The cost-utility ratio of reducing salt intake and its impact on the incidence of cardiovascular disease in Argentina*

Daniel Ferrante,[1] *Jonatan Konfino,*[1] *Raúl Mejía,*[2] *Pamela Coxson,*[3] *Andrew Moran,*[4] *Lee Goldman,*[5] *and Eliseo J. Pérez-Stable*[3]

Suggested citation (original article) Ferrante D, Konfino J, Mejía R, Coxson P, Moran A, Goldman L, et al. Relación costo-utilidad de la disminución del consumo de sal y su efecto en la incidencia de enfermedades cardiovasculares en Argentina. Rev Panam Salud Publica. 2012;32(4):274–80.

ABSTRACT

Objective. *Estimate the cost-utility ratio of an intervention to reduce dietary salt intake in people over the age of 35 in Argentina.*

Methods. *The intervention consisted of reducing salt content in food by 5% to 25%. A simulation model was used to measure the impact of policies on heart disease in order to predict incidence, prevalence, mortality, and cost trends for heart and cerebrovascular disease in the population aged 35–84. The intervention modeled the impact and costs of a 3-gram reduction in dietary salt intake by reducing the amount of salt in processed food and salt added to food by the participants themselves over a 10-year period. Changes in event occurrence during this period and gains in quality-adjusted life years (QALY) were estimated in high- and low-impact scenarios.*

Results. T*he intervention generated a net savings of US$ 3 765 million and a gain of 656 657 QALYs in the high-impact scenario and a savings of US$ 2 080 million and 401 659 QALY in the low-impact scenario. The result would be reductions in the incidence of heart disease (24.1%), acute myocardial infarction (21.6%), and stroke (20.5%), as well as in mortality from heart disease (19.9%) and all causes (6.4%). Benefits were observed for all age groups and both genders.*

Conclusions. I*mplementing this strategy to reduce salt intake would produce a very positive health impact, both in QALY gains and savings in economic resources.*

Key words Sodium, dietary; cardiovascular diseases; cost-benefit analysis; Argentina.

Cardiovascular diseases have become the leading cause of death and disability in many developing countries (1, 2). In Argentina, these diseases cause 32% of all deaths and are one of the leading causes of mortality. They are also responsible for nearly half of the deaths that occur during the productive age of life (3). In recent years, prevalence of hypertension and smoking has remained high in Argentina. In addition, prevalence of diabetes, obesity, and sedentary lifestyle has increased (4).

In Argentina, 28.8% of the new cases of heart disease in men and 27.3% of new cases in women (5) can be attributed to hypertension. One important factor that causes elevated blood pressure is sodium intake. It is estimated that 25% of the Argentine population always adds salt to its food (4) and measurements of urinary sodium excretion indicate that approximately 10 g of salt are consumed daily (6). Although this study has limitations and direct national measurements

[1] National Ministry of Health, Buenos Aires, Argentina. Send correspondence to Daniel Ferrante, dferrante@masl.gov.ar
[2] Center for the Study of State and Society, Buenos Aires, Argentina.
[3] Division of General Internal Medicine, Department of Medicine, University of California, San Francisco, California, United States of America.
[4] Division of General Internal Medicine, Department of Medicine, Columbia University, New York, New York, United States of America.
[5] College of Physicians and Surgeons, Columbia University, New York, New York, United States of America.

* Complete translation of the article published in the special issue on Cardiovascular disease prevention and dietary salt reduction, Pan American Journal of Public Health, October 2012.

of salt intake have not been performed, there is a consensus that in Argentina consumption is more than the 5 g daily intake that is recommended as the maximum amount (6).

The World Health Organization (WHO) recommends reduction of dietary salt as a cost-effective strategy that can reduce morbidity and mortality due to cardiovascular disease in developing countries (7).

A linear relationship has been described between reduced dietary salt and lower blood pressure. According to some studies, if salt intake were reduced by 3 g a day the decrease in blood pressure achieved would be up to 5.6 mm Hg in persons with hypertension and persons over 65 years of age, and 3.5 mm Hg in the general population (8, 9).

Initiatives to reduce the salt content of processed food as well as communication and educational strategies to reduce daily salt intake have been implemented with successful results in industrialized countries such as Great Britain and the United States (10–12). The reduced salt intake that can be achieved by implementation of national policies may be greater than that attained as a result of the advice given by health care professionals (13).

With the strong support of international, academic, and nongovernmental organizations, Argentina is implementing interventions that could have a positive effect on health. The *Argentina Saludable* (Healthy Argentina) national plan, for example, includes three main areas of population-based interventions: control of tobacco consumption, healthy diet, and active lifestyle (14). The *Menos Sal Más Vida* (Less Salt More Life) initiative, which aims to reduce salt intake, is one of the components of this plan. However, the cost-utility ratio of this intervention has not been calculated, which is necessary for those responsible for implementing health policies as well as those in charge of decision-making about this matter.

