce unplanned secondary care use. [16, 21] Material deprivation is one of the

factors that affect the way health services are used; in a population-based cohort study, Brokamp et al. [22] found that a 10% increase in deprivation level caused a 1.03-fold increase (95% CI 1.03-1.04) in length of hospital stay and a 1.02-fold increase (95% CI: 1.01-1.04) in risk of hospital utilization. Raphael [23] gave the definition of social determinants of health as "economic and social conditions that shape the health of individuals, communities and jurisdictions as a whole". Gender, education, income, housing, employment and access to healthcare shown an association with ill health.

Strong associations between social determinants and several health outcomes in different populations have been well documented as reported in Braveman et al..[24] Collaboration between public health workers and clinicians, developing health-promotion strategies, can improve the health outcomes for socially disadvantaged populations and can add more understanding of the mechanisms by which social determinants influence health. [25,26]

Despite the compelling evidence on the social determinant of health, very few large community interventions have been conducted worldwide. The landmark health initiatives conducted in Trieste over the past 50 years, afford a comprehensive approach to these issues, along with mental and paediatric health. [27-29] Trieste lies at the extreme northeast of Italy, close to the borders with Austria and Slovenia. The area is mostly urban (inhabitants: 234,493; area: 212 km^2; density: 1,107/km^2; foreign nationality: 10% in 2019). [30]

In the last census conducted in Italy by the National Institute of Statistics in 2011, 27.6% of people residing in Trieste were over 65 years of age (vs 20.5% in Italy) and life expectancy at birth was 79 years for males and 83.6 years for females (vs 79.5 for males and 84.4 for females in Italy). In Trieste, the mortality rate for all causes was 14.5 per 1000 inhabitants (vs 10.0 per 1000 inhabitants in Italy) and the birth rate was 7.3 per 1000 inhabitants (vs 9.2 per 1000 inhabitants in Italy). Fifty percent of the

population was not in the labour force (vs 49.2 in Italy) and 4.7% were looking for a job (vs 5.8% in Italy); 52.7% of residents in Trieste had a low education level (vs 58.7% in Italy), 32.0% had a high school diploma (vs 30.2% in Italy) and 16.3% had a university degree or higher (vs 11.5% in Italy). [30]

The city has been, and still is, rich in contrasts and owes much of its centuries-old tradition of multilingualism and multiculturalism to its role as a port which, however, has also brought inequalities in the physical and social milieu and in health. In particular, at the beginning of the new millennium, an increase in population aging, a prevalence of chronic conditions and polypharmacy, and inequalities in the distribution of risk factors and welfare reliance, including public housing, resulted in uncontrolled access to care explainable more in terms of social determinants and uncoordinated provision of medical care than of acute clinical progression demand. In particular, in Trieste, there are well defined neighbourhoods known as “Microaree”, with 500 up to 2500 inhabitants, characterized by a high prevalence of social housing, economic and social hardship and poor environment quality.

To improve the health status and the social capital of these deprived communities, in 2006, the local health authorities, in conjunction with the voluntary and public social housing sectors and private citizens, implemeted a proactive joint intervention program called “Habitat Microaree” (HM). The HM project started on 1 January 2006 in eight “Microaree” and was designed to act both at the individual level, ensuring proper access to health facilities and social services, as well as improving the coordination of services; and at the community level, supporting hospital discharges. The HM project was conceived as a joint intervention delivered in people's life setting and designed to act on multiple levels, health, social and housing, through a paradigm shift: services no longer as a set of a-priori defined activities, but co-produced with people in order to engage them. [31]

In 2016, the University of Udine set up a retrospective cohort study to evaluate the effectiveness of this community-based social intervention, in terms of reduction of urgent admissions to both hospital and the emergency department, comparing subjects who lived in the microarea with subjects who lived in the neighbouring non-microarea quarters of Trieste. In conjunction and in coordination with this study, the University of Turin worked on the analysis of the social capital generated by the intervention in relation to the health status. Here we present the results of the retrospective cohort study.

Methods

The HM project started on 1 January 2006 in eight "Microaree" of Trieste accounting for a total of 11,380 residents. Eight multi-professional teams were set up, one for each microarea, consisting of experts in continuum of care from the local health district, social workers from the municipality of Trieste and agents from the social housing agency. [31] The HM activities to support the health and rights of citizens were linked to 4 intervention areas: (a) assessment of the priority health problems of the people residing in each microarea; (b) optimization of interventions in support of home healthcare to prevent institutionalization and improper hospitalization; (c) promotion of collaboration between different institutions providing services to the same individual and on the same territory, through the active participation of the inhabitants; and (d) fostering an active and participatory community. The close interrelationship and interdependence between socio-economic factors, individual behaviours, the context of life and health make the reality of the Microaree extremely difficult to represent by classifying activities univocally in relation to specific objectives and areas of intervention. Table 1 shows some examples of the interventions delivered in the eight "Microaree" of Trieste.

