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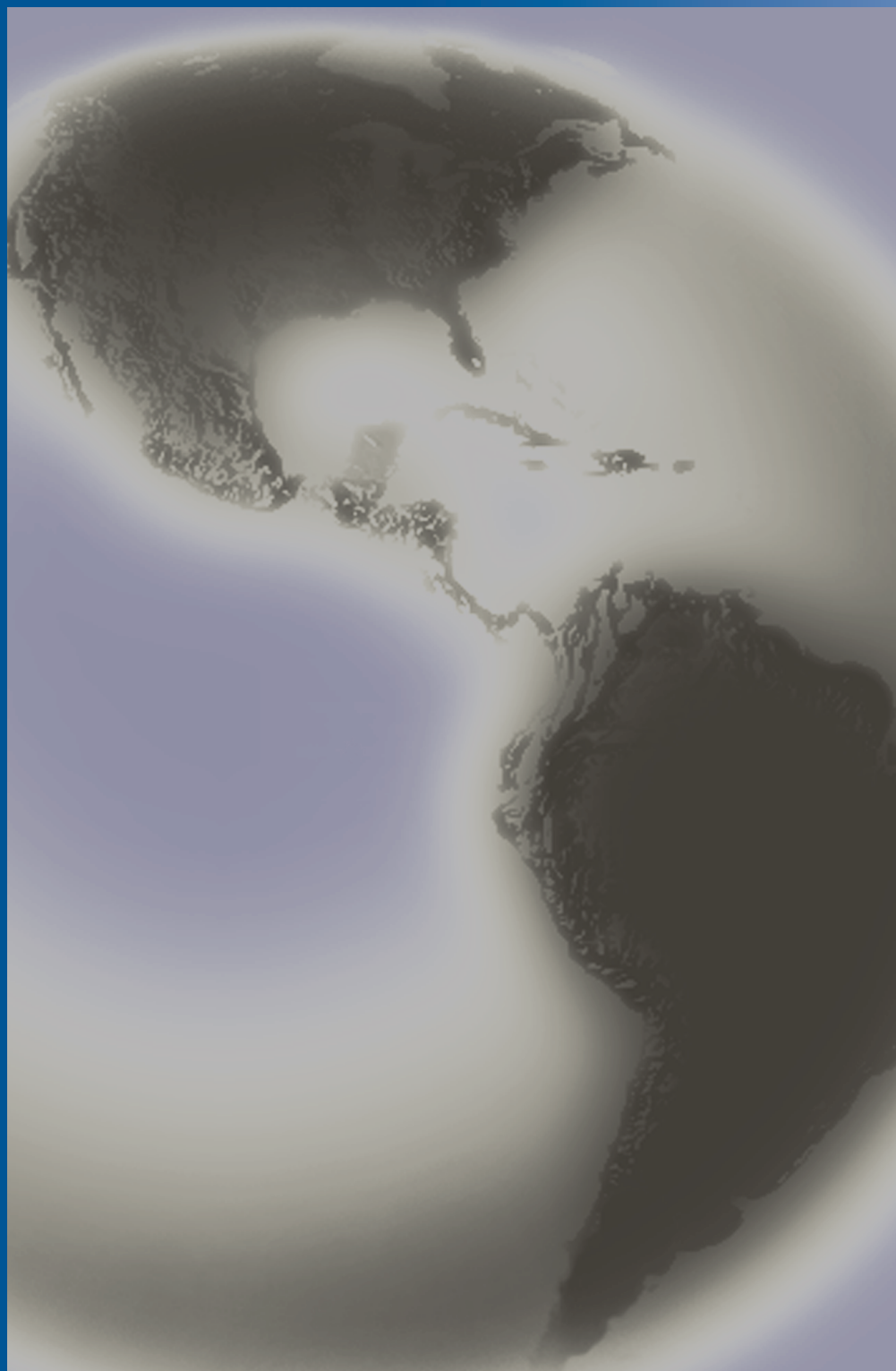
THEMATIC ISSUE
ECONOMICS OF NONCOMMUNICABLE DISEASES

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About the thematic issue on economics of noncommunicable diseases

The global health burden of noncommunicable diseases (NCDs) is large and growing, and this group of diseases already accounts for 70% of total deaths. Global evidence indicates that the high health burden of NCDs translates into significant economic and social costs that threaten to diminish the quality of life of millions of individuals, impoverish families, jeopardize universal health coverage, and increase health disparities within and between countries. Evidence consistently shows that the NCD epidemic cannot be tackled through interventions and policies in the health sector alone. In particular, prevention measures that address NCD risk factors involve a range of sectors including finance, trade, education, agriculture, and transportation. As economics has become the common language among decision makers across sectors, it is imperative that health authorities leverage economic information to more effectively communicate the urgency of tackling NCDs and related risk factors.

This thematic issue of the *Pan American Journal of Public Health* is part of a continued collaboration between the Public Health Agency of Canada (PHAC) and PAHO/WHO to facilitate intragovernmental dialogue for a better understanding of NCD issues by making economic evidence available in the Americas, and to assist countries in integrating economic approaches into their NCD prevention and control policies.

EDITORIALS

ARTICLES

Advancing the economics of noncommunicable diseases in the Americas

Carissa F. Etienne[1]

The global health burden of noncommunicable diseases (NCDs) is large and growing, as this group of diseases already accounts for 70% of total deaths (1). Global evidence indicates that the high health burden of NCDs translates into significant economic and social costs that threaten to diminish the quality of life of millions of individuals, impoverish families, jeopardize universal health coverage, and increase health disparities within and between countries (2). On the other hand, less than 2% of global donor health funding is directed towards preventing these diseases (3). Recognizing the trends in NCDs and the global evidence on their multidimensional costs and their potential to hamper development, Goal 3 of the Sustainable Development Goals includes a specific target (Target 3.4) of reducing mortality from NCDs by one-third by 2030 (4).

NCDs are largely preventable, and proven solutions to reduce their burden exist at both the clinical and policy levels. In May 2017, the 70th World Health Assembly endorsed updates to the menu of cost-effective and feasible policy options for the prevention and control of NCDs, taking into consideration the emergence of new evidence of cost-effectiveness and new recommendations made by the World Health Organization (WHO) following the adoption of the Global Action Plan in 2013. Of the 88 interventions in the updated menu of policy options, 15 are highlighted as most cost-effective[2] and most feasible for implementation (often referred to as "best buys") (5). Of note, many of these cost-effective interventions require the involvement of government sectors beyond health. Evidence consistently shows that the NCD epidemic cannot be tackled through interventions and policies in the health sector alone. In particular, prevention measures that address NCD risk factors involve a range of sectors including finance, trade, education, agriculture, and transportation. As economics has become the common language among decision makers across sectors, it is imperative that health authorities of the Pan American Health Organization/World Health Organization (PAHO/WHO) Member States leverage economic information to more effectively communicate the urgency of tackling NCDs and related risk factors.

While PAHO/WHO Member States are committed to curbing the NCD epidemic, the limited and fragmented regional and country-specific information on the economic burden of NCDs undermines effective advocacy for the comprehensive development, financing, and implementation of multisectoral policies on NCDs. Currently, evidence is largely focused on the direct costs to health systems, as well as for specific disease or risk factors. This lack of information presents a barrier to advancing a comprehensive NCD agenda. Developing evidence at the country and regional levels on (a) the impact of NCDs on social and economic development, (b) the costs and benefits of implementing prevention and control measures in country-specific contexts, (c) the impact of NCDs on socioeconomic inequalities, and (d) the potential linkages between changing trade patterns and NCDs is essential for communicating the urgency of tackling NCDs, fostering evidence-based NCD policies, promoting NCD policy coherence across sectors, and ultimately, reducing the heavy burden of NCDs in the Region of the Americas.

PAHO/WHO is committed to strengthening its Member States' capacity to use economic evidence on NCDs to advocate for a wholistic government approach to NCDs. Therefore, PAHO/WHO has been working with partners, including the

1 Director, Pan American Health Organization, Regional Office for the Americas of the World Health Organization, Washington, D.C., United States of America.

2 Average Cost-Effectiveness Ratio ≤ I\$ 100/DALY in low- and middle-income countries. DALY = Disability Adjusted Life-Years, a measure of quality and quantity of life.