The objective of this study was to estimate the cost-utility ratio of an intervention that aims to reduce the dietary salt intake of persons over 35 years of age in Argentina.

MATERIALS AND METHODS

A cost-utility analysis was performed in terms of the increase in quality-adjusted life years (QALY) that would occur as a result of a 3 g daily reduction in salt. This reduction, estimated through simulation models, would be achieved as a result of implementation of policies that aim to reduce the salt content of processed food and decrease the amount of salt added by consumers (intervention), compared to the current situation (without intervention).

Description of the intervention

The intervention was based on agreements recently reached with representatives of the Argentine food industry so that—initially voluntarily and then through regulations—the salt content of their products is reduced by 5–25% according to the food group the product belongs to. These agreements, which stipulate progressive reduction of salt (or sodium) intake with initial goals of reduction in 2-4 year periods, include food categories that contribute a significant percentage of the salt consumed in the normal diet (e.g., bread products, meat products, canned foods, soups, dressings). The gradual reductions that are planned take into account health impact as well as technological feasibility and consumer adaptation. The intervention also includes mass media education of the population in order to reduce the amount of salt used in home-prepared food (15).

Model of impact on heart disease and cerebrovascular disease

In order to estimate the impact of intervention, the Markov-based simulation model of policy impact on heart disease (16) adapted for Argentina was used. With this system a model of incidence of heart disease and cerebrovascular disease is developed. Prevalence, mortality, and cost in the adult population are also considered, and used to predict the number of cases of heart disease in previously healthy persons and mortality related to this disease as well as other causes (11, 17). In order to estimate the risk of heart disease according to information from population-based surveys, the 35–84 year old population was stratified according to age, sex, and six risk factors: systolic blood pressure (<130, 130–139, ≥140 mm Hg), tobacco consumption (active smoker, non-smoker exposed to second-hand smoke, non-smoker without exposure), HDL cholesterol (<35, 35-49, ≥50 mg/dL), LDL cholesterol (<100, 100-129, ≥130 mg/dL), body mass index (<25, 25-29.9, ≥30 kg/m^2), and diabetes mellitus (yes or no). These risk factors were combined with each age and sex stratum and the risk of developing heart disease was estimated for each combination according to the Framingham equations.

In the persons with heart disease the initial event (cardiac arrest, acute myocardial infarction, or angina pectoris) and its sequelae during the next 30 days were identified. Incidents after the initial event, myocardial revascularization, and mortality due to heart disease and other causes in patients with coronary heart disease were also calculated according to age, sex, and history of previous events. The annual cost and quality-of-life adjustment were calculated for each clinical situation and cardiovascular event.

The population distribution, risk factor prevalence rate, coefficients used, event rate, mortality rate, cost, and quality-of-life adjustment could be modified for the simulations.

Data and assumptions used to estimate impact

Population assumptions. The estimated Argentine population aged 35-84 years in 2010, by age and sex, and the demographic forecasts by age group were obtained from the National Institute of Statistics and Censuses (INDEC), and used to calculate the number of persons that would be included in the model each year (18).

Risk factors. The risk factor prevalence rates were obtained from the 2009 National Survey of Risk Factors (19) and the CARMELA Study (20) conducted in the city of Buenos Aires in 2005 with objective measurements of factors such as blood pressure, cholesterol, blood glucose, weight, and height.

Prevalence, incidence and case fatality. The incidence of myocardial infarction was obtained from the population registry for these cases in the province of Buenos Aires (21) and adjusted for the rest of the country by direct standardization. The case fatality rates for heart disease and cerebrovascular disease were obtained from the hospital data registries (22, 23) of the Office of Health Statistics and Information of the Argentine Ministry of Health (24) and the information provided by scientific societ-

ies. The prevalence rates for heart disease and cerebrovascular disease were estimated based on the rates reported for the United States, which were adjusted for Argentina according to the survey results (25, 26) and expert opinions.

Mortality assumptions. The data on mortality due to specific causes by year, age, and sex for the 1997-2010 period was obtained from the Office of Health Statistics and Information of the Ministry of Health (27). For the Argentine version of the policy impact on heart disease simulation model the 10th edition of the International Statistical Classification of Diseases and Related Health Problems (ICD-10) (28) was used, particularly the codes for myocardial infarction (I21, I22), angina pectoris and other forms of heart disease (I20, I23-I25), and a fixed percentage of "ill-defined" cardiovascular causes that include fatal and nonfatal events (I47.2, I49.0, I46, I50, I51.4, I51.5, I51.9 and I70.9). Codes I60-I69 were used for stroke. In order to correct the possible underestimation of coronary mortality due to use of the codes that refer to "ill-defined" cardiovascular causes, the correction factors described above were used (29).

Calculation of impact and utility. Utility, measured in QALY, was estimated and weighted for each year lived with each health condition based on the values reported in the literature (30). Since specific weights with regard to the quality of life for Argentina were not available, the standard international values were used (30).

Cost and data on resource use. Only costs from the perspective of the Ministry of Health were considered. The costs are shown in United States dollars (US$) with an exchange rate of $4.40 (Argentine pesos) per dollar.[6] It was estimated that the cost of intervention would be equivalent to the cost of program implementation—with the human resources and other inputs suggested by WHO—plus the cost of social media campaigns (7). It was calculated that the total annual cost of intervention would be US$1.6 million, which would include the following: 56.0% for the mass media campaign, education, meetings with representatives of the food industry and other social actors; 41.5% for the cost of human resources, the main program, and local training and monitoring actions; and 2.5% for inputs (Table 1).

[6] Banco Central de la República Argentina exchange rate in February 2012 (http://www.bcra.gov.ar).

TABLE 1. Costs used for cost-utility ratio analysis

Cost concept	Cost (US$)[a]
Cost of heart disease	
Acute myocardial infarction	2 018.00
Recent diagnosis of angina	1 009.00
Chronic angina (annual cost)	500.00
Hospital admission due to cardiac insufficiency	1 351.00
Revascularization surgery and coronary angiography	4 789.00
Coronary angioplasty	1 539.00
Cost of intervention (annual)	
Human resources[b]	655 789.00
Biochemical food analysis	39 474.00
Transport	13 158.00
Mass media campaign	900 000.00
Annual total (without reduction)	1 608 421.00

[a] United States dollars. Exchange rate: US$1.00 = $4.40 (Argentine pesos) according to Banco Central de la República Argentina exchange rate in February 2012 (http://www.bcra.gov.ar).
[b] Includes coordinator, professionals, assistants, and inspectors.

The cost for the health sector was estimated based on previous studies (31), databases (32), and the resources used according to hospital registries, administrative data, and discharges from public hospitals (24). In order to obtain the total cost for the country, the estimated cost was applied to the public sector, *obras sociales* (umbrella organizations for employed workers), and the private sector on a proportional basis according to their participation in health coverage. The estimates were adjusted for inflation of the health sector according to the historical series of the consumer price index (33).

Data and assumptions used to estimate program cost

Cost-utility ratio. The cost per QALY gained was calculated by arithmetical division of the difference in the cost of the strategies analyzed compared to the current situation (non-intervention), and the difference in the resulting QALYs in each strategy.

Perspective of analysis. For expenditures, the model was constructed from the perspective of the health care provider, taking into account the three main subsectors in Argentina (public, union, and prepayment).

Time horizon and reduction rate. The year 2010 was used as reference since it was the last year in which vital statistics (mortality) data was available. Model calculations were performed for the next 10 years with a 3% annual reduction rate

High-impact and low-impact scenarios. In order to evaluate the stability of the conclusions and the impact of the assumptions on the results, the final impact of reduced salt intake was modified. The high-impact scenario was based on research that suggests a 3 g reduction in daily dietary salt intake of the entire population aged 35–84 years would lead to a 5.61 mm Hg reduction in systolic blood pressure in hypertensive persons and persons over 65 years of age, and a 3.51 mm Hg reduction in the rest of the population. For the low-impact scenario it was considered that the same reduction in salt intake would have less impact in both groups, with reductions in blood pressure of 3.60 mm Hg and 1.80 mm Hg, respectively (11, 16, 34, 35).

Results report. The total estimated cost of intervention, marginal cost (difference in cost between situations with intervention and without intervention), total impact of intervention, and marginal effect (expressed as the difference between QALYs with intervention and without intervention) were established. Calculation of the cost-utility ratio of the strategy compared to the current situation (without intervention), expressed as the incremental cost-utility ratio (quotient of marginal cost and marginal effect), was planned. The additional cumulative cost of each QALY gained during the 10 year study period would be estimated based on analysis of the incremental cost-utility ratio, applying the reduction rate to the cost as well as effects (36).

The total number of QALYs gained in a 10 year period as a result of reduced incidence and mortality of heart disease, myocardial infarction, and stroke, as well as deaths due to all causes were predicted. The QALYs gained for each of these events was estimated by age and sex for the high- impact scenario. In addition, a cost-utility ratio analysis was

performed for the high- and low-impact scenarios.

Although it was not the main objective of this study, the cardiovascular events avoided annually were estimated, including total events as well as events by age and sex. In order to put this intervention into perspective, the number of events that would be avoided if all patients with hypertension received adequate treatment—rather than the 40% that currently receive treatment—was also estimated, assuming an average reduction of 15 mm Hg in blood pressure.

RESULTS

The total estimated cost of intervention was US$14 million for the 10 year period (approximately US$0.80 per capita for the population aged 35–84 years in the study period), including the cost of intervention and the communication strategy (Table 2).

In the high-impact salt reduction scenario—even considering the cost of program implementation—the intervention generated net savings of US$3 765 million as a result of reduced events and hospital admissions. The reduction in salt intake was associated with a 656 657 gain in QALYs. In this case, intervention would produce a net savings in resources with a beneficial effect that, according to the usual practice, does not require additional analysis of the incremental cost-utility ratio. For the low-impact scenario, the net savings was US$2 080 million, with a 401 659 gain in QALYs (Table 2).

In the high-impact scenario, the net savings that this intervention could generate would be equivalent to 0.7% of the total health budget of Argentina.

In 10 years of intervention, application of this series of measures could reduce the annual number of new cases of heart disease, myocardial infarction, and stroke, as well as deaths due to heart disease and total deaths, which would lead to an increase in the QALYs gained as a result of reduced salt intake (Figure 1). The largest gain in QALYs in the 10 year period was recorded in men aged 55–64 years (135 127 QALYs) in the high-impact scenario.

Also in the high-impact scenario, the annual reduction in the number of events analyzed was 24.1% for heart disease, 21.6% for myocardial infarction, 20.5% for stroke, 19.9% for deaths associated with heart disease, and 6.4% for deaths due to all causes.

With intervention, proportional reductions in new cases of heart disease and stroke were observed, regardless of sex or age (Figures 2 and 3).

In general, in the high-impact scenario 22 800 cases of heart disease, 13 517 myocardial infarctions, 13 118 cases of stroke, 5 867 coronary deaths, and 16 896 deaths due to all causes would be avoided (Table 3).

With implementation of these policies the impact obtained would be slightly less than that achieved if adequate and timely treatment of all persons with hypertension, rather than the 40% that currently receive treatment, was guaranteed (Table 3).

DISCUSSION

This analysis showed that implementation of policies to reduce salt intake would lead to a significant reduction in the health care costs associated with cerebrovascular disease. This reduction would be greater than the cost of intervention and would represent a significant gain in QALYs. The proposed intervention could be beneficial for all persons over 35 years of age. These results would only be produced by the impact of lower salt intake on reduced blood pressure. Other factors that cause hypertension or risk of the events studied were not modified. The results presented agree with the results found in studies conducted in other countries (10, 11, 37, 38).

Although a 3 g reduction in daily dietary salt would be highly beneficial for health, this change is difficult to achieve in the short term (39). In order to change the lifestyle of the population, it is necessary to resort to multidisciplinary interventions that have an impact on all aspects associated with the behavior that is to be modified. The Less Salt More Life initiative proposed jointly by the Ministry of Health with other ministries and social actors includes most of the recommended elements: involvement of different sectors of the society, mass media educational campaigns, and evaluation and monitoring processes (7). In this regard, mechanisms that monitor and assess compliance with the agreements with the food industry will still need to be implemented. For this purpose, the recommendations on this subject by the regional group of experts should be followed.

One of the limitations of the analysis presented, like all cost-utility ratio studies, is that the information on cost and impact is from secondary data sources and assumptions. Therefore, it is susceptible to information biases. Changes in data magnitude or assumptions could produce significant changes in the re-

TABLE 2. Cost-utility ratio analysis of salt reduction intervention in high-impact and low-impact scenarios according to 10 year model, Argentina (2010–2020)

Scenario	Cost of intervention[a] (millions of US$)[b]	Cost of heart disease (millions of US$)	Costs unrelated to heart disease (millions of US$)	Marginal cost (millions of US$) (cost of salt reduction–total cost of current situation) (1)	QALY[c]	Marginal effect (QALY salt reduction – QALY current situation) (2)	Incremental cost-utility ratio (US$ per QALY) (1)/(2)
Current	0.00	17 931.00	120 594.00	0	169 993.822		
With high-impact salt reduction	14.00	16 001.00	118 759.00	–3 765	169 650.479	656 657	NA[d]
With low-impact salt reduction	14.00	16 693.00	119 752.00	–2 080	169 395.481	401 659	NA

[a] Cost of 10 years of intervention (2010-2020) at annual rate of US$1.6 million with 3% annual reduction rate.
[b] United States dollars. Exchange rate: US$1.00 = $4.40 (Argentine pesos), according to Banco Central de la República Argentina exchange rate in February 2012 (http://www.bcra.gov.ar).
[c] QALY: Quality-adjusted life years.
[d] NA: Not applicable.

FIGURE 1. Gain in quality-adjusted life years (QALY) by age group and sex according to 10 year model, Argentina (2010–2020)

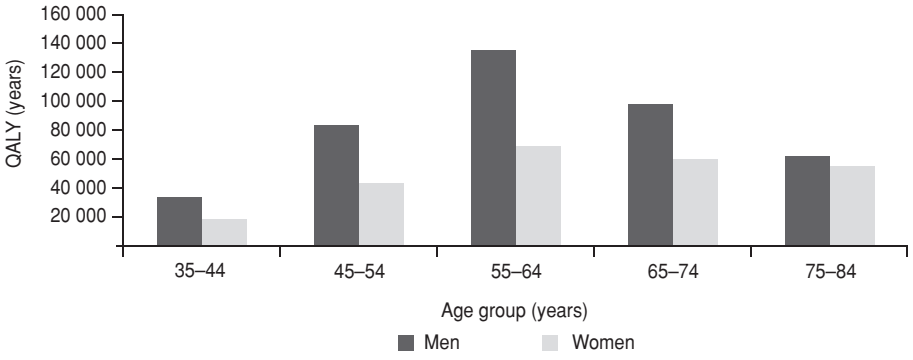

FIGURE 2. Reduction in incidence of heart disease by age group and sex according to 10 year model, Argentina (2010–2020)

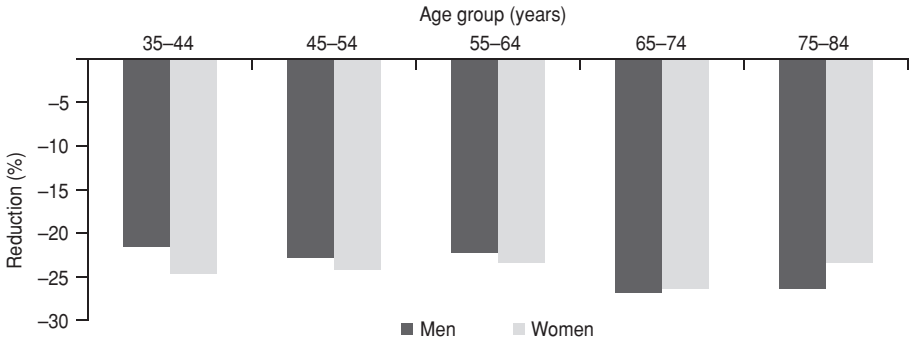

FIGURE 3. Reduction in incidence of cerebrovascular disease by age group and sex according to 10 year model, Argentina (2010–2020)

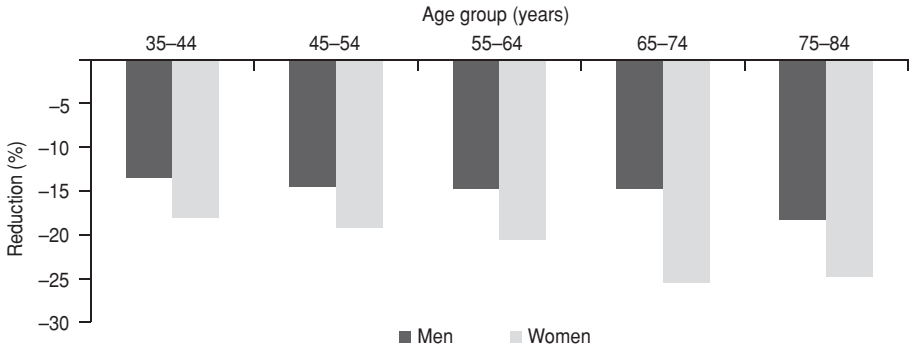

TABLE 3. Reduction in number of annual cardiovascular events in each scenario compared to absence of intervention according to 10 year model, Argentina (2010–2020)

Scenario	Cardiovascular disease	Acute myocardial infarction	Stroke	Coronary death	Death
With high-impact sodium reduction	22 800	13 517	13 118	5 867	16 896
With low-impact sodium reduction	14 641	8 892	8 595	3 861	10 327
Without sodium reduction and with antihypertensive treatment[a]	27 360	16 220	17 053	7 040	19 430

[a] Treatment of all patients with hypertension according to World Health Organization guidelines.

sults. The evidence that salt reduction is associated with reduced blood pressure is from systematic reviews and it may not be applicable at the population level, although this is a recommendation made by several authorities (12, 40). Furthermore, in this study a linear relationship between reduced salt intake and hypertension was assumed, although some studies suggest that this relationship may not be linear (35) and that the impact of salt reduction may be even greater.

Another possible limitation is related to the method used to estimate per capita salt intake, since the specific studies that are required have not been conducted. Nevertheless, for simulation according to this model it is not necessary to have accurate information. Although the policy impact on heart disease simulation model was originally designed to be used in the United States, it has been adapted to other countries such as China (41) and Argentina (5). Finally, although it is not the result of specific validated studies, the percentage of cardiovascular events that the model attributes to hypertension in Argentina is comparable to the percentage attributed by the INTERHEART Latin American study (42, 43) and comparisons with the burden of disease suggest that it may be valid for Argentina (5).

In spite of these limitations the simulation showed that, even if it does not reach the goal of 5 g of daily salt intake proposed by WHO (44), reduced salt intake could have a very positive effect on health in Argentina.

Reduction of the salt content of food, supported by communication and education strategies for the general population, could be effective and feasible for prevention and control of cardiovascular disease in other countries of the Region where inequalities in access to treatment of hypertension (45) and increased salt intake (2,4) have been observed.

This analysis shows that implementation of policies that reduce salt intake could have benefits for public health at a cost that is low enough so that it would clearly compensate for the investment required. This information, which was obtained by careful evaluation, could be useful to those responsible for decision-making and promotion of health policies that seek to control hypertension in the population as a whole.

Acknowledgements. We acknowledge the collaboration of Kirsten Bibbings-Domingo from the University of California, San Francisco and her team for support in data analysis and review of the manuscript.

REFERENCES

1. World Health Organization. Chronic diseases, a vital investment. WHO Global Report. Geneva; WHO; 2005.
2. Pan American Health Organization. Health in the Americas 2007. Washington, D.C.: PAHO; 2007. (Scientific Publication No. 622).
3. Argentina, Ministerio de Salud de la Nación. Estadísticas vitales. Información básica, año 2010. Buenos Aires: Ministerio de Salud de la Nación; 2010. Available from: http://www.deis.gov.ar/publicaciones/archivos/Serie5Nro52.pdf Accessed 30 September 2012.
4. Ferrante D, Linetzky B, Konfino J. Encuesta Nacional de Factores de Riesgo: evolución de la epidemia de las enfermedades crónicas no transmisibles 2009. Rev Argent Salud Publica. 2011;2:34–41.
5. Moran A, Degennaro V, Ferrante D, Coxson PG, Palmas W, Mejía R, et al. Coronary heart disease and stroke attributable to major risk factors are similar in Argentina and the United States: the Coronary Heart Disease Policy Model. Int J Cardiol. 2011;150:332–7.
6. Ferrante D, Apro N, Ferreira V, Virgolini M, Aguilar V, Sosa M, et al. Feasibility of salt reduction in processed foods in Argentina. Rev Panam Salud Publica. 2011;29(2): 69–75.
7. Gaziano TA, Galea G, Reddy KS. Scaling up interventions for chronic disease prevention: the evidence. Lancet. 2007;370: 1939–46.
8. He FJ, MacGregor GA. How far should salt intake be reduced? Hypertension. 2003;42:1093–9.
9. He FJ, MacGregor GA. Effect of modest salt reduction on blood pressure: a meta-analysis of randomized trials. Implications for public health. J Hum Hypertens. 2002;16:761–70.
10. Food Standards Agency. Impact assessment of the revised salt reduction targets. London: FSA; 2009. Available from: http://www.food.gov.uk/multimedia/pdfs/consultation/iarevsaltredtargets.pdf Accessed 21 September 2010.
11. Bibbins-Domingo K, Chertow GM, Coxson PG, Moran A, Lightwood JM, Pletcher MJ, et al. Projected effect of dietary salt reductions on future cardiovascular disease. N Engl J Med. 2010;362:590–9.
12. Public Health Agency of Canada. Mobilizing for dietary salt reduction in the Americas. Miami, FL: PHAC; 2009. Available from: http://www.paho.org/english/ad/dpc/nc/salt_mtg_rpt.pdf Accessed 21 September 2010.
13. He FJ, MacGregor GA. Effect of longer-term modest salt reduction on blood pressure. Cochrane Database Syst Rev. 2004;3.
14. Argentina, Ministerio de Salud de la Nación. Plan Argentina Saludable. Buenos Aires: Ministerio de Salud de la Nación; 2010. Available from: http://www.msal.gov.ar/argentina_saludable/plan/argsal.html Accessed 30 September 2012.
15. Sellers DE, Crawford SL, Bullock K, McKinlay JB. Understanding the variability in the effectiveness of community heart health programs: a meta-analysis. Soc Sci Med. 1997;44:1325–39.
16. Weinstein MC, Coxson PG, Williams LW, Pass TM, Stason WB, Goldman L. Forecasting coronary heart disease incidence, mortality, and cost: the Coronary Heart Disease Policy Model. Am J Public Health. 1987;77:1417–26.
17. Bibbins-Domingo K, Coxson P, Pletcher MJ, Lightwood J, Goldman L. Adolescent overweight and future adult coronary heart disease. N Engl J Med. 2007;357:2371–9.
18. Argentina, Instituto Nacional de Estadísticas y Censos. Sistema Estadístico Nacional. Buenos Aires: INDEC; 2009. Available from: http://www.indec.gov.ar/ Accessed 31 July 2010.
19. Argentina, Ministerio de Salud de la Nación. Segunda Encuesta Nacional de Factores de Riesgo. Buenos Aires: Ministerio de Salud de la Nación; 2011.
20. Schargrodsky H, Hernández-Hernández R, Champagne BM, Silva H, Vinueza R, Silva Ayçaguer LC, et al. CARMELA: assessment of cardiovascular risk in seven Latin American cities. Am J Med. 2008;121: 58–65.
21. Caccavo A, Álvarez A, Bello F, Ferrari A, Carrique A, Lasdica S, et al. Incidencia poblacional del infarto con elevación del ST o bloqueo de rama izquierda a lo largo de 11 años en una comunidad de la provincia de Buenos Aires. Rev Argent Cardiol. 2007;75:185–8.
22. Blanco P, Gagliardi J, Higa C, Dini A, Guetta J, Di Toro D, et al. Infarto agudo del miocardio. Resultados de la Encuesta SAC 2005 en la República Argentina. Rev Argent Cardiol. 2007;75:163–70.
23. Sposato LA, Esnaola MM, Zamora R, Zurrú MC, Fustinoni O, Saposnik G, et al. Quality of ischemic stroke care in emerging countries: the Argentinean National Stroke Registry (ReNACer). Stroke. 2008;39:3036–41.
24. Argentina, Ministerio de Salud de la Nación. Egresos de establecimientos oficiales por diagnostico, 2007. Buenos Aires: Ministerio de Salud de la Nación; 2009. Available from: http://www.deis.gov.ar/publicaciones/Archivos/Serie11Nro3.pdf Accessed 30 September 2012.
25. Melcon CM, Melcon MO. Prevalence of stroke in an Argentine community. Neuroepidemiology. 2006;27:81–8.
26. De Sereday MS, González C, Giorgini D, De Loredo L, Braguinsky J, Cobeñas C, et al. Prevalence of diabetes, obesity, hypertension and hyperlipidemia in the central area of Argentina. Diabetes Metab. 2004;30:335–9.
27. Argentina, Ministerio de Salud de la Nación. Estadísticas vitales. Información básica, 2010. Buenos Aires: Ministerio de Salud de la Nación; 2010. Available from: http://www.deis.gov.ar/publicaciones/archivos/Serie5Nro52.pdf Accessed 30 September 2012.
28. Pan American Health Organization. International Statistical Classification of Diseases and Related Health Problems. 10th revision (ICD-10). Volume I. Washington, D.C.: PAHO; 2008. Available from: http://ais.paho.org/classifications/Chapters/index.htm Accessed 30 September 2012.
29. Lozano R, Murray CJ, López AD, Satoh T. Miscoding and misclassification of ischaemic heart disease mortality. Geneva: World Health Organization; 2001 (Global Programme on Evidence for Health Policy Working Paper No. 12).
30. Gold MR, Siegel JERL, Weinstein MC, eds. Cost-effectiveness in health and medicine. Oxford: Oxford University Press; 1996.
31. Borracci R, Rubio M, Insua J. Análisis de costos médicos y resultados de la cirugía coronaria sin circulación extracorpórea. Rev Argent Cardiol. 2006;74:289–96.
32. Base de Datos de Costos Sanitarios Argentinos. Documento Técnico N° 3. Buenos Aires: Instituto de Efectividad Clínica y Sanitaria; 2010. Available from: www.iecs.org.ar Accessed 30 September 2012.
33. Instituto Nacional de Estadísticas y Censos. Serie histórica del índice de precios al consumidor (IPC) en el Gran Buenos Aires. Buenos Aires: INDEC; 2010. Available from: http://www.indec.mecon.ar/principal.asp?id_tema=748. Accessed 30 September 2012.
34. MacGregor GA, Markandu ND, Sagnella GA, Singer DR, Cappuccio FP. Double-blind study of three sodium intakes and long-term effects of sodium restriction in essential hypertension. Lancet. 1989;2:1244–7.
35. Sacks FM, Svetkey LP, Vollmer WM, Appel LJ, Bray GA, Harsha D, et al. Effects on blood pressure of reduced dietary sodium and the Dietary Approaches to Stop Hypertension (DASH) diet. N Engl J Med. 2001;344:3–10.
36. Drummond M, Sculper M, Torrance G, O' Brien B, Stoddart G. Cost-effectiveness analysis. Methods for the economic evaluation of health care programmes. Oxford: Oxford University Press; 2005. Pp. 103–33.
37. Danaei G, Ding EL, Mozaffarian D, Taylor B, Rehm J, Murray CJ, et al. The preventable causes of death in the United States: comparative risk assessment of dietary, lifestyle, and metabolic risk factors. PLoS Med. 2009;6:e1000058.
38. Palar K, Sturm R. Potential societal savings from reduced sodium consumption in the U.S. adult population. Am J Health Promot. 2009;24:49–57.
39. Hooper L, Bartlett C, Davey SG, Ebrahim S. Advice to reduce dietary salt for prevention of cardiovascular disease. Cochrane Database Syst Rev. 2004;(1):CD003656.
40. Beaglehole R, Bonita R, Horton R, Adams C, Alleyne G, Asaria P, et al. Priority actions for the non-communicable disease crisis. Lancet. 2011;23;377(9775):1438–47.
41. Moran A, Gu D, Zhao D, Coxson P, Wang YC, Chen CS, et al. Future cardiovascular disease in China: Markov model and risk

factor scenario projections from the Coronary Heart Disease Policy Model-China. Circ Cardiovasc Qual Outcomes. 2010;3(3):243–52.
42. Lanas F, Avezum A, Bautista LE, Díaz R, Luna M, Islam S, et al. Risk factors for acute myocardial infarction in Latin America: the INTERHEART Latin American Study. Circulation. 2007;115:1067–74.
43. Yusuf S, Hawken S, Ounpuu S, Dans T, Avezum A, Lanas F, et al. Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): case-control study. Lancet. 2004;364:937–52.
44. World Health Organization. Global strategy on diet, physical activity and health. Geneva: WHO; 2004. Available from: http://www.who.int/dietphysicalactivity/strategy/eb11344/strategy_english_web.pdf Accessed 21 September 2010.
45. Gulliford MC, Mahabir D, Rocke B. Socioeconomic inequality in blood pressure and its determinants: cross-sectional data from Trinidad and Tobago. J Hum Hypertens. 2004;18:61–70.

Manuscript received on 1 May 2012. Revised version accepted for publication on 9 October 2012.

Relación costo-utilidad de la disminución del consumo de sal y su efecto en la incidencia de enfermedades cardiovasculares en Argentina

RESUMEN

Objetivo. Estimar la relación costo-utilidad de una intervención dirigida a reducir el consumo de sal en la dieta de personas mayores de 35 años en Argentina.

Métodos. La intervención consistió en reducir entre 5% y 25% el contenido de sal en los alimentos. Se utilizó el modelo de simulación del impacto de las políticas sobre la enfermedad coronaria para predecir la evolución de la incidencia, la prevalencia, la mortalidad y los costos en la población de la enfermedad coronaria y cerebrovascular en personas de 35 a 84 años. Se modeló el efecto y los costos de una disminución de 3 g de sal en la dieta, mediante su reducción en alimentos procesados y en la añadida por los consumidores, por un período de 10 años. Se estimó el cambio en la ocurrencia de eventos en este período y la ganancia en años de vida ajustados por la calidad (AVAC) en un escenario de efecto alto y otro de efecto bajo.

Resultados. La intervención generó un ahorro neto de US$ 3 765 millones y una ganancia de 656 657 AVAC en el escenario de efecto alto y de US$ 2 080 millones y 401 659 AVAC en el escenario de efecto bajo. Se obtendrían reducciones en la incidencia de enfermedad coronaria (24,1%), infarto agudo de miocardio (21,6%) y accidente cerebrovascular (20,5%), y en la mortalidad por enfermedad coronaria (19,9%) y por todas las causas (6,4%). Se observaron beneficios para todos los grupos de edad y sexo.

Conclusiones. La implementación de esta estrategia de reducción del consumo de sal produciría un efecto sanitario muy positivo, tanto en AVAC ganados como en recursos económicos ahorrados.

Palabras clave Sodio en la dieta; enfermedades cardiovasculares; análisis costo-beneficio; Argentina.