Table 1. Some Examples of the interventions of HM project

Aim	Purpose	Activity areas (examples)	Target
Activities mainly aimed at **health** promotion, focusing primarily on health determinants.	**Fostering the exercise of the right to citizenship**	Providing orientation, assistance and support to families and individuals for access to health and social services and the fulfilment of procedures related to housing, employment and income support (simplify access to Offices and Agencies, Project In-town help desk, work placement grants, community service or socially useful work).	Adults, elderly, disabled, community
	Contributing to the respect of children's right to education	Accompaniment to school. School support also for children with Special educational needs (SENs), Learning disabilities (LDs), (strengthen engagement with teachers and school institutions, after-school childcare services).	Children
	Developing community empowerment: **Fostering inter-generational and inter-ethnic knowledge and coexistence/integration**	Organization of recreational and cultural group, community and inter-generational activities (libraries, reading and poetry; shows and movies; singing and music; old-fashioned and new games; excursions, exhibitions; parties and special events; language courses, courses on computer and cell phone use, arts and crafts courses; etc.).	Children, adults, elderly, disabled, community
		(Involvement of asylum seekers and refugees in MA activities, as part of the convention with the ICS)	Adults
	Optimizing the use of collective resources	Collection and distribution of unsold food items (food bank). Collection, maintenance, and distribution of toys, clothes, furniture, appliances, home devices (flea markets, charity shops) and other materials.	Community
		Courses on how to re-use and recycle materials.	Children, adults, elderly, disabled
Activities mainly aimed at **primary prevention** to reduce the occurrence of diseases and injuries.	**Combating isolation and loneliness**	Ensure accessibility of Microarea offices and/or other community spaces for group and community activities. Home visits and individual meetings.	Children, adults, elderly, disabled
		Self-help groups (anxiety, violence, etc.).	Adults, elderly, disabled

	Promoting the adoption of sustainable healthy lifestyles and encouraging socialization	Organize meetings and classes to discuss issues related to lifestyles and **health risk factors**, also in collaboration with other local authority agencies, such as the Department of Prevention, Mental Health and Addiction Services and Voluntary Associations (AA, Hiperyon, etc.). Offer opportunities for intergenerational **recreational**, **physical and sport activities** (play and sport for children and teenagers, light exercise, dancing, walks, *Group on the move* project, self-defence courses,etc.). Cooking courses. Care of the community garden. Preparation and consumption of meals (social breakfasts and lunches).	Children, adults, elderly, disabled, community
	Supporting vaccination campaigns	Raise the awareness of individuals, families and the community, also by organizing dedicated meetings.	Children, adults, elderly, disabled, community
Activities primarily aimed at **secondary prevention** for early detection of diseases.	**Improving access to regional screenings**	Raise the awareness of individuals and the community, also by organizing dedicated meetings.	Adults, elderly, disabled, community
Activities mainly aimed at **tertiary prevention** to avoid the onset of complications or relapses following an illeness and/or at **quaternary prevention** to avoid the effects of hyper-medicalization.	**Promoting home-care for vulnerable people, avoiding institutionalization**	Provision of support and assistance to carry out day to day activites at home and outside home. Promote assisted cohousing and the development of supportive housing solutions. Provide information, orientation and support to Care Givers (Alzheimer group…).	Adults, elderly, disabled
	Promoting home-care for vulnerable people, avoiding institutionalization	Provision of support and assistance to carry out day to day activites at home and outside home. Promote assisted cohousing and the development of supportive housing solutions. Provide information, orientation and support to Care Givers (Alzheimer group…).	Adults, elderly, disabled

Source: "Il programma Habitat Microaree Trieste. Linee di indirizzo progettuali e operative. Available from: https://www.disuguaglianzedisalute.it/wp-content/uploads/2019/10/01allegato-2018_ASUITS_Linee-di-indirizzo-HM.pdf"

The study cohort and the associated variables of interest were extracted through record linkage with the administrative databases of the Regional Repository of MicroData (RRMD) of the Friuli Venezia Giulia region, using an anonymous identifier. The general population was made up by subjects who had lived in Trieste continuously in the four years preceding 2006. Based on the address of each subject on 1 January 2006, the general population was categorized as: 1) 'resident in a microarea (M)' 2) 'non resident in a microarea (NM)'. In order to make the two groups comparable, each M subject was matched with a NM subject through propensity score [32, 33]. We used the Nearest Neighbour Matching method with a greedy algorithm without replacement. [34-36] The matching variables were: sex, the 2001 deprivation index by Caranci, [37] age on 1 January 2006, the Charlson index [38] constructed using hospital admissions in the four years preceding 1 January 2006, use of selected drugs in the year prior to 1 January 2006, identified according to the Anatomical Therapeutic Chemical classification system (ATC). [39] The Caranci deprivation index is an estimate obtained by summing the standardized indicators of five traits, low level of education, unemployment, non-home ownership, one parent family and overcrowding, that operationally combined represent the multidimensionality of the social and material concept of deprivation.[37] The deprivation index by Caranci is available for each census block level in Italy. In our study, the categorized deprivation Caranci index was assigned based on the census block level of the subject's residence. The Charlson index predicts the mortality risk of a patient who has had one or more hospital admissions for a range of comorbid conditions in a defined time period. For each identified comorbid condition a score is assigned, that depends on the risk of dying from that condition. [38] We considered hypertension drugs (ATC: 'C02', 'C03', 'C04', 'C07', 'C08'), diabetes drugs (ATC: 'A10A', 'A10B', 'A10X') and ulcer drugs (ATC: from 'A02BC01' to 'A02BC05', 'A02BA', 'A02AA', 'A02AB', 'A02AC', 'A02AD', 'A02AF', 'A02AG', 'A02AH', 'A02AX', 'A02X', from

'A02BD01' to 'A02BD07', 'A02BB', 'A02BX'). We matched five 'non microarea' subjects to each 'microarea' subject by propensity score. Out of the five 'non microarea' subjects, we selected the one whose residence was closer to the residence of the matched 'microarea' subject.

At the end of the matching process we obtained a cohort in which we considered as 'participant' to HM program the subjects who lived in a microarea continuously during the follow-up period (MP), and as 'non participant' to HM program the subjects who lived in a non-microarea for any length of time during the follow-up period (NMP). In order to maximize the differences between the participants to HM and the non-participants to HM, we focused our analysis only on stable residents, thus excluding individuals who alternated periods living in a microarea with periods living in a non-microarea. Furthermore, we considered the first two years as latency time. The follow up of the resulting cohort, therefore, lasted from 1 January 2008 to 31 December 2015.

The study outcomes were 1st admission to a regional hospital, 1st admission to a local Emergency Department (ED), multiple admissions to a regional hospital and to a local ED, during the follow-up period. The 1st admission to a regional hospital was identified as the earliest hospital admission for all causes, for each International Classification of Diseases 9th edition (ICD9-CM) diagnosis class, and for each specific diagnosis (ICD9-CM defined), during the study period. The date of the admission was defined as the 'index date' and each comorbidity was identified. The 1st admission to the ED was defined as the earliest ED admission for all causes occurring during the follow-up period, with the date of admission as the 'index date'.

Admissions to regional hospitals were stratified in two groups: Ordinary (Planned+Day hospital) and Urgent, while ED admissions were analysed according to triage priority codes: white (non-urgent conditions), green (minor injuries or illnesses), yellow (potentially life threating conditions) and red (life threating

conditions). In the analysis we also accounted for multiple hospital admissions and for multiple ED admissions. Multiple admissions were defined as repeated admissions of the same patient during the study period. We categorised multiple admissions in three classes: 0 admissions, 1 admission, ≥2 admissions.

Participants and non-participants in the HM project intervention were compared in terms of 1st hospital admission and 1st access to ED, using Cox regression models. Person-time was calculated as difference between index date and beginning of follow-up. Multiple hospital admissions and ED accesses were analysed using ordered logistic regression models setting as reference the 0-category. All models were adjusted by age at the start of follow-up, by Charlson index and by the Caranci 2001 deprivation index, and stratified by sex. The statistical software used for the analysis was the SAS software, Version 9.4 (SAS Institute Inc., Cary, NC, USA). This study was conducted in accordance with the 1964 Helsinki declaration and its later amendments.

Patient and Public Involvement statement

Anonymised patient data, from administrative databases, were used in this study; neither the patients nor the public were personally involved.

Ethics approval

This study did not require ethical approval since data were extracted from the administrative databases of the Regional Repository of MicroData using an anonymous identifier.

Results

At enrolment, the MP subjects were 10,588, and a corresponding number of matched NMP subjects was identified. The stable residents at the beginning of the follow-up period were a total of 16,256 (Table 2).

Table 2. Microarea partecipant (MP) and Non Microarea participant (NMP) stable residents

	MP (n. 6963)		**NMP** (n. 9293)	
	Females	**Males**	**Females**	**Males**
n. (%)	3793 (54.5%)	3170 (45.5%)	5020 (54.0%)	4273 (46.0%)
Mean age (sd)	57.7 (19.7)	53.6 (19.8)	54.5 (22.3)	50.3 (20.6)

The total follow-up time was 80325.19 years, with mean value equal to 4.90 years (median=5.5 years; Q1=1.9 years; Q3=8 years). The Hazard Ratio (HR) that compares MP and NMP for 1st hospital admission for all causes was 0.95 (95%CI 0.91 – 0.99) while HRs for planned and urgent 1st admissions were, respectively, 0.97 (95%CI 0.91 – 1.02) and 0.95 (95%CI 0.90 – 1.01) (Figure 1). Stratifying by gender, while in males, MP and NMP hazards for 1st admissions seemed to be broadly the same, in females the HR for 1st planned admission was 0.95 (95%CI 0.88 – 1.02) and for urgent admission was 0.91 (95%CI 0.87 – 0.97) (Figure 2). When the analysis focused on the specific causes of hospitalization, i.e., by ICD9-CM diagnosis blocks, the HR of 1st urgent admission for mental disorders in females was 0.39 (95%CI 0.18 – 0.82).An increased, albeit not statistically significant, HR for planned admissions for mental disorders was also observed [HR 1.51 (95%CI 0.76 – 2.96)] (Figure 3). Again in females, the HR for 1st urgent hospitalization caused by diseases of the genitourinary system was 0.74 (95%CI 0.49 – 1.11), whereas for planned admissions the HR was 1.03 (95%CI 0.82 – 1.31). Analysis of data on hospitalization for diseases of the circulatory and respiratory systems showed a different pattern: HRs for circulatory system diseases were 1.15 (95%CI 0.98 – 1.35) for urgent hospitalization, and 0.91 (95%CI 0.70 – 1.81) for planned admissions. HRs for respiratory system diseases were 0.95 (95%CI 0.74 – 1.21) for urgent and 0.63 (95%CI 0.42 – 0.94) for planned hospitalizations, respectively.

In males, the most relevant results concerns hospitalization for diseases of the genitourinary system, with HR for 1st urgent admissions equal to 0.65 (95%CI 0.42 –

1.01), and for diseases of the circulatory system, with HR equal to 0.91 (IC95% 0.77 – 1.08) for 1st urgent hospitalization and 1.37 (95%CI 1.08 – 1.74) for planned admissions (Figure 4).

Focusing on the specific diagnoses, some relevant results emerged: in females, the HR for 1st urgent admission for psychosis (n.27; ICD9-CM 290-299) was equal to 0.15 (95%CI 0.05 – 0.51), while for acute respiratory infections (n.34; ICD9-CM 460-466) HR was 0.44 (95%CI 0.21 – 0.95). In males, the HR for 1st urgent admission for psychoses (n.21) was 0.49 (95%CI 0.19 – 1.27), and for other forms of heart disease (n. 197; ICD9-CM 420-429) 0.72 (95%CI 0.54 – 0.97). Regarding multiple admissions for all causes (Table 3), the Odds Ratio (OR) was 0.93 (95% 0.89 – 0.98) in females and 0.98 (95%CI 0.93 – 1.03) in males.

Table 3. Frequency distribution of all multiple hospital admissions (urgent+planned) by type of partecipant and gender

MULTIPLE ADMISSIONS	PARTECIPANT	SEX	FREQ	%
≥ 2 admissions	MICROAREA	F	1318	23.9
		M	1103	20.0
	NOT MICROAREA	F	1732	31.4
		M	1357	24.6

For urgent hospitalizations (Table 4), the OR was 0.95 (95%CI 0.90 – 1.00) in females and 1.03 (95%CI 0.96 – 1.09) in males.

Table 4. Frequency distribution of multiple urgent hospital admissions by type of partecipant and gender

MULTIPLE ADMISSIONS	PARTECIPANT	SEX	FREQ	%
≥ 2 admissions	MICROAREA	F	681	23.7
		M	607	21.2
	NOT MICROAREA	F	886	30.9
		M	695	24.2

Of particular relevance was the OR for multiple urgent admissions for fractures (ICD9-CM 800-829) in females, equal to 0.75 (95%CI 0.58 – 0.97). Analysing hazards for 1st

access to ED, a slight reduction emerged for white codes, both in females and in males; the HRs were respectively 0.97 (95%CI 0.89 – 1.05) and 0.94 (95%CI 0.86 – 1.03). This reduction was found also for green codes but only in females: HR 0.94 (95%CI 0.87-1.00). For other priority codes, no risk differences emerged (data not shown). For what concerns multiple accesses to ED, again a minor reduction emerged for white codes both in females and in males, with ORs respectively equal to 0.97 (95%CI 0.91 – 1.02) and 0.97 (95%CI 0.92 – 1.03), and for green codes, but only in females, with OR equal to 0.95 (95%CI: 0.91-1.00). No further significant results emerged for other priority codes (data not shown).

Discussion

We focused on the hazards of 1st hospitalization as main measurable outcomes, under the hypothesis that after the 1st hospital access patients are more likely to be involved in a controlled clinical follow-up and, therefore, subsequent hospital admissions may not be independent events. Our results show a slight reduction in hazard of 1st hospitalization for all causes in MP. For urgent admissions in females, the reduction appears to be more pronounced. Similarly, hazards for 1st access to ED for the lowest priority access code, both in females and in males, seem to be slightly decreased. This reduction was found also for green codes but only in females, while for other priority codes, no risk differences emerged. In the literature, interventions such as patient education, needs assessment, telephone support and follow-up have been shown to effectively reduce hospital admissions. [40] A meta-analysis by Panagioti et al. [41] showed that interventions aimed at improving self-management support, reduced health services utilization, with no negative impact on patient health outcomes; in particular, robust evidence in this sense was found for respiratory and cardiovascular disorders. Coherently with these results, in our study, MP females, showed a lower risk for acute respiratory infections, while in MP males, a lower risk of 1st urgent hospitalization for 'other forms of heart disease' was observed. However, the most

remarkable finding that emerged from our study concerns psychosis, particularly in females. The longitudinal SMILE study in the Netherlands (Groffen et al. 2008) [42] has shown that persons reporting material deprivation were at higher risk of physical and mental disorders. In a meta-analysis of the effect of early interventions for psychosis, Randal et al [43] describe a positive effect in terms of hospitalization reduction. McFarlane and colleagues, [44] noted that admission rates for psychotic episodes were reduced by a community-wide program of early identification and intervention initiated in 2001.

Multiple admissions represent a patient safety concern as well as a public cost. [40] Socioeconomic status is strongly associated with hospital outcome measures and there is evidence showing that some multifaceted interventions can successfully reduce hospital readmissions. [45] In a randomized control trial carried out between 1992 and 1996, Naylor and colleagues [46] studied the effectiveness of nurse–centered discharge planning and follow-up intervention for subjects at higher risk of readmission. Twenty-four weeks after hospital discharge, readmission was more frequent for patients in the control group than in the intervention group.

Our results also suggest that the HM project was effective in reducing multiple admissions for all causes in females (Table 3), and particularly for fractures.

For what concerns ED care services, there is evidence of an increased demand in countries where population aging generates more diverse and complex care needs. [47] Factors such as lack of access to affordable primary care around-the-clock and lack of awareness of available services or of diagnostic and therapeutic protocols, explain why the demand for these services is persistently increasing. In addition, patients of low socioeconomic status tend to prefer hospital care to primary care, because hospital care is perceived as higher quality and more convenient and accessible. [48] Our results show that during the multifaceted HM project, the hazards of 1st access to ED for white codes slightly decreased, both in females and in males.

Our study presents some limitations: our data derive from administrative databases through an anonymous identifier, therefore, although in actual facts not all residents were directly involved in the HM project, for the purposes of our analysis, all residents in the selected microareas were considered as participants in the HM project. This may have introduced a certain degree of misclassification with a likely underestimation of the effectiveness of the intervention. Moreover, between 2009 and 2012, the HM project was extended to a further three microareas, therefore, among those whom we considered non-participants, there were residents who were in fact involved in the intervention. Again, this might have contributed to underestimate the effectiveness of the intervention. Our results suggest that the HM programme was more effective with females; based on the reports of the multi-professional teams, a possible explanation may be that it was easier to involve females than males. This, however, represents a limitation in terms of results generalizability.

Our study also presents a number of strengths: it involved a wide cohort for a long follow-period and the use of administrative databases provided a complete picture of the subjects' access to health care facilities, diagnoses, therapies and procedures during the study period. To our knowledge, this is one of few studies that evaluate the effectiveness of a social intervention in terms of impact on health services. In our view, this study may represent the starting point for a more comprehensive assessment aimed at determining the impact of the HM project on the healthcare system also in terms of costs, a topic of significant interest since sustainability of the public health service is a matter of great current concern.

Conclusions

Our results show that by acting on the social determinants of health, the burden on the health service can be controlled and reduced. Our evidence shows that during the follow-up period, there was a reduction of 1st urgent hospital admissions in the social

intervention area, especially in females and for specific diagnoses such as psychosis. Also multiple admissions were decreased in the intervention group, again, mainly in females and for specific diagnoses such as fractures.

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Competing interests declaration

All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: this retrospective cohort study was supported by a fund allocated by the local health authority of Trieste “Azienda Sanitaria Universitaria Integrata di Trieste” on 31st August 2016 (CUP E97B16000340002); no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

Contributors

LC, FB, MGCD and FP conceived, designed and coordinated the study. MS, EA CE and FP collected data. MG, LC, VR defined the statistical analysis plan and performed the analysis. LC, MG, FB, MGCD and FP interpreted the results. LC and MG drafted the paper. FB, MGCD, MS, EA CE, FP and VR critically revised the manuscript.

Transparency statement

All authors declare that this manuscript is an honest, accurate, and transparent account of the study being reported; no relevant aspects of the study have been omitted. The study has been conduct as it was planned, with no relevant discrepancies.

Role of the funding source

This retrospective cohort study was supported by a fund allocated by the local health authority of Trieste "Azienda Sanitaria Universitaria Integrata di Trieste" on 31st August 2016 (CUP E97B16000340002) through an *ad hoc* agreement with the University of Udine. Researchers acted independently from the funder and all authors had full access to all data (including statistical reports and tables) in the study and can take responsibility for the integrity of the data and the accuracy of the data analysis.

Data sharing statement

All data relevant to the study are included in the article. No additional data available.

Dissemination declaration

The results of this retrospective cohort study were presented to public healthcare authorities, non-profit organisations, social housing, and citizens, during an *ad hoc* conference held in Trieste on 14 and 15 June 2018.

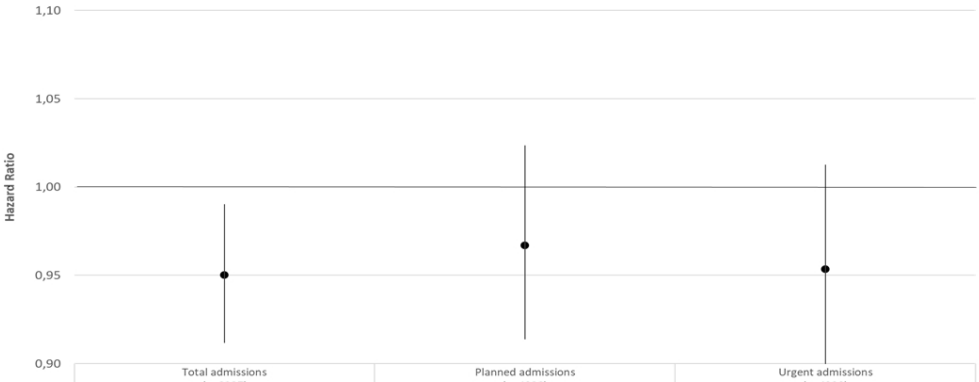
Figure legends

Figure 1. HRs for 1st hospital admission; MP vs NMP. Analysis adjusted for age and Charlson and deprivation indexes

Figure 2. HRs for 1st hospital admission; MP vs NMP by gender. Analysis adjusted for age and Charlson and deprivation indexes

Figure 3. HRs for 1st hospital admission by ICD-9-CM blocks of diagnosis; MP vs NMP (females). Analysis adjusted for age and Charlson and deprivation indexes

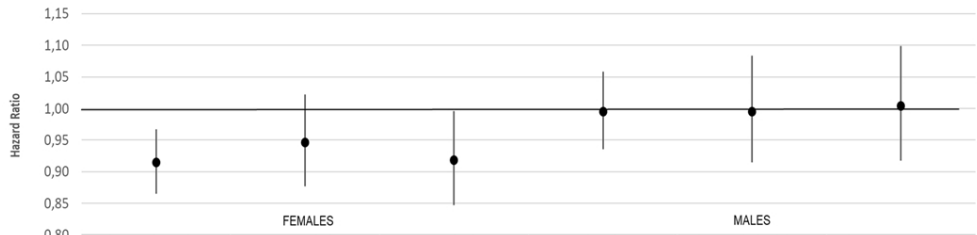
Figure 4. HRs for 1st hospital admission by ICD-9-CM blocks of diagnosis; MP vs NMP (males). Analysis adjusted for age and Charlson and deprivation indexes



	Total admissions (n. 9237)	Planned admissions (n. 4898)	Urgent admissions (n. 4339)
Hazard Ratio	0,95	0,97	0,95
HRLowerCL	0,91	0,91	0,90
HRUpperCL	0,99	1,02	1,01

Figure 1. HRs for 1st hospital admission; MP vs NMP. Analysis adjusted for age and Charlson and deprivation indexes

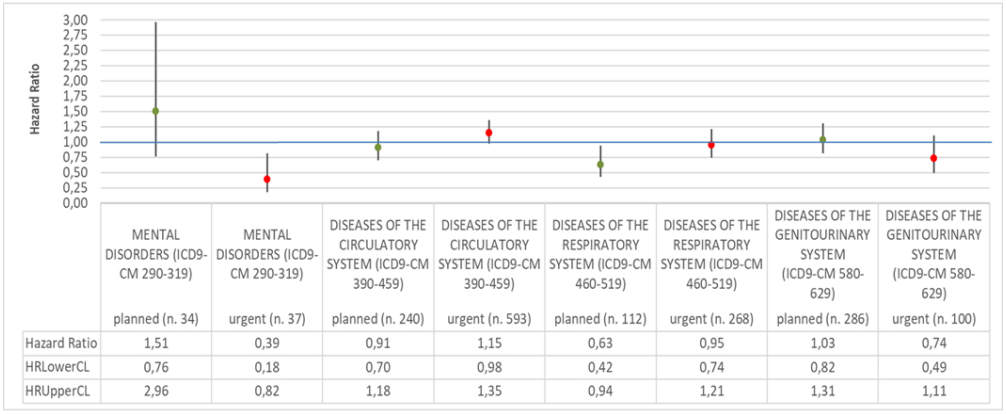
90x90mm (300 x 300 DPI)



	Total admissions (n. 5102)	Planned admissions (n. 2691)	Urgent admissions (n. 2411)	Total admissions (n. 4135)	Planned admissions (n. 2207)	Urgent admissions (n. 1928)
Hazard Ratio	0,91	0,95	0,92	1,00	1,00	1,00
HRLowerCL	0,87	0,88	0,85	0,94	0,91	0,92
HRUpperCL	0,97	1,02	1,00	1,06	1,08	1,10

Figure 2. HRs for 1st hospital admission; MP vs NMP by gender. Analysis adjusted for age and Charlson and deprivation indexes

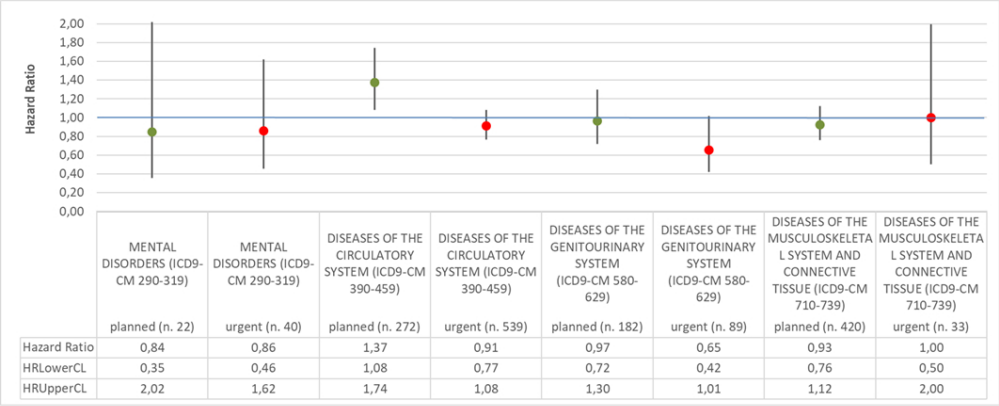
90x90mm (300 x 300 DPI)



	MENTAL DISORDERS (ICD9-CM 290-319) planned (n. 34)	MENTAL DISORDERS (ICD9-CM 290-319) urgent (n. 37)	DISEASES OF THE CIRCULATORY SYSTEM (ICD9-CM 390-459) planned (n. 240)	DISEASES OF THE CIRCULATORY SYSTEM (ICD9-CM 390-459) urgent (n. 593)	DISEASES OF THE RESPIRATORY SYSTEM (ICD9-CM 460-519) planned (n. 112)	DISEASES OF THE RESPIRATORY SYSTEM (ICD9-CM 460-519) urgent (n. 268)	DISEASES OF THE GENITOURINARY SYSTEM (ICD9-CM 580-629) planned (n. 286)	DISEASES OF THE GENITOURINARY SYSTEM (ICD9-CM 580-629) urgent (n. 100)
Hazard Ratio	1,51	0,39	0,91	1,15	0,63	0,95	1,03	0,74
HRLowerCL	0,76	0,18	0,70	0,98	0,42	0,74	0,82	0,49
HRUpperCL	2,96	0,82	1,18	1,35	0,94	1,21	1,31	1,11

Figure 3. HRs for 1st hospital admission by ICD-9-CM blocks of diagnosis; MP vs NMP (females). Analysis adjusted for age and Charlson and deprivation indexes

90x90mm (300 x 300 DPI)



	MENTAL DISORDERS (ICD9-CM 290-319) planned (n. 22)	MENTAL DISORDERS (ICD9-CM 290-319) urgent (n. 40)	DISEASES OF THE CIRCULATORY SYSTEM (ICD9-CM 390-459) planned (n. 272)	DISEASES OF THE CIRCULATORY SYSTEM (ICD9-CM 390-459) urgent (n. 539)	DISEASES OF THE GENITOURINARY SYSTEM (ICD9-CM 580-629) planned (n. 182)	DISEASES OF THE GENITOURINARY SYSTEM (ICD9-CM 580-629) urgent (n. 89)	DISEASES OF THE MUSCULOSKELETAL SYSTEM AND CONNECTIVE TISSUE (ICD9-CM 710-739) planned (n. 420)	DISEASES OF THE MUSCULOSKELETAL SYSTEM AND CONNECTIVE TISSUE (ICD9-CM 710-739) urgent (n. 33)
Hazard Ratio	0,84	0,86	1,37	0,91	0,97	0,65	0,93	1,00
HRLowerCL	0,35	0,46	1,08	0,77	0,72	0,42	0,76	0,50
HRUpperCL	2,02	1,62	1,74	1,08	1,30	1,01	1,12	2,00

Figure 4. HRs for 1st hospital admission by ICD-9-CM blocks of diagnosis; MP vs NMP (males). Analysis adjusted for age and Charlson and deprivation indexes

90x90mm (300 x 300 DPI)

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract Page 1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found Page 2
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported Page 3
Objectives	3	State specific objectives, including any prespecified hypotheses Pages 5-6
Methods		
Study design	4	Present key elements of study design early in the paper Pages 6-8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection Pages 6-7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up Pages 6-7
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed Page 6 for matching criteria and *Results*, page 8 for number of exposed and unexposed (participants and not participants)
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable Page 7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group Pages 6-8
Bias	9	Describe any efforts to address potential sources of bias Pages 7-8
Study size	10	Explain how the study size was arrived at Page 6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why Pages 7-8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding Pages 7-8
		(*b*) Describe any methods used to examine subgroups and interactions Pages 7-8
		(*c*) Explain how missing data were addressed Not applicable
		(*d*) If applicable, explain how loss to follow-up was addressed Not applicable
		(*e*) Describe any sensitivity analyses Not applicable
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially

		eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed Page 8
		(b) Give reasons for non-participation at each stage Not applicable
		(c) Consider use of a flow diagram Not applicable
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders Not applicable
		(b) Indicate number of participants with missing data for each variable of interest Not applicable
		(c) Summarise follow-up time (eg, average and total amount) Page 8
Outcome data	15*	Report numbers of outcome events or summary measures over time Tables 2 and 3 pages 9 and 10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included See page 8, for list of confounders and Figures 1 to 4 for adjusted estimates and confounders
		(*b*) Report category boundaries when continuous variables were categorized Not applicable
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period Not applicable
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses Not applicable
Discussion		
Key results	18	Summarise key results with reference to study objectives Pages 10-13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias Page 12
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence *Discussion*, pages 12 and *Conclusions*, page 13.
Generalisability	21	Discuss the generalisability (external validity) of the study results Page 12
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based *Role of the funding source*, page 14

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.