High Blood Press Cardiovasc Prev (2014) 21:45–51
DOI 10.1007/s40292-013-0033-0

ORIGINAL ARTICLE

Population Health Needs Assessment and Healthcare Services Use in a 3 Years Follow-Up on Administrative and Clinical Data: Results from the Brisighella Heart Study

Arrigo F. G. Cicero · Martina Rosticci · Sergio D'Addato · Cristina Baronio · Giulia Grossi · Elisa Grandi · Claudio Borghi

Received: 24 October 2013 / Accepted: 7 November 2013 / Published online: 16 November 2013

Abstract
Introduction A large number of epidemiological trials clearly show the impact of the main cardiovascular disease risk factors in term of hospitalization and related cost, but relatively less frequently if this reflect the health needs of a given population.
Aim To develop a model for the health needs-assessment that will be applied to verify if and how the prevalence of some classical risk factors for cardiovascular disease predicts mortality and hospitalisation episodes at 3 years, and if it could express the health need of that population. The long-life clinical record of 1,704 subjects, recruited during the 2004 Brisighella Heart Study survey, has been monitored. We defined the health profile of these subjects at 2004 (based on clinical history, smoking and dietary habits, physical activity, drug use, anthropometric data, blood pressure, and hematological data) and then sampled data relative to their hospitalisations, mortality, and general medical assistance.
Results Our results shows that age over 65 years (OR 4.08; 95 % CI 2.74–6.08), hypertension (OR 3.44; 95 % CI 2.36–5.01) and hypercholesterolemia (OR 1.33; 95 % CI 0.92–1.94) increase the probability to get hospitalised. Furthermore, the burden of care was defined and computed for our sample. Vascular and respiratory diseases [Burden of health care (Bc) = 24.5 and 36.5, respectively] are the most costly DRGs which means that the biggest part of our resources directed to cardiovascular patients were provided for these diagnoses.
Conclusion The application of the proposed model could help policy makers and researchers in directing resources and workforce in the treatment of cardiovascular diseases.

Keywords Public health · Epidemiology · Population study · Cardiovascular disease

1 Introduction

Health is a high priority in public health planning and decision-making, processes by which health, services and resources are connected to each other [1]. Moreover, the integration of the scientific researches in the assistance process is one of the most important challenges that it is currently set to the health care purchaser [2, 3] and the best match between health and health care needs and service activities becomes more and more outlined [4, 5]. Assessing population health needs is one of the most difficult tasks, because of the lack of epidemiological information on the spread of diseases, their seriousness and their capacity to impair as well as the lack of timely and appropriate information on them [6]. In the absence of routine morbidity data, attempts to develop indices of health needs have involved the use of proxy measures, such as death rates or census indicators, that do not directly incorporate information on health status [7]. Aware that it is only against the health needs of the local population that service use can be legitimately compared [8], we propose

For the Brisighella Heart Study Group.

A. F. G. Cicero · M. Rosticci · S. D'Addato · C. Baronio · G. Grossi · E. Grandi · C. Borghi
Department of Medical and Surgical Sciences, University of Bologna, Bologna, Italy

A. F. G. Cicero (✉)
Department of Medical and Surgical Sciences, Sant'Orsola-Malpighi University Hospital, Via Albertoni, 15, 40138 Bologna, Italy
e-mail: afgcicero@cardionet.it

the use of an epidemiological model that describes the volume of resources necessary to maintain the health needs of a population as depending upon the prevalence of diseases (the morbidity), the utilisation of health services to cure, these diseases and the consequent human, technological and financial resources employed. According to this model, the management of the supply of health services depends on the monitoring of the relationship between population, disease, health services and resources. Our focus is on cardiovascular disease (CVD)—mainly coronary heart disease (CHD) and cerebrovascular disease—being the major cause of mortality and morbidity in developed countries [9] and among the greatest contributors to the health care system expenditure.

Problems with different sources databases were usually retrieved in the past and recent research in Italy and the use of Registries and administrative data in our country is still considered controversial due to its low sensitivity and appropriateness [10].

The aim of our study is to apply a model for the population health needs-assessment in order to verify if and how the prevalence of some classical risk factors for cardiovascular disease predicts mortality and hospitalisation episodes at 3 years, and if it expresses the health need of that population.

2 Methods

The previously proposed epidemiological model [11], sets and measures in terms of rate and risks all the activities that contributes to protect, promote or restore the health. For example, prevention, which fits to avoid that a population gets sick and therefore expresses a need of health, and disease management, adopted to identify and cluster sick subjects and to restore their health status, are taken into account as determinant factors [12]. Therefore, the main variables of the relationship are the preventive activity, expressed by the relationship among the disease (prevalence of risk factors for CVD) and the observed population; the "commitment" activity, expressed by the relationship among the episodes of illness (cluster of visits and/or procedures and/or admission that are related to a particular illness, disease or condition, in a life-period of time) and the disease; the health care services provision, expressed by the relationship among the employed resources (as intermediary product measured by admission, days hospitalisations, length of stay) and the episodes of care or hospitalisations (Fig. 1)

This research has been carried out in the context of the Brisighella Heart Study (BHS), a prospective, population-based longitudinal epidemiological investigation involving 2,939 randomly selected subjects (1,491 men and 1,448 women), aged 14–84 years, free of cardiovascular disease at enrolment, living in the northern Italian rural town of Brisighella, promoted in 1972 by the University of Bologna [13–16]. Brisighella was chosen as site of the study because of the homogeneity of life-style among its residents, with a very low rate of immigration and emigration. Subjects were clinically evaluated at baseline and every 4 years following enrolment when extensive clinical and laboratory data were obtained in addition to the assessment of morbidity and mortality

The BHS protocol and its sub-studies have been approved by the Ethical Board of the University of Bologna and all volunteers involved gave their signed consent to the participation to the study.

The full protocol has been largely described elsewhere [17]. The study structure includes different phases and subprojects [18, 19]. For this study, we took the medical records of 1,704 subjects, enrolled in 1996 during one of the BHS follow-up. The definition of health profile of these subjects is based on a complete set of data regarding clinical history, smoking and dietary habits, physical activity, drug use, anthropometric data, blood pressure, glycaemia, uric acid, total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C) and triglycerides. We defined those following as possible risk factors which should be evaluated in order to understand risk factors impact on the health needs assessment process. Hypertension, hypercholesterolemia and diabetes were defined on the basis of laboratory and/or instrumental measurement (Hypertension ⇒ SBP $\geq$140 mmHg or DBP $\geq$90 mmHg; Hypercholesterolemia ⇒ LDL-C $\geq$160 mg/dl; Diabetes ⇒ Glycaemia $\geq$126 mg/dl; obesity ⇒ BMI $\geq$30 kg/m^2) and on the drug use [20, 21].

Hospitalisations, mortality, and general assistance were collected from 2004 to the whole 2007, from official mortality statistic, census of Brisighella municipality, inpatients hospital admissions and local health authority databases (Death Registry from AUSL Ravenna, Birth Registry, Hospitalisation and Outpatient Registry). From demographical data we retrieved the medical history of 1,704 patients among the entire population studied in that period.

Diseases coding for Mortality were classified by the International Statistical Classification of Diseases, injuries and Causes of Deaths, Ninth edition (ICD-9, V, Table 2) [22] For a better esteem of the load of the health care services, a new indicator is introduced: the burden of health care (Bc), calculated by the relationship among morbidity, resources consumed and medical activities indicators in the following 3 year period, such as the formula listed in Fig. 1. This calculation derives from the ratio of the productivity of services determined by the relationship between days of hospitalisation and resources by events of care which estimates usually the average part of resources dedicated to a specific cause.

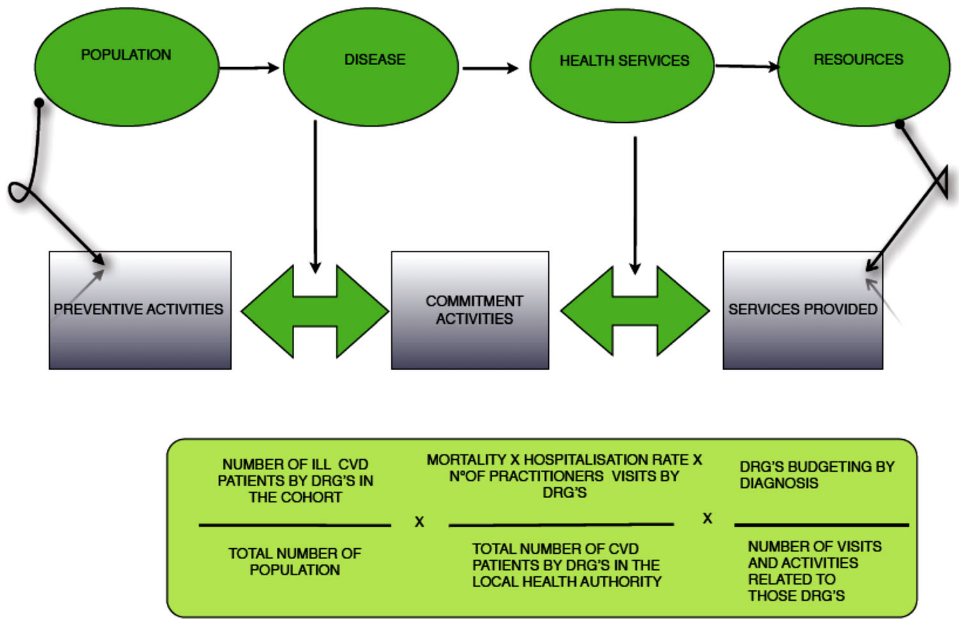

Fig. 1 The epidemiological model: relationship between population health status and services used

Hospitalisation and events of care were identified with number of patients registered in the hospital one or more times for a single disease, included all the exams that the patient needs to fulfil for a single cause of investigation during an outpatient treatment or follow-up or day service care. The employed resources were expressed by days of hospitalisation, average days of hospitalisation and average computed points by DRG's.

2.1 Statistical Analysis

Data have been collected in an apposite database and statistically analysed with the help of the SPSS 19.0, version for Window, statistical software. A descriptive analysis has been carried out for all the parameters. For each binary or categorical parameter, total sample size, and observed frequency as a percentage has been computed. For each continuous parameter we output: mean and 95 % confidence intervals of the means. We performed also a risk analysis of the data: prevalence; odds ratio (OR), attributable risk (AR), attributable fraction (AF) [23] that is the "fraction of all cases (exposed and unexposed) that would not have occurred if exposure had not occurred". The risk analysis was performed using the parameters as dummy variables and so dividing the population in exposed and unexposed.

3 Results

The 1,704 subjects enrolled, 817 men (47.9 %) and 887 women (52.1 %), were aged 21–92 years; no significant differences were observed in the aged distribution between sex (men: range 22–92, mean 58, mode 65 years; women: range 21–88, mean 57.4, mode 64 years). The health status profile is resumed in Table 1. As listed in the Table, our population has a mean value for SBP and DBP below the ESC parameter for Hypertension diagnosis, while only 25.05 % has higher limits. The most frequent risk factor (49.2 %) is the hypercholesterolemia, especially in women (52.1 %) . The mean HDL, nonetheless, is 49.1 % for men and 56.2 % for women, that gives us an idea of the small part of high risk patient (defined by ESC). Distribution of fat could be a determinant of the pattern of the population, though the medium BMI is 26.8 for men and 26.5 for women.

In 2004–2007 period, 1,096 hospital inpatient admissions (A) for all causes were registered, counting for 7,154 days of hospitalisation (HD) and 6.5 days of mean length of stay (LS_m). The number of subjects admitted (SA) was 599 (35.2 % of the cohort), 347 (20.4 %) admitted once, 142 (8.3 %) twice, 53 (3.1 %) three time. The rate of admission was 162.5 ‰ per year for all cause, the relation HA/SA was 1.8. The mean Bc for all causes was 11.9 days, each episode of illness consumed 11.9 days of hospitalisation in average. Table 2 shows the Burden of care for each diseases category, determined on health care provided data. Over a total amount of 12.4 Bc weighted for all CVD causes taken into account in our model, the most important cause of disease involved in health care service usage is Pulmonary Arterial diseases (highest Burden of care 36.5 days)

Concerning the CVD, rate of admission was 28.3 ‰ per year, for all CVD causes were admitted 120 subject: 82 once, 22 twice, 7 three times, 5 four times, 2 five and 1 six times and 1 subject eight times, computing at all 191

Table 1 Health status profile of the Brisighella population at the 2004 follow-up survey

Risk factors				Parameter		
Prevalence	All	Men	Women	Mean value (95 % CI)	Men	Women
Hypertension (%)	427	184	243	SBP (mmHg)	125.8 (124.5–127.2)	126.3 (124.8–127.7)
	25.05 %	22.5 %	27.4 %	DBP (mmHg)	73.4 (72.7–74.1)	71.8 (71.1–72.5)
Hyperchole-sterolemia (%)	838	376	462	TC (mg/dL)	227.8 (225.0–230.6)	236.3 (233.5–239.0)
	49.2 %	46.0 %	52.1 %	LDL-C (mg/dL)	153.4 (150.9–155.0)	157.5 (155.0–160.0)
				HDL-C (mg/dL)	49.1 (48.2–49.9)	56.2 (55.3–57.0)
				TG (mg/dL)	126.8 (122.5–131.2)	112.6 (108.8–116.4)
Diabetes (%)	41	22	19	Fasting plasma glucose (mg/dL)	85.0 (83.4–86.5)	82.7 (81.2–84.2)
	2.4 %	2.7 %	2.1 %			
Obesity (%)	402	140	262	Body mass index (kg/m^2)	26.8 (26.6–27.1)	26.5 (26.2–26.8)
	23.6 %	17.1 %	29.5 %			
Smoking habit (%)	274	151	123			
	16.1 %	18.5 %	13.9 %			

SBP systolic blood pressure, *DBP* diastolic blood pressure, *TC* total cholesterol, *LDL-C* low-density lipoprotein cholesterol, *HDL-C* high-density lipoprotein cholesterol, *TG* triglycerides

Table 2 Health care provided and relative expenditure by diagnosis at discharge during the period 2004–2007

Disease categories	A	SA	HD	LS_m	A/SA	Bc
Hypertension (401–405)	6	3	46	7.7	2	15.3
Ischemic heart disease (410–414)	30	16	227	7.6	1.9	14.2
Pulmonary arterial disease (415–417)	3	2	73	24.3	1.5	36.5
Other heart disease (420–429)	55	30	368	6.7	1.8	12.3
Cerebrovascular disease (430–438)	47	33	447	9.5	1.4	13.5
Disease of arteries, arterioles, capillary (440–448)	21	9	221	10.5	2.3	24.5
Disease of veins, lymphatic vases (451–459)	29	27	102	3.5	1.1	3.7
Total	191	120	1,484	7.8	1.6	12.4

A admission, *SA* number of subject admitted, *HD* days of hospitalisation, LS_m mean length of stay, *Bc* burden of health care

hospital admission. Total days of hospitalization for CVD were 1,484 (20 %) in 3 years. The length of stay varied from 1 day (27 recover) to 52 days, only 3 exceed the 30 days. Fifteen subjects were admitted at list once for coronary heart disease (code 410–414), 8 of which discharge with diagnosis of acute myocardial infarction (AMI), 3 fatal. Cerebrovascular disease (code 430–438) was cause of admission in 35 subjects, which 5 were Stroke, 1 TIA, and 7 dead.

Relation between health pathway and service use was analysed through the risk analysis, as shown in Table 3. The higher odds ratio is associated to age over 65, due to the disability and dependency factors related to the health status: probability in having hospitalisation and admissions is 4 times higher compared to adults of the general population (OR 4.08; 95 % CI 2.74–6.08). Hypertension increases three times the probability of health care usage in the sample as well and explains the 34.4 % of CVD admissions (3.44; 95 % CI 2.36–5.01). Other risk factors are not statistically significant. Attributable fraction due to the age (>65) is 72.8 %, which means that the older age could have an increasing and necessary influence on being admitted and hospitalised. The risk is doubled for people presenting diabetes, even if at a population level, diabetes causes only the 2.7 % of CVD admission. Obesity and smoking habit do not seem to modify significantly the risk of hospitalisation, in our population. The Attributable Fraction, in the meanwhile, tells us the proportion of risk that we avoid by eliminating the exposure in the population. The highest result is found for age >65, Hypertension and Diabetes, each, so that their comorbidities in any pattern give to patients a more difficult risk to manage (72.8; 67.7 and 53.2 % respectively).

In the Brisighella sample, 664 (38.9 %) individuals were not exposed to any major risk factors, 774 (45.4 %) subjects present one major risk factor (hypertension or

Table 3 Relationship between health pathway and service use; risk analysis

Age >65 aa	95 % CI	Hypertension	95 % CI	Hyper-cholesterolemia	95 % CI
OR 4.08	2.74; 6.08	OR 3.44	2.36; 5.01	OR 1.33	0.92; 1.94
AR 9.48 %	6.63; 12.33	AR 9.67 %	6.15; 13.18	AR 1.88 %	−0.56; 4.31
AF 72.8 %	60.6; 81.3	AF 67.7 %	54.5; 77.0	AF 23.5 %	−8.4; 45.9
Diabetes	**95 % CI**	**Obesity**	**95 % CI**	**Smoking habit**	**95 % CI**
OR 2.33	0.96; 5.65	OR 0.98	0.64; 1.53	OR 0.56	0.30; 1.03
AR 7.78 %	−3.11; 18.67	–	–	–	–
AF 53.2 %	−0.2; 78.1	AF 1.4 %	−48.2; 34.5	AF 42.0 %	−3.8; 67.6

OR odds ratio, *AR* attributable risk, *AF* attributable fraction

Table 4 Risks of hospital admission by exposition at 1 or more risk factors

1 RF	95 % CI	2 RF	95 % CI	3 RF	95 % CI
OR 2.44	1.57; 3.79	OR 2.64	1.75; 3.98	OR 3.38	1.11; 10.27
AR 5.17 %	2.88; 7.46	RA 8.14 %	3.81; 12.47	RA 13.11 %	−4.46; 30.68
AF 56.7 %	34.3; 71.5	FA 58.5 %	40.2; 71.2	FA 65.6 %	15.8; 85.9

OR odds ratio, *AR* attributable risk, *AF* attributable fraction

hypercholesterolemia or diabetes), 246 (14.4 %) subjects present two risk factors and 20 (1.2 %) subject three. Being exposed to more than one risk factor increased the risk of admission as shown in Table 4. The combination of three risk factors effect on the hospitalisation outcome increases the risk of being admitted by 13.11 %. This situation is composed by a very restricted group in our population which would not let good significance to our results.

4 Discussion

The need to govern the increasing sanitary demand and, at the same time, to strengthen the quality and the efficiency of the Health System can be afforded by offering effective and appropriate sanitary services. This model can predict the usage of resources based on a field provisional estimate done on a health needs assessment. Still, the usage of resources covers more services for respiratory diseases, including neoplastic and allergic sequelae in the older adult, with a Burden of care which is more than doubling the other categories. This cause of admission could be the target of an rational policy of hospitalisation appropriateness program. Our result suggests us that Brisighella population has an important role on a preventing level because it shows consequences of cardiovascular risk factors on the respiratory tract, which usually ends the physiological process of cardiovascular deficit. The proposed concept of the burden of care can be applied on diseases with a very high social impact such as cerebrovascular disease, which prevalence is highly increasing, their consequences highly disabling and costly, but that is potentially preventable [24]. As previously said, in our population, cardiovascular risk factors doesn't imply worst effect on a cerebrovascular outcomes (measured by hospitalisations) but we didn't study the effect on cognitive impairment, previously established by the Finnish paper published in 2013 [25].

There has been extensive research to identify a measure that predicts health services utilisation [26–28] and the main conclusion of the most part of Authors is that the risk assessment is potentially useful for resource allocation, in managing health care. New methodologies of analyses for the modelling of the effect of risk variables on health outcomes done by propensity scores which predicts differences at organisational levels are described in literature [29, 30]. However, the main obstacle remains the limited available information about the population health profile, which could be explored with different methodologies a part from administrative data [31]. In fact, the situation is quite similar to that of the choice of the best intervention for a specific cluster of ill subjects: we try to apply the results of clinical trials (carried out on well-selected patients, generically affected by no more than the studied disease) to the general population (affected by more diseases, taking different drugs, not constantly monitored by a physician).

In the Brisighella population, the risk of CVD was inferior to that esteemed with the hospitalisation rate, a widely used parameter in cost-effectiveness evaluations, but attributable for the more to a little group of subjects with well-defined characteristics of exposure. The resources spent on an admission do not adequately describe either the sanitary needs or the relief load and the "cost" associated to the disease. The utilisation of Bc was aimed at identifying the individual contribution of diseases and attributing the use of the services to the individuals. By using the prevalence of disease and the cost of an event of care, it seems possible to define the overload of services consumed by different population sub-groups (exposed and not exposed) during a period of time and to identify the resources necessary to satisfy population health care needs. Moreover, it appears possible to define whether spending resources, whose health care policy on population (for diffuse risk) or high risk (for concentrate risk) strategies are direct practical effects, are useful public health intervention in order to address patient needs and manage public expenditure. As explained in Martin et al. [32] the economic care programme in UK were theorised by using a productivity function which includes inputs (such as resources used) and outcomes in health by taking into account population health needs and environmental factors [32].

In our population, obesity and smoking habit do not seem to modify significantly the risk of hospitalisation: this observation could be partly unexpected, especially as it regards smoking. However, prior to this evaluation we carried out a specific educational intervention on high risk subjects in Brisighella, and it is highly probable that the most responsive to the intervention (i.e. the ones who stopped smoking) were the subjects with higher risk [33], who on the other hand remained hypertensive, diabetic and/or hypercholesterolemic. In this report we did not consider physical activity as a hospitalization determinant, since in a previous paper we already showed that it is strongly related to mortality but not on morbidity in the Brisighella Study [34].

The main limitation of this study is that the model was applied in a specific setting that is probably not directly applicable to different ones and to a relatively small cohort of subjects monitored for hospitalization cost for a short time.

However, our applied epidemiological methodology allows to explore this relative weight of the population and each single individuals involved in the cohort study so that we could produce health by guaranteeing their follow-up and preventing fatal events. The main limitation of this model is that it is fairly applicable only where integrated data on the studied population are available as in the Brisighella Heart Study, from a clinical to an administrative level. Epidemiological studies have to be implemented in different countries to sample sufficient data to estimate the specific population health needs.

Acknowledgments We are very grateful to Dr. Simona Nascetti who firstly hypothesized this work and to Dr. Valentina Di Gregori for her scientific consultancy. Moreover we are grateful to the Brisighella municipality, the Faenza Health District and the Brisighella GPs who always actively co-work to the efficiency of the Brisighella Heart Study

Conflict of interest Authors had no conflict of interests in writing this paper and making the presented analyses, and no relationship with industries was intervened for the publication of this paper.

References

1. Right J, Williams R, Wilkinson JR. Health needs assessment. Development and importance of health needs assessment. Br Med J. 1998;316:1310–3.
2. Bero LA, Grilli R, Grimshaw JM, Harvey E, Oxman AD, Thomson MA. Closing the gap between research and practice: an overview of systematic review of interventions to promote the implementation of research findings. Br Med J. 1998;317:465–8.
3. Brownson RC, Jones E. Bridging the gap: translating research into policy and practice. Prev Med. 2009;49:313–5.
4. Henser M, Fulop N. The influence of health needs assessment on health care decision-making in London health authorities. J Health Serv Res Policy. 1999;4:90–5.
5. Taylor-Robinson DC, Milton B, Lloyd-Williams F, O'Flaherty M, Capewell S. Planning ahead in public health? A qualitative study of the time horizons used in public health decision-making. BMC Public Health. 2008;18(8):415.
6. Williams R, Wright J. Health needs assessment. Epidemiological issues in health needs assessment. Brit Med J. 1998;316:1379–82.
7. Congdon P. Health status and healthy life measures for population health need assessment: modelling variability and uncertainty. Health Place. 2002;7:13–25.
8. Gibson A, Asthana S, Brigham P, Moon G, Dicker J. Geographies of need and the new NHS: methodological issue in the definition and measurement of the health needs of local population. Health Place. 2002;8:47–60.
9. Grimes DS. An epidemic of coronary heart disease. QJM. 2012;105(6):509–18.
10. Bartolomeo N, Treretoli P, Serio G. Record linkage between hospital discharge data and death record in the Puglia Region in 2001–2006 (Italy). Ig Sanità Pubbl. 2010;66(3):273–86.
11. Nascetti S, Falasca P, Ancarani A, Odo Wani FO, Gaddi A A. An epidemiological model for health needs assessment. Epidemiol Prev. 2000;24:228–32.
12. Starfield B. Basic concepts in population health and health care. J Epid Comm Health. 2001;55:452–4.
13. Descovich GC, Cavallo G, Mannino G, Lenzi S. The Brisighella survey: a study of dietary habits. Minerva Med. 1983;74:547–55.
14. Menotti A, Farchi G, Seccareccia F and the RIFLE Research Group. The prediction of coronary heart disease mortality as a function of major risk factors in over 30,000 men in the Italian RIFLE pooling project (risk factors and life expectancy). A comparison with the MRFIT primary screeners. J Cardiov. 1994;1:263–70.
15. Menotti A, Lanti M, Puddu PE, et al. The risk functions incorporated in Riscard 2002: a software for the prediction of cardiovascular risk in the general population based on Italian data. Ital Heart J. 2002;3:114–21.
16. Menotti A, Lanti M, Agabiti-Rosei E, et al. Riskard 2005. New tools for prediction of cardiovascular disease risk derived from Italian population studies. Nutr Metab Cardiovasc Dis. 2005;15:426–40.
17. Ardigò D, Bernini F, Borghi C, on behalf of the ADSL project investigators, et al. Advanced diagnostic support in lipidology project: role for phenotypic and functional evaluation of lipoproteins in dyslipidemias. Clin Lipidol. 2010;5:329–37.
18. Cicero AFG, Dormi A, D'Addato S, Borghi C, on behalf of the Brisighella Heart Study Staff. From risk factor assessment to

cardiovascular disease risk and mortality modification: the first 40 years of the Brisighella Heart Study. Clin Lipidol. 2011;6:269–76.
19. Gaddi A, Cicero AFG, Odo Wani FO, Dormi A, Pasquarelli V, D'Addato S. The realisation of a project aimed at reducing the plasmatic lipid level in a large Italian population improves the mean calcium daily intake: the Brisighella Study. Eur J Clin Nutr. 2001;55:97–106.
20. Borghi C, Dormi A, Veronesi M, Sangiorgi Z, Gaddi A, on behalf of the Brisighella Heart Study Working Party. Association between different lipid-lowering treatment strategies and blood pressure control in the Brisighella Heart Study. Am Heart J. 2004;148:285–92.
21. Cicero AFG, Dormi A, Nascetti S, D'Addato S, Gaddi A. Relative role of major risk factors for type 2 diabetes development in the historical cohort of the Brisighella Heart Study: an 8-years follow-up. Diabet Med. 2005;22:1263–6.
22. World Health Organization. Manual of the international statistical classification of diseases, injuries and causes of deaths: ninth revision. Geneve: WHO; 1977.
23. Hanley JA. A heuristic approach to the formulas for population attributable fraction. J Epidemiol Community Health. 2001;55:508–14.
24. Gaddi A, Cicero AFG, Nascetti S, Poli A, Inzitari D, on behalf of the Italian Study Group for the study of Dismetabolic Diseases and Atherosclerosis. Cerebrovascular disease in Italy and Europe: it is necessary to prevent a "pandemia". Gerontology. 2003;49:69–79.
25. Virta JJ, Heikkilä K, Perola M, et al. Midlife cardiovascular risk factors and late cognitive impairment. Eur J Epidemiol. 2013;28:405–16.
26. Hornbrook MC, Goodman MJ. Assessing relative health plan risk with the RAND-36 health survey. Inquiry. 1995;32:56–74.
27. Starfield B, Weiner J, Mumford L, Steinwachs D. Ambulatory Care Groups: a categorization of diagnoses for research and management. Health Serv Res. 1991;26:53–74.
28. Parkerson GR, Harrell FE, Hammond WE, Wang XQ. Characteristics of adult primary care patients as predictors of future health services charges. Med Care. 2001;39:1170–81.
29. Iezzoni LI. Risk and outcomes. In: Iezzoni LI, editor. Risk adjustment for measuring health care outcomes. 2nd ed. Chicago: Health Administration Press; 1997. p. 1–41.
30. Kuttner R. The risk-adjustment debate. N Engl J Med. 1998;339:1952–6.
31. Contopoulos-Ioannidis DG, Karvouni A, Kouri I, Ioannidis JP. Reporting and interpretation of SF-36 outcomes in randomised trials: systematic review. BMJ. 2009;12(338):a3006. doi:10.1136/bmj.a3006.
32. Martin S, Rice N, Smith PC. Comparing costs and outcomes across programmes of health cares. Health Econ. 2012;21:316–7.
33. Cicero AF, Dormi A, D'Addato S, Gaddi AV, Borghi C. Long-term effect of a dietary education program on postmenopausal cardiovascular risk and metabolic syndrome: the Brisighella Heart Study. J Womens Health. 2010;19:133–7.
34. Cicero AF, D'Addato S, Santi F, Ferroni A, Borghi C, Brisighella Heart Study. Leisure-time physical activity and cardiovascular disease mortality: the Brisighella Heart Study. J Cardiovasc Med. 2012;13:559–64.