United Nations Inter-Agency Task Force on NCDs (UNIATF), the Organization for Economic Co-operation and Development (OECD), the Economic Commission for Latin America and the Caribbean (ECLAC), the United States Centers for Disease Control and Prevention (CDC), and the Public Health Agency of Canada (PHAC), to support regional efforts to implement PAHO/WHO Action Plans for the Prevention and Control of Noncommunicable Diseases through policy-focused evidence on the economics of NCDs. This thematic issue of the *Pan American Journal of Public Health* is part of a continued collaboration between PHAC and PAHO/WHO to facilitate intragovernmental dialogue for a better understanding of NCD issues by making economic evidence available in the Americas, and to assist PAHO/WHO Member States in integrating economic approaches into their NCD prevention and control policies. It is our hope that national health authorities will use the evidence presented in this issue to more vigorously advocate for the comprehensive development, financing, and implementation of evidence-based multisectoral policies on NCDs and their related risk factors.

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Appreciation

Building collaborations to integrate economics into noncommunicable disease action

Theresa Tam[1]

In the past decade, we have seen extraordinary momentum in countries' commitment to the noncommunicable disease (NCD) agenda, culminating in the inclusion of NCDs in the 2030 United Nations Sustainable Development Goals. Nonetheless, many countries face recurring challenges as they move towards healthy public policies that scale up multisectoral action on NCDs.

NCDs are a "wicked" problem (1) that cannot be understood or solved from the perspective of a single discipline or sector alone. As a global community, we have committed to engaging the efforts and expertise of all sectors of society to address NCDs (2). Those of us in the field of public health need to draw on our strengths as convenors to work with colleagues in non-health sectors and social science disciplines to find and implement NCD solutions.

Countries need to see how progress on NCDs will benefit their societies. Non-health sectors need to have a case for healthy public policy articulated in economic concepts and measures. As well, public health authorities are seeking more effective public health policy-making.

Economics can address many of these needs. It offers measures which can be understood by various sectors and has become an accepted analytical language of public policy. It speaks to and shapes the thinking of decision-makers in many of the sectors that are essential for action on NCDs. It can help forecast socioeconomic and epidemiological trends and provide insights into lifestyle behaviour and evidence about causal relationships. It can also provide the means to assess how policies impact wellbeing, including inequalities and, in turn, inform the design of effective interventions.

By bringing economic reasoning into its communications with other sectors, government central authorities, and multilateral organizations, public health will strengthen the impetus for whole-of-society action. Tobacco-focussed economics research, for example, has led the way to examine individuals' and industry's responses to taxes, as well as other implications of tobacco control. However, the economic analysis needed to guide multisectoral policy response is less advanced for other NCD risk factors.

Why such sparseness in economic analyses? One constraint is the limited integration of economic data in surveillance infrastructure. Building surveillance capacity and platforms that integrate health expenditure as well as multisectoral socioeconomic data with epidemiological information, remains challenging for all jurisdictions in the Americas. In Canada, initial steps include expansion of the Canadian Chronic Diseases Surveillance System[2] to incorporate healthcare cost and socioeconomic data. Also, in April 2017, the Public Health Agency of Canada (PHAC) launched the online, interactive Health Inequalities Data Tool[3], providing 70 indicators of health determinants and health status, disaggregated by socioeconomic variables.

Another possible explanation is the relatively limited collaboration between public health researchers and the broad range of economists and other social scientists in the Americas. Currently, practical applications of health economics focus largely on health care systems. However, these health-care-driven applications of economic methods may not be a good fit for complex public health issues. By opening up our collaborations to include economists from outside the health sector (e.g. in agriculture, transportation, environment), as well as other social scientists, public health can engage their expertise to address these complexities.

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[2]   https://infobase.phac-aspc.gc.ca/ccdss-scsmc/data-tool/
[3]   https://infobase.phac-aspc.gc.ca/health-inequalities/

Through knowledge translation and interdisciplinary collaboration among public health professionals, economists, other social scientists, policy makers and practitioners, innovative multisectoral interventions can be developed that take theory to practice. They can also engage the expertise and resources of diverse sectors. In Canada, for example, PHAC's *Multisectoral Partnerships to Promote Healthy Living and Prevent Chronic Disease*[4] are exploring partnership arrangements and funding models to advance innovative solutions.

At the global level, multilateral organizations, including the World Bank,[5] the Organisation for Economic Co-operation and Development[6], the World Health Organization (WHO) and the United Nations Development Programme[7], are contributing to the integration of economic analysis and evidence for NCDs. In the Americas, PHAC has been working with the Pan American Health Organization (PAHO) to scout a path to integrate economics into NCD efforts and facilitate research collaborations. This work, through the WHO Collaborating Centre on NCD Policy at PHAC, began with collaboration on the 2005 WHO publication "Chronic Disease: A Vital Investment". It continues with participation in PAHO's series of workshops on the economics of NCDs and this special supplement. I am pleased that PHAC and other Canadian academic economists have contributed.

This special supplement is an important milestone in advancing the integration of economics into efforts to address NCDs in the Americas. I look forward to continuing collaboration across the Americas to deepen the analysis and increase the uptake of economics on NCDs questions resulting in better public policy and healthier populations.

Disclaimer. The views expressed in this manuscript do not necessarily reflect those of the Government of Canada, and may not necessarily reflect the opinion or policy of the RPSP/PAJPH or PAHO.

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[6]   e.g. OECD trends, inequalities and clustering analysis (4).
[7]   e.g. WHO-UNDP Task force on NCDs (5).

Identifying patterns of unhealthy diet and physical activity in four countries of the Americas: a latent class analysis

Sahara Graf[1] and Michele Cecchini[2]

ABSTRACT

Objectives. *To determine clusters of individuals who present similar health behaviors in terms of diet, physical activity, and sedentarism, in four countries of the Americas: Brazil (2013), Chile (2009), Mexico (2012), and the United States of America (2013). This makes it possible to determine which of these behaviors occur simultaneously, as well as the demographic and sociodemographic characteristics associated with each cluster.*

Methods. *The individual-level data analyzed were drawn from national health interviews and health examination surveys in Brazil, Chile, Mexico, and the United States, for different time periods. Using international physical activity guidelines and national dietary guidelines, the health behaviors of each individual were assessed. A latent class analysis was conducted to classify individuals into clusters based on these behaviors, and was followed by multinomial regressions to determine the characteristics of those in each class.*

Results. *Overall, most individuals belonged to the classes characterized by average or unhealthy diets but sufficient amounts of physical activity. However, large differences exist across countries and population groups. Men with higher socioeconomic characteristics were globally more likely to belong to the least healthy class in each country.*

Conclusions. *Findings from this analysis support the implementation of more refined policy actions to target specific unhealthy behaviors in different population groups, defined by gender, age group, socioeconomic status, and, to some extent, place of residence. The at-risk populations identified through this paper are those that should be targeted by upcoming interventions.*

Keywords Epidemiology; diet; life style; exercise; Americas.

In recent decades, unhealthy lifestyles have fueled an epidemic of noncommunicable diseases (NCDs) that are now the first cause of health burden worldwide (1). In the Americas, it is estimated that over 200 million people are living with

an NCD, and that NCDs are associated with 79% of all deaths (2). The prevalence of diabetes, cardiovascular diseases, and other chronic diseases has increased significantly, particularly in Latin American countries (3). Meanwhile, diet quality has deteriorated, and physical activity (PA) has not risen, despite an increasing volume of public policies (4).

Lack of PA, high amounts of sedentary behavior (SB), and low-quality diet are

well-known key risk factors for NCDs (1). These behaviors have a dual effect. In addition to being key risk factors for NCDs, they are also key risk factors for obesity (3), which in turn can lead to NCDs. In 2014, approximately 58% of the adult population in Latin America and the Caribbean was overweight, including 23% of obese people (5). Overweight affects over 50% of the population in nearly all the countries of Latin America

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and the Caribbean. In 2015, high body mass index (BMI) led to over 4.5 million deaths worldwide (1). This double pathway to NCDs makes prevention of these risk factors all the more crucial. This is especially true since healthy dietary choices and PA have all been proven to be effective in the prevention and treatment of NCDs (6).

Tackling major risk factors or NCDs requires more than a single preventive intervention; fundamental change can only occur through wide-ranging strategies that address multiple determinants of health (such as diet and PA) (7). Furthermore, cost-effectiveness of a preventive measure is typically improved by targeting a high-risk population (8). This increases the proportion of individuals who benefit and therefore the health benefits gained per unit of money spent.

Policies must be tailored to fit the needs of specific groups of people, to target multiple specific behaviors that may vary across the population. These unhealthy behaviors, as well as the subpopulations that exhibit these behaviors, are likely to be country-dependent. Therefore, tailoring prevention policies to meet the needs of different countries is key.

This paper aims to identify high-risk groups, that is, ones that are most likely to exhibit unhealthy dietary behaviors, lack of PA, or excessive SB, as well as the characteristics that define them, in four countries of the Americas: Brazil (2013), Chile (2009), Mexico (2012), and the United States of America (2013). Findings from this paper can be used to inform the tailoring of prevention policies in these countries and to increase the effectiveness and cost-effectiveness of population-based actions to tackle unhealthy behaviors and associated NCDs.

MATERIALS AND METHODS

Data

The analyses undertaken in the following article are based on individual data, which were drawn from national health interviews and health examination surveys from Brazil, Chile, Mexico, and the United States. The data for Brazil were drawn from the Pesquisa Nacional de Saúde (National Health Survey) (PNS) 2013. The dataset for Chile includes data from the Encuesta Nacional de Salud (National Health Survey) (ENS), and refers to survey year 2009. Mexican data is

from the Encuesta Nacional de Salud y Nutrición (National Health and Nutrition Survey) (ENSANUT) 2012. Finally, the database for the United States includes the data from the National Health and Nutrition Examination Survey (NHANES) of 2013. The analyses were performed using self-reported data on dietary behaviors, PA, and SB.

Dietary habits were surveyed either through a 24-hour recall (United States) or food frequency questionnaires (Brazil, Chile, and Mexico). The 24-hour recall makes it possible to record precise data on types and amounts of food consumed, and from that extract daily nutrient intakes. The food frequency questionnaires assess the frequency with which different foods are consumed, on a daily or weekly basis. The foods included in the questionnaires differ by country. These two approaches are validated, and are widely used (9).

The PA questionnaires used in the different surveys resemble the General Physical Activity Questionnaire (GPAQ) (10), which was used for the NHANES, or the International Physical Activity Questionnaire (IPAQ) (11). Depending on the country, PA was surveyed either globally, without breaking it down into categories, or by domain (leisure, transport-related, work-related, and domestic and gardening). Most questionnaires also survey the intensity of the PA (vigorous or moderate). SB was surveyed similarly for Chile, Mexico, and the United States, by asking the length of daily sedentarism on a "usual day." For Brazil, only daily television time was available, which we used as a proxy.

Statistical analysis

Our analysis is based on latent class analysis (LCA). LCA is a statistical technique that is used to sort individuals from a heterogeneous population into homogenous unobservable (latent) classes. The algorithm uses observable variables (manifest variables) to separate individuals into groups of people who share similar characteristics, by searching for the most frequent and similar patterns among the distributions of these variables. The technique produces latent class membership probabilities, which list the probability of belonging to each latent class, and the item-response probabilities, which list the probability of possessing a certain

manifest characteristic conditional on latent class membership. These probabilities are model based: they depend on the model specification and estimated parameters, and are therefore called posterior probabilities. LCA has been used to study the clustering of risky behaviors in young people (12), epidemiologic outcomes (13), and PA and SB (14).

Variables concerning PA, SB, and diet were used as the manifest variables. PA was assessed by determining whether the World Health Organization (WHO) recommendations were met or not (15). Sedentarism was assessed by determining whether daily SB was seven hours or more, as risk of mortality increases significantly beyond this threshold (16). Consistent with previous studies (17), for Brazil we established that an individual exhibited excess SB if daily television watching time was three hours or more. Diet was evaluated differently depending on the country. We followed the most recent national guidelines pertaining to each country included: Brazil (18), Chile (19), Mexico (20), and the United States (21).

To ensure that the best fitting latent class model was selected for each country, models running from two to six classes were estimated and compared. The analysis produces the Akaike Information Criterion (AIC), the Bayesian Information Criterion (BIC), the Adjusted Bayesian Information Criterion (ABIC), the Consistent Akaike Information Criterion (CAIC), as well as the G^2, which is a likelihood-ratio χ^2 statistic that is similar to the more renowned Pearson χ^2. The AIC and BIC represent relative model fit. Previous work shows that the AIC tends to overestimate the number of classes necessary, while the BIC tends to underestimate it (22). The ABIC adjusts on sample size (23). When studying larger samples, the most likely error is overfitting, and it is best to use a more parsimonious criterion such as the BIC (24); furthermore, the CAIC has been shown to behave similarly to the BIC in several simulations (25). As the samples used for our analyses were large (N > 2 000 for all datasets), our models were chosen based on the BIC and CAIC, as well as overall interpretability of the resulting classes.

Additionally, 200 randomly selected seeds were used to estimate each model. The analysis produces the percentage of seeds associated with the best fitted model,

which is the percentage of iterations resulting in the highest log-likelihood. This number indicates whether the resulting model most likely represents a local maximum (low percentage), or a global maximum (high percentage). A higher percentage indicates that the model appears well identified (26). Entropy (between 0 and 1) indicates level of separation of classes; higher levels of entropy indicate better separation of latent classes. Weights were used for all analyses, and were standardized through the LCA plug-in.

After the LCAs were completed, multinomial logistic regressions were run, using latent class membership as the dependent variable. The regressions were conducted outside the scope of the LCA plug-in, as this method was less time-consuming, and has been used in other studies (14). Individuals were assigned to the latent class for which they had the highest latent class membership probability. Age, gender, socioeconomic status (SES), education level, level of BMI as identified by WHO thresholds (27), a geographic variable (apart from for the United States), and ethnicity (United States only) were included in the regressions.

For Brazil and Chile, the geographic variable indicates whether an individual lives in a urban or rural area. For Brazil, the variable was extracted from the original national health survey database. For Chile, the variable was created using data from the National Statistics Institute (Instituto Nacional de Estadísticas) (28); regions whose rural population was higher than the national average were considered to be rural, while those whose rural population was lower were considered to be urban. For Mexico, the variable used was included in the original database, and establishes a region as rural, urban, or metropolitan. No regional variables were available for the United States; however, an ethnicity variable was included in the analysis: non-Hispanic white, non-Hispanic black, Mexican-American, and other ethnicity.

For variables with a trend (level of education, SES, age), the reference chosen for the regressions is the middle category. After running the regressions, the relative risk ratios (RRRs) were studied. RRRs are comparable to odds ratios, as they are the exponentiated parameters resulting from the regressions.

All analyses were undertaken with the Stata/MP 14.1 software package. The LCAs were carried out using the DoLCA plug-in from the Methodology Center at Penn State University (29). This plug-in produces maximum likelihood estimates for parameters using the "expectation-maximization" (EM) algorithm. It constructs the classes and produces the class membership probabilities and item-response probabilities. All observations containing missing data for the manifest variables were removed before estimation.

RESULTS

A total of 36 316 individuals for Brazil, 4 770 for Chile, 2 222 for Mexico, and 6 239 for the United States were included in the study. To strengthen the analysis, no individuals were excluded on the basis of age. The data for Brazil refer to ages 18-90; the data for Chile refer to ages 15-100; the data for Mexico refer to ages 20-69; and the data for the United States refer to ages 12-80.

Across the different samples, men are more numerous only in Brazil (Table 1). In all countries, a larger share of the population has high SES, while a low or medium level of education is most prominent in Brazil, Chile, and Mexico. In the United States, non-Hispanic white people represent the largest share of the sample, followed by people of other ethnicities, non-Hispanic black people, and Mexican American individuals. Those living in rural areas represent 41% of the sample or less in all countries. In all countries, the majority of individuals (between 57.0% and 70.3%) are overweight or obese. Mexico and the United States have the highest levels of obesity. More than half the population report meeting the WHO recommendations for PA in Chile, Mexico, and the United States, while in Brazil fewer than 30% reach the target. In Brazil, Chile, and Mexico, most of the population displays low SB, while in the United States less than 50% of the sample does so.

The item-response probabilities resulting from the latent class analyses represent the probability for a member of a latent class of meeting or exceeding the recommendations in terms of diet, PA, or SB. For instance, if the item-response probability for high fruit and vegetable (FV) consumption in class 1 is 0.15, as is the case for class 1 in Brazil, then there is a 15% chance that a member of class 1 consumes at least the recommended minimum amount of FV. Therefore, a higher percentage for FV is positive, but a higher percentage for sodium (for instance, class 1 in the United States) is negative. These item-response probabilities are what are used to define and label the different latent classes.

Supplementary Annex Table 1 displays the descriptive statistics for the key variables of the study by country and latent class. It must be noted that the share of individuals in each latent class, as well as the share of health-related behaviors, are not the ones used to identify and label the different latent classes, as they are simple weighted descriptive statistics and not probabilities. This explains why the rates do not always match the latent class membership and item-response probabilities presented below.

The choice of optimal number of latent classes for each country was based on the fit statistics resulting from the analysis (Annex Table 2), as well as overall interpretability of the classes.

The diet, PA, and SB patterns in each latent model differ by country (Figure 1). However, overall, classes are characterized by high probabilities of PA and low probabilities of SB, with the exception of one class in Chile, Mexico, and the United States, in which PA is low and SB is high, as well as two classes in Brazil, in which PA is low but so is SB. In each country, a least healthy latent class can be identified (class 1 in all countries), based on the probabilities of PA, sedentarism, and dietary behaviors. However, healthiest classes can be more difficult to pinpoint, as the balance between good quality diet and levels of PA/SB can be difficult to establish.

The final models chosen for Brazil, Chile, and Mexico have three classes, while the final model for the United States has four classes.

The models for Chile and Mexico are comparable (Panels b and c): one class with a rather unhealthy diet, a low probability of sufficient PA and high probability of excessive SB (class 1); one class that displays a poor quality diet, but healthy levels of PA and SB (class 2); and a final class that is clearly the healthiest, with a high probability of PA, a low probability of SB, and a healthy diet (class 3). For both countries, the second class has the highest membership probability (82%), while the third class represents 14% and 13% of the sample in Chile and Mexico, respectively, and the first class represents 4% and 5%, respectively.

TABLE 1. Descriptive statistics for Brazil (2013), Chile (2009), Mexico (2012), and the United States (2013), in study of patterns of unhealthy diet and physical activity

Characteristic	Brazil (N = 36 316) (%)	Chile (N = 4 770) (%)	Mexico (N = 2 222) (%)	United States (N = 6 239) (%)
Gender				
Male	57.20	47.78	45.36	48.26
Female	42.80	52.22	54.64	51.74
Age (yr)				
< 20	4.00	11.29	NA[a]	12.79
20-34	38.66	26.55	37.08	24.48
35-49	34.57	30.09	35.39	23.50
50-64	19.96	19.94	22.59	23.14
65+	2.83	12.13	4.94	16.08
SES[b]				
Low	35.01	33.21	33.10	37.65
Medium	20.10	31.42	19.03	14.34
High	44.89	35.37	47.87	48.01
Education				
Low	40.11	33.49	6.69	14.39
Medium	37.79	43.92	69.94	21.80
High	22.10	22.59	23.37	63.82
Ethnicity				
Non-Hispanic white	NA	NA	NA	65.37
Non-Hispanic black	NA	NA	NA	11.30
Mexican American	NA	NA	NA	9.81
Other ethnicity	NA	NA	NA	13.53
Rurality				
Not rural	87.65	59.45	NA	NA
Rural	12.35	40.55	25.22	NA
Urban	NA	NA	17.21	NA
Metropolitan	NA	NA	57.57	NA
Weight status				
Normal weight (BMI[c] < 25)	43.01	35.39	29.68	34.20
Overweight (25 ≤ BMI < 30)	37.32	39.33	35.11	30.86
Obese (BMI ≥ 30)	19.67	25.28	35.21	34.94
Diet indicators[d]				
High FV[e] intake (≥ 5/day)	22.57	15.74	27.98	NA
High pulses intake	71.80	NA	NA	NA
High dairy intake	41.36	7.10	22.47	NA
High intake of foods of animal origin	70.50	NA	9.33	NA
High fish intake	NA	10.60	NA	NA
High cereals intake	NA	14.22	NA	NA
High intake of cereals/pulses	NA	NA	9.72	NA
High calorie intake	NA	NA	NA	39.90
High fiber intake	NA	NA	NA	12.07
High protein intake	NA	NA	NA	79.82
High sodium intake	NA	NA	NA	93.46
High intake of cholesterol and fat	NA	NA	NA	81.17
Physical activity				
Meet WHO[f] recommendations	29.32	72.07	84.65	57.19
Low sedentary behavior	76.40	85.10	91.02	46.80

Source: Prepared by the authors based on the study results.
[a] NA = not applicable.
[b] SES = socioeconomic status.
[c] BMI = body mass index.
[d] Descriptive statistics for diet indicators express whether consumption meets or exceeds recommendations.
[e] FV = fruits and vegetables.
[f] WHO = World Health Organization.

TABLE 2. Results from multinomial regressions on latent class membership in Brazil, Chile, Mexico, and the United States[a]

Class/Characteristic	Brazil (N = 35 762)		Chile (N = 4 639)		Mexico (N = 2 122)		United States (N = 4 628)	
	RRR[b]	SE[c]	RRR	SE	RRR	SE	RRR	SE
Class 1	Ref.[d]		Ref.		Ref.		Ref.	
Class 2								
Gender								
Male	Ref.		Ref.		Ref.		Ref.	
Female	1.05	0.12	0.96	0.21	3.05***	0.85	1.16	0.16
Age group (yr)								
< 20	1.78	0.74	0.30***	0.09	NA[e]		NA	
20-34	0.94	0.12	0.92	0.34	0.77	0.26	1.00	0.20
35-49	Ref.		Ref.		Ref.		Ref.	
50-64	0.96	0.15	0.92	0.30	0.92	0.38	0.63*	0.12
65+	2.34**	0.65	0.36***	0.10	0.72	0.49	0.91	0.17
SES[f]								
Low	0.77	0.13	1.30	0.30	0.89	0.37	1.17	0.25
Medium	Ref.		Ref.		Ref.		Ref.	
High	1.17	0.20	0.48**	0.12	0.46*	0.18	0.75	0.17
Education								
Low	0.72*	0.11	0.62*	0.14	0.75	0.56	1.41	0.28
Medium	Ref.		Ref.		Ref.		Ref.	
High	0.68**	0.09	0.71	0.23	0.33**	0.11	0.88	0.15
Rurality								
Not rural	Ref.		Ref.		NA		NA	
Rural	0.50***	0.10	1.21	0.28	1.77	0.66	NA	
Urban	NA		NA		1.19	0.49	NA	
Metropolitan	NA		NA		Ref.		NA	
Ethnicity								
Non-Hispanic white	NA		NA		NA		Ref.	
Non-Hispanic black	NA		NA		NA		1.56**	0.24
Mexican American	NA		NA		NA		1.09	0.25
Other ethnicity	NA		NA		NA		1.48*	0.25
Constant[g]	0.04***	0.0086	30.68***	10.21	23.00***	9.08	0.72	0.20
Class 3								
Gender								
Male	Ref.		Ref.		Ref.		Ref.	
Female	1.38***	0.11	2.46**	0.75	2.37*	0.82	0.67***	0.08
Age group (yr)								
< 20	1.42	0.29	0.37*	0.17	NA		NA	
20-34	1.08	0.09	0.86	0.41	0.69	0.28	1.63**	0.25
35-49	Ref.		Ref.		Ref.		Ref.	
50-64	1.06	0.11	1.66	0.73	1.08	0.51	0.81	0.12
65+	1.23	0.27	0.89	0.41	0.50	0.45	0.79	0.12
SES								
Low	1.16	0.14	0.54	0.19	0.95	0.48	0.88	0.16
Medium	Ref.		Ref.		Ref.		Ref.	
High	1.50***	0.17	0.82	0.30	0.74	0.33	0.81	0.15
Education								
Low	0.60***	0.06	0.42*	0.15	0.34	0.31	1.51*	0.26
Medium	Ref.		Ref.		Ref.		Ref.	
High	2.33***	0.21	0.93	0.39	0.97	0.37	1.13	0.16

TABLE 2. Continued

Class/Characteristic	Brazil (N = 35 762)		Chile (N = 4 639)		Mexico (N = 2 122)		United States (N = 4 628)	
	RRR[b]	SE[c]	RRR	SE	RRR	SE	RRR	SE
Rurality								
Not rural	Ref.		Ref.		NA		NA	
Rural	0.88	0.10	0.74	0.24	1.77	0.77	NA	
Urban	NA		NA		0.61	0.28	NA	
Metropolitan	NA		NA		Ref.		NA	
Ethnicity								
Non-Hispanic white	NA		NA		NA		Ref.	
Non-Hispanic black	NA		NA		NA		0.89	0.12
Mexican American	NA		NA		NA		1.32	0.24
Other ethnicity	NA		NA		NA		1.35*	0.19
Constant	0.05***	0.0056	1.17	0.52	2.37	1.16	2.66***	1.15
Class 4	NA		NA		NA			
Gender								
Male	NA		NA		NA		Ref.	
Female	NA		NA		NA		0.61***	0.07
Age group (yr)								
< 20	NA		NA		NA		NA	
20-34	NA		NA		NA		1.33	0.21
35-49	NA		NA		NA		Ref.	
50-64	NA		NA		NA		0.81	0.13
65+	NA		NA		NA		0.66**	0.11
SES								
Low	NA		NA		NA		0.80	0.14
Medium	NA		NA		NA		Ref.	
High	NA		NA		NA		0.72	0.13
Education								
Low	NA		NA		NA		1.20	0.21
Medium	NA		NA		NA		Ref.	
High	NA		NA		NA		1.09	0.16
Rurality								
Not rural	NA		NA		NA		NA	
Rural	NA		NA		NA		NA	
Urban	NA		NA		NA		NA	
Metropolitan	NA		NA		NA		NA	
Ethnicity								
Non-Hispanic white	NA		NA		NA		Ref.	
Non-Hispanic black	NA		NA		NA		1.02	0.13
Mexican American	NA		NA		NA		1.63**	0.30
Other ethnicity	NA		NA		NA		1.14	0.16
Constant	NA		NA		NA		3.09***	0.69

Source: Prepared by the authors based on the study results.

[a] * = significant at the 5% level; ** = significant at the 1% level; *** = significant at the 0.1% level.

[b] RRR = relative risk ratio.

[c] SE = standard error.

[d] Ref. = reference.

[e] NA = not applicable, when a certain category or class was not included for a particular country.

[f] SES = socioeconomic status.

[g] The constant represents the intercept of the model.

Diet quality is overall higher in Brazil than in Chile and Mexico, but the pattern remains similar (Panel a). The third latent class for Brazil (16% membership probability) is the healthiest, with average levels of FV and dairy consumption, the highest probability of sufficient PA and lowest probability of excessive SB. The two other classes display a low probability of PA, but also a low probability of SB. The first class (75% probability) exhibits the lowest probabilities of FV and dairy consumption, but higher probabilities for consumption of pulses and foods of animal origin. They are also the least likely to be sufficiently physically active. Those in the second class (9% probability of membership) are both the biggest eaters and the most sedentary.

For the United States model, nutrients and macronutrients rather than food

FIGURE 1. Item-response probabilities for various health-related behaviors across latent classes in Brazil (2013), Chile (2009), Mexico (2012), and the United States (2013), in study of patterns of unhealthy diet and physical activity
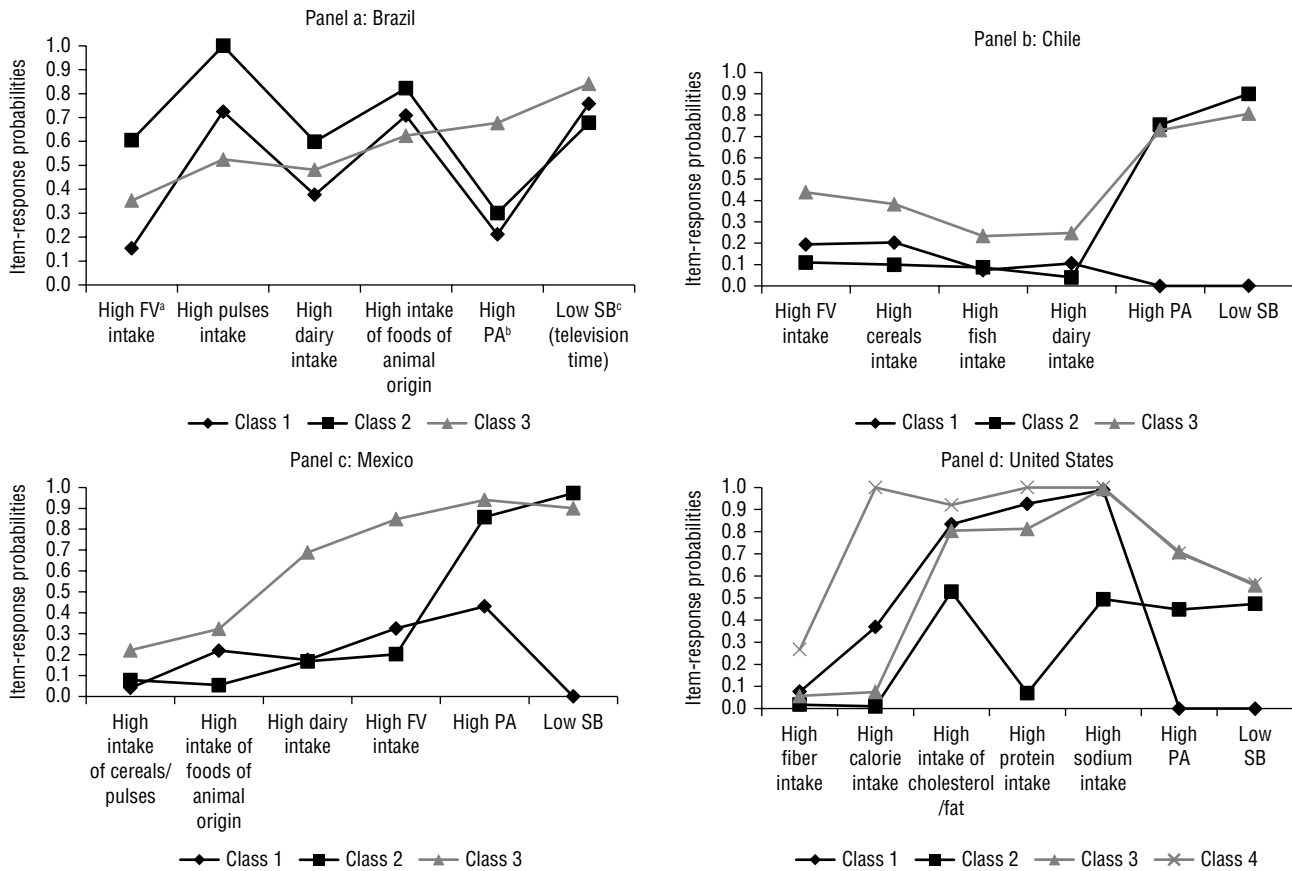
Source: Prepared by the authors based on the study results.
[a] FV = fruits and vegetables.
[b] PA = physical activity.
[c] SB = sedentary behavior.

TABLE 3. Summary of results, showing population groups with unhealthy dietary and physical activity patterns in Brazil (2013), Chile (2009), Mexico (2012), and the United States (2013)

Country	Least healthy latent class	Low-quality diet
Brazil	Males, under 65, with low education, living in a rural area	Males, under 65, with low education, living in a rural area
Chile	Males, under 20 or over 65, with low education, high SES[a]	Aged 20-64, with low or medium SES, medium or high education
Mexico	Males, with high education, high SES	Females, with low or medium SES or education
United States	Females, over 50, non-Hispanic white	Males, aged 20-34, with low education, of other ethnicity

Source: Prepared by the authors based on the study results.
[a] SES = socioeconomic status.

categories were used to describe diet quality (Panel d). The third and fourth classes (42% and 31% probability, respectively) display similar, healthy levels of PA and SB; however, the third class displays low consumption of fiber and calories, while the fourth class has the highest consumption of those two diet indicators. The second class (12% probability) is characterized by comparably low probabilities of nutrient intakes and PA, while the first latent class (15%

membership probability) displays high probabilities of excessive intake of protein, cholesterol/fat and sodium: virtually no PA: and excessive SB for all its members.

Multinomial regressions made it possible to determine the possible links between latent class membership and other sociodemographic characteristics (Table 2). The reference class for each country is the class that was deemed least healthy (class 1 in all countries).

Table 3 reports a summary of results. In Brazil, men under 65 with a low level of education living in a rural area are most likely to display unhealthy patterns of diet and PA. In Chile, men under 20 or over 65, with low education or high SES, are most at risk for unhealthy diet paired with insufficient PA. In Mexico, men with high SES and education are most likely to present an unhealthy lifestyle, by consuming few healthy foods and by displaying very high levels of SB and low levels

of PA. In the United States, non-Hispanic white women over the age of 50 are most likely to display unhealthy behaviors.

DISCUSSION

Results show that, overall, men with higher socioeconomic characteristics are more likely to be in the least healthy latent classes. However, in Brazil, those with low education are more likely to be sorted into the least healthy class, while in the United States, it is women who are more likely to belong to the least healthy latent class. In terms of low-quality diet, those with lower socioeconomic attributes and in younger age groups are most at risk.

In a policy perspective, these at-risk populations are the ones that should be targeted by interventions. In recent years, many countries have been implementing public policies encouraging a healthy lifestyle. These policies include fiscal and pricing measures, transport policies, product reformulation, school-based and worksite interventions, and more (4). Communication policies, such as food labeling, and mass media and social media campaigns, have also been shown to have some impact. Very often, however, these types of measures do not focus on specific population groups but rather target indistinctly the whole population.

Findings from this analysis support the implementation of more refined policy actions to target specific unhealthy behaviors in different population groups, defined by gender, age group, socioeconomic status, and, to some extent, place of residence. Our findings also indicate that, consistently across countries, individuals with a lower socioeconomic status are more likely to have an unhealthy diet. Available evidence suggests that upstream interventions, including community-based interventions and environmental changes, would be particularly effective in modifying dietary behaviors and in tackling obesity in these population groups (32, 33). Programs like "Santiago Sano" (34) meet many of the WHO guiding principles for effective interventions to prevent obesity and childhood obesity, such as inclusivity and participation, environmental support, and multisectoral engagement (35). Scaling up the implementation of similar interventions in Latin American countries may further support other ongoing actions to tackle unhealthy behaviors in disadvantaged population groups.

Further work is needed to understand how policy actions can be adapted to target specific population groups and how the effectiveness of interventions varies across population groups. Analyses presented in this paper provide new insights about the clustering of unhealthy healthcare behaviors. However, with few exceptions (e.g. price measures), there is still limited knowledge about how different population groups respond to the same policy action. Future research should focus on understanding which factors influence the effectiveness of policies across population groups and on identifying best practices to maximize the cost-effectiveness of interventions.

A latent class analysis was conducted to determine clusters of individuals who present similar health behaviors, and establish their defining characteristics. Unlike traditional cluster analysis, LCA is a finite mixture model, meaning that it builds clusters using a probabilistic model rather than by calculating a distance (such as in principal component analysis or multiple component analysis). The model therefore possesses goodness of fit statistics, rendering evaluation of the model possible.

In LCAs, data are often drawn from small-scale surveys including only a couple hundred individuals. Here, the sample sizes range from 2 222 (Mexico) to 36 316 (Brazil), drawn from nationally representative, internationally recognized regular health surveys, representing four countries of the Americas. Following this study, different behavioral groups in each country, as well as their characteristics, can now be distinguished thanks to the multinomial regressions run after the LCA. Running ordinal multinomial logistic regressions would have led to interesting results as well, but it would have required ordering the latent classes, which we believe would have introduced bias into the analyses.

Some limitations should be noted. The dietary, PA, and SB data used in this study are self-reported. The dietary data were collected through 24-hour recalls (United States) and food frequency questionnaires (Brazil, Chile, and Mexico). The PA data were retrieved either through the GPAQ (United States) or similar questions. The sedentarism data were retrieved through questions on time spent sitting or on time spent watching TV (Brazil). Self-reported dietary data have some limitations due to underestimation of the intake, recollection bias, and social desirability bias (30). These drawbacks hold for self-reported PA and sedentarism data, which may also be unremarkable, intermittent, or incidental (31). Nonetheless, self-reported data is widely used in the literature (30) as datasets based on objective measures of patterns of diet and PA are virtually non-existent at the population level.

The latent class analysis was conducted using the national dietary guidelines from the countries studied. The data provided by the surveys sometimes didn't contain all the variables necessary to fully test adherence to the recommendations. For instance, the survey for Chile didn't include information on pulses consumption, while the national guidelines include this item. Nevertheless, we believe sufficient variables were included to correctly assess diet quality.

Conclusions

The analyses in this paper have established the subpopulations at highest risk for unhealthy lifestyles in four countries, based on their dietary, PA, and sedentarism behaviors. As such, future policy actions aimed at increasing healthy lifestyles should target these groups of individuals.

Conflicts of interest. None declared

Disclaimer. Authors hold sole responsibility for the views expressed in the manuscript, which may not necessarily reflect the opinion or policy of the *RPSP/PAJPH* or PAHO. In addition, the opinions expressed and arguments employed herein do not necessarily reflect the official views of the OECD or of its member countries. Complementary information for this article can be found in OECD Health Working Paper No. 100, which can be downloaded at http://dx.doi.org/10.1787/54464f80-en.

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RESUMEN

Identificación de pautas poco saludables de alimentación y actividad física en cuatro países de la Región de las Américas: un análisis de clases latentes

Objetivos. Determinar conglomerados de personas que presentan comportamientos similares con respecto a la salud en materia de alimentación, actividad física y vida sedentaria en cuatro países de la Región de las Américas: Brasil (2013), Chile (2009), Estados Unidos de América (2013) y México (2012). Esto permite determinar cuáles de estos comportamientos se presentan simultáneamente, así como las características demográficas y sociodemográficas propias de cada conglomerado.

Métodos. Los datos a nivel individual que se analizaron se obtuvieron de entrevistas nacionales de salud y encuestas sobre exámenes de salud en Brasil, Chile, Estados Unidos y México para diferentes períodos. Se evaluaron los comportamientos de cada persona con respecto a la salud a partir de directrices de actividad física internacionales y directrices alimentarias nacionales. Se realizó un análisis de clases latentes para clasificar a los personas en conglomerados basados en dichos comportamientos, seguido de regresiones polinómicas para determinar las características de los integrantes de cada clase.

Resultados. En términos generales, la mayor parte de las personas pertenecían a las clases caracterizadas por una alimentación promedio o insalubre, pero con niveles suficientes de actividad física. Sin embargo, hay grandes diferencias entre los distintos países y grupos poblacionales. Los hombres con las características socioeconómicas más altas tenían más probabilidades en general de pertenecer a la clase menos saludable de cada país.

Conclusiones. Los resultados de este análisis apoyan la ejecución de acciones de políticas públicas más refinadas, dirigidas a determinados comportamientos nocivos en diferentes grupos poblacionales, definidos por género, grupo etario, nivel socioeconómico y, hasta cierto punto, lugar de residencia. Las próximas intervenciones deben dirigirse a los grupos poblacionales en riesgo establecidos en este artículo.

Palabras clave   Epidemiología; dieta; estilo de vida; ejercicio; Américas.

RESUMO

Identificar padrões de alimentação pouco saudável e atividade física em quatro países das Américas: análise de classes latentes

Objetivos. Determinar aglomerados de indivíduos com comportamentos de saúde semelhantes quanto à alimentação, atividade física e sedentarismo em quatro países das Américas: Brasil (2013), Chile (2009), México (2012) e Estados Unidos (2013) a fim de determinar os comportamentos que ocorrem simultaneamente e as características demográficas e sociodemográficas associadas a cada aglomerado.

Métodos. Os dados ao nível do indivíduo analisados no estudo foram obtidos em entrevistas de saúde nacionais e pesquisas de saúde realizadas no Brasil, Chile, México e Estados Unidos em diferentes períodos. Os comportamentos de saúde de cada indivíduo foram avaliados segundo as diretrizes internacionais de atividade física e as diretrizes nacionais de alimentação. Foi realizada uma análise de classes latentes para classificar os indivíduos em aglomerados de acordo com os comportamentos, seguida da análise por regressão polinômica para determinar as características destes comportamentos em cada classe.

Resultados. A maioria dos indivíduos pertencia a classes caracterizadas por alimentação média ou pouco saudável, porém com nível suficiente de atividade física. No entanto, existem grandes diferenças entre os países e os grupos populacionais. Verificou-se maior probabilidade de os indivíduos do sexo masculino de nível socioeconômico mais alto pertencerem à classe menos saudável em cada país.

Conclusões. Os achados desta análise apoiam a implementação de ações de política mais apuradas dirigidas a determinados comportamentos pouco saudáveis em diferentes grupos populacionais, definidos por gênero, faixa etária, condição socioeconômica e, em certa medida, local de residência. As populações em risco identificadas no estudo devem ser o principal alvo de intervenções imediatas.

Palavras-chave   Epidemiologia; dieta; estilo de vida; exercício; Américas.

Integrating economics into the rationale for multisectoral action on obesity

Vivian L. Ellis[1] and Olga V. Milliken[1]

ABSTRACT	Obesity is a compelling example of the challenges of championing and mobilizing a response that involves the whole of government and all of society. This paper discusses the need for economic rationales to strengthen the case for government intervention on obesity, with a view to better engaging the expertise and resources of nonhealth sectors. The paper also briefly reviews economic theory and evidence that could support an integrated multisectoral rationale for action, noting opportunities to expand the integration of economic evidence in the Americas.
Keywords	Obesity; models, economic; health behavior; health economics; public health.

Taking action to address obesity, particularly childhood obesity, has high priority in the Americas for government investments and for efforts involving all of society. Member States of the Pan American Health Organization (PAHO) have adopted various multilateral frameworks to address obesity. The PAHO five-year Plan of Action for the Prevention of Obesity in Children and Adolescents (1) provides a framework for action for Member States. The World Health Organization (WHO) Global Action Plan for the Prevention and Control of Noncommunicable Diseases 2013-2020, the PAHO Strategy for the Prevention and Control of Noncommunicable Diseases, and the PAHO Plan of Action for the Prevention and Control of Noncommunicable Diseases target actions on unhealthy diets

and physical inactivity, which are key modifiable risk factors for obesity (2, 3).

Nevertheless, making concerted action on obesity a reality remains a challenge for many Member States (4). Consensus within public health authorities and academics (5) is not generally enough to convince other sectors within governments and throughout societies to take comprehensive multisectoral action. For example, in 2016, while almost two-thirds of PAHO Member States reported having multisectoral plans for NCDs, including obesity, only one-fifth reported policies in place to promote healthy eating by reducing the impact on children of marketing of foods, including nonalcoholic beverages and foods high in sugar (6). Considering the unanimity for scaling up action, the questions arise: What's missing? What could strengthen the case in the Americas?

While concerted political leadership can mobilize nonhealth actors (7, 8), public health experts recognize that

engaging nonhealth sectors, within and without governments, typically requires a solid economic case for action. Otherwise, nonhealth actors may see themselves neither in the problem nor its solutions. Global and regional policy documents (2, 3) have stressed the importance of economic and development impacts in the rationale to scale up action on obesity. Conversely, lack of solid economic rationales can legitimize resistance to obesity action. Additionally, multilateral funders and central agencies within governments may require economic rationales to support budget decisions or regulations.

This paper highlights economic rationales for government intervention on obesity. The article briefly reviews economic theory and evidence that could support an integrated rationale for multisectoral action, highlighting evidence from the Americas. The authors' companion paper (9) in this special supplement discusses gaps in methods and evidence needed for a comprehensive investment case.

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WHAT WILL ECONOMIC DECISIONMAKERS LOOK FOR IN THE CASE FOR OBESITY ACTION?

With some exceptions (10), public health rationales for action often have no or limited economic insights, despite their emphasis on societal benefits. Or, economic rationales are advanced in a secondary analysis developed after the epidemiological one. For example, in Canada, there has been a recurring knowledge gap with respect to economic evidence and analysis in the study of public health, including on obesity (11). A recent report by the National Academies of Science, Engineering, and Medicine of the United States of America (12) found that while economic evidence has potential to show not just what works, but what works within budget constraints, in practice such evidence may not be effectively produced or applied. In Latin America and the Caribbean (LAC), there is sparse, but widely varying, evidence of the health care cost burden of obesity (13). Further, in LAC, evidence from economic evaluations is uncommon in health policy formation, and few nutrition and physical activity interventions have economic evaluations (9).

Additionally, across the Americas, what economic evidence there is draws most heavily on health sector data. Verifiable health care system costs can be compelling. However, evidence of causes, risks, costs, and benefits that is focused on the health sector can convey the message that obesity is fundamentally a health sector management problem. Health care expenditures alone do not demonstrate why others should engage their resources towards the solution. Nonhealth actors may take the position that obesity needs to be addressed by better priority setting and more efficient use of resources within the health sector.

The economic burden of obesity is alarmingly large (9). Nevertheless, a descriptive measure of that burden would not in itself provide a sufficient justification for what many economic sectors would see as intrusion into markets and individual choices. Nor would that measure guide policy responses or explain why nonhealth sectors need to engage in solutions. Experts from sectors where economics provides the primary underpinning for policy analysis will ask why

government intervention is needed and why their sector needs to be engaged. Their starting point is that societal well-being is optimized as long as markets are working perfectly. Thus, they will seek an explanation why, in a particular case, markets do not work perfectly. That is, they will seek a causal explanation, grounded in economic theory, why individuals and producers are not making healthy choices on their own. Consequently, these economic specialists will expect economic analyses and evidence of causes, risks, and the costs and benefits of intervention that are more comprehensive than those familiar to public health specialists. They will also pose the question of how and by how much their sectors' and overall societal well-being will be impacted by intervention.

While traditional economic theory takes perfect markets as the starting point, it acknowledges that markets may fail to support optimal decision-making. When this happens, intervention may be justified to correct inefficiencies or to mitigate them. That said, the cost of inefficiencies needs to be weighed against the cost of correcting them and the distributional consequences of a corrective action (14). The scope of market failures is broad, and their impact is wide-ranging. Also, in practice, market failures, and interventions to mitigate them, may be sensitive to local or country contexts. Welfare economics is an established branch of economics that looks at the

impact of policies on well-being at the level of individuals, markets, and society as a whole and that considers distributional effects. Our companion paper (9) looks at how welfare economics, particularly cost-benefit methodologies, can be used to assess an investment case for intervention.

Going beyond traditional market imperfections, economists increasingly recognize that human behavior is not consistent with the ideal of rationality used in traditional economic models (15). Behavioral economics provides an umbrella of approaches that seek to extend the standard economic framework and account for evidence on human behavior, by borrowing from psychology and sociology (16). Health behavior questions have been cited as inspirations for theoretical research in behavioral economics from the beginning. In practice, however, economists from nonhealth sectors are ahead in applying behavioral economics theory for public policy (16). Nonetheless, among health policymakers and practitioners, there is high interest in low- and middle-income countries, where a recent survey found an appetite to use insights from behavioral economics in the design and implementation of health policies (17). Figure 1 offers a visualization of a cycle in which innovations in economic theory are applied to obesity-related questions to inform interventions, which in turn calibrate and refine theory.

FIGURE 1. Cycle for the integration of economic theory into multisectoral public health action on obesity
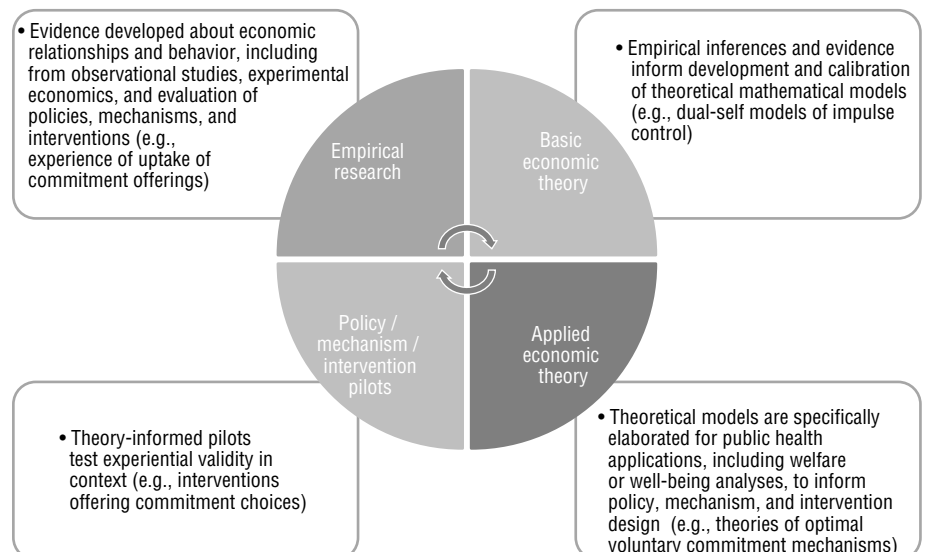
Source: Proposed and developed by the authors.

ECONOMIC RATIONALES FOR INTERVENTION TO PREVENT OBESITY

Enabling individuals by "making healthy choices the easy choices" is a touchstone of public health policy formation, anchored in the 1986 Ottawa Charter for Health Promotion. Similarly, policy insights from economics about obesogenic behaviors and environments often focus on individuals, particularly choices involving risky health behaviors (18). Understanding individuals' economic choice behavior can also provide a framework to examine decisions by private and nonprofit firms and government entities, as well as to assess how changing market contexts impact choices.

Individuals

When making choices in the standard economic model as applied to health, individuals make tradeoffs that can have different health impacts. Individuals allocate time between income-earning work and "leisure." They then allocate income toward consuming healthy versus unhealthy products, as well as "leisure" time toward healthy activities (e.g., exercise, food preparation, nurturing, volunteering) versus unhealthy pastimes (e.g., screen time). Further, looking over the long term, individuals make tradeoffs between consuming now versus investing in their uncertain future health, which adds complexity. Under this standard economic model of choice, rational, forward-looking people choose to consume unhealthy products even though they know the risks to their future health. Government intervention would decrease societal well-being. However, economists have recognized that many people struggle unsuccessfully to adopt positive health behaviors (19). Economics' mathematical models of market failure and human behavior can explain why individuals struggle, and offer insights into policy responses.

If individuals place an incorrect or incomplete value on their consumption of a product or activity, they will either overconsume or underconsume. This market failure potentially leads to not only less benefit for themselves but also to a loss of overall societal welfare (well-being), referred to as a deadweight loss (DWL). Figure 2a and Figure 2b are standard neoclassical representations that show the effect of underconsumption and of overconsumption as compared to consumption that maximizes societal well-being. When consumers undervalue a product or activity, they consume less than the societal optimum; when they overvalue a product or activity, they consume more than the societal optimum.

Imperfect information. How can individuals misvalue benefits and costs? *Incomplete information* is one classic explanation. When consumers do not know all about the costs, benefits, and risks of a behavior, they will overconsume unhealthy products and underconsume healthy ones (18). Policy prescriptions involving information dissemination are appealing to economists since addressing information gaps can raise societal well-being, with modest impact on other economic actors. However, information campaigns, such as mass media advertising, have been generally assessed within broader multi-intervention nutrition and activity strategies, so their impact is difficult to isolate (20). Moreover, they are most effective for one-time health behavior decisions rather than repetitive obesity-related choices about food, beverages, and physical activity (20).

Externalities. When individuals do not experience the full cost, benefit, or risk of their choice, others in society pay the costs, accrue the benefits, or bear the risk. The standard economic model describes this market failure as an externality. In standard health economics models, externalities can happen when individuals overvalue unhealthy choices or undervalue healthy ones because their future health maintenance costs are shared by insurers or the public system.

Again, Figure 2a and Figure 2b show that individuals' valuation of their net benefit of consumption is either too high or too low compared to the societal valuation. With an externality, some of the costs and benefits go to another party, but there is still a loss of overall societal well-being (deadweight loss). The differential between societal and individual valuation can be magnified when individuals live in the present, discounting future impacts more than the insurer or government. Evidence on how much individuals need to be paid to risklessly postpone consumption varies across countries, possibly for economic or cultural reasons. Wang et al.'s recent comparison of 53 countries found that subjects from Latin America had the second-lowest willingness to wait to consume after those from Latin Europe and Africa (21). (The rate that individuals need to be paid to wait to consume is the riskless discount rate.)

As a policy response to an externality, sales and excise taxation on unhealthy products, or price subsidies on healthy ones, can close the gap in individuals'

FIGURE 2. Loss of societal welfare (well-being) due to externalities in individuals' consumption choices[a]

(a) Underconsumption of healthy products or activities

(b) Overconsumption of unhealthy products or activities
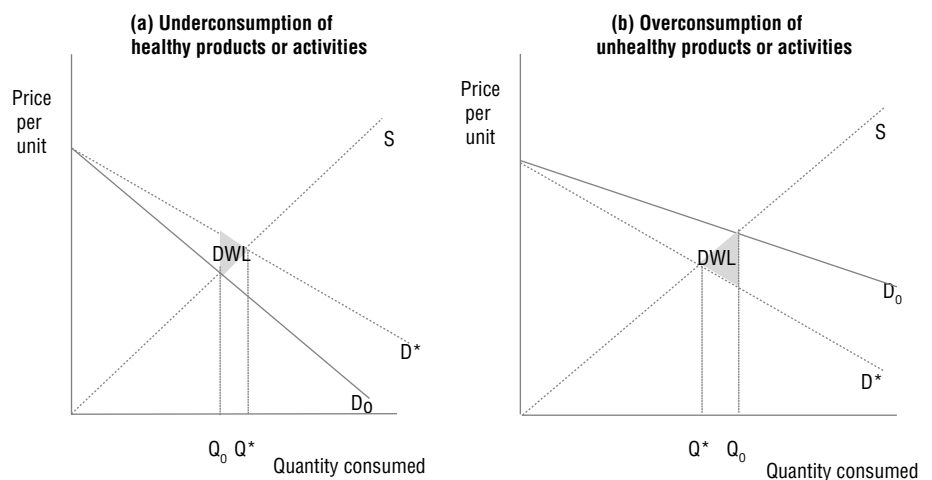
Source: Prepared by authors following standard neoclassical theory.
[a] Individuals' equilibrium consumption is not societally optimal when private valuations of products or activities do not match societal ones: (a) underconsumption of healthy products and activities; (b) overconsumption of unhealthy products and activities, with societal deadweight loss (DWL) in welfare. Correctly valued societal demand curve (D*) with optimal equilibrium quantity consumed (Q*); individuals' own privately valued demand curve (D_O) and suboptimal quantity consumed (Q_O); supply curve (S). In (a), $Q_O < Q^*$; in (b), $Q_O > Q^*$.

valuations. How much sales and excise taxes will move consumption, who will bear the incidence of the tax, and how much tax revenue will be raised will largely depend on how elastic, or sensitive, individuals' consumption choices are to price (that is, the price elasticity of demand). For example, if demand is very inelastic, consumers will typically bear much of the tax, but their behavior will not change much. Consumers' income will also impact their sensitivity to price changes, with lower-income groups being more sensitive. (The greater impact on low-income groups raises distributional questions. However, when consumption of unhealthy products falls in response to taxes, these groups obtain the greatest health benefit.)

Societal benefit will also depend on cross-elasticities that explain shifts in consumption of related products.[2] Elasticities of demand can vary widely by country and subregion, leading to large variances in the effectiveness and distributional consequences of taxes.

In health economics, tobacco and alcohol have had priority in country-level research on elasticities of demand. There is sparse price elasticity evidence in the Americas for nonalcoholic beverages and food (22, 23), except for the United States (24), especially regarding cross-elasticities between key healthy and unhealthy substitutes. A recent multicountry report contributes own price and income elasticities for Latin America as a region (25). However, Mexico's soda tax experience shows that prospective studies limited to own price elasticities may underestimate a tax's impact, especially when it is rolled out in the context of a comprehensive set of interventions that promote healthy substitutes. A pretax study found inelastic demand (22), but posttax evaluations found large reductions in demand (26).

Nonstandard models: changing preferences, constrained rationality, and constrained self-control. The axioms of rational behavior underpinning economics' standard model are strong, especially to value risky future outcomes. Additionally, assumptions about unchanging individual preferences are

embedded. So, while the individuals are modeled as thinking rationally in the "here and now" about a lifetime of choices, it is assumed that likes and dislikes for products or activities will not change, nor will their attitudes about risk, nor their impatience for consuming today versus tomorrow. That is, standard economic theory does not explain how individuals' preferences are formed or how they might be influenced to change. Even taking constant preferences as given, questions arise about whether rational choice represents the way people think (15). While workarounds for traditional assumptions and alternate theories are possible, the key test of validity is how well they match evidence on human behavior (27, 28) (Figure 1).

How consumption preferences change in response to previous consumption can account for many observed patterns of habituation and addiction. With habituation, changes in behavior may have only a small influence today, but a much larger result in the future, should the change in behavior be sustained. *Rational addiction models* assume that, for people who have consumed a habit-forming product or activity, the level of enjoyment from consumption today is reinforced by past consumption (19). (While the label "rational addiction" can be off-putting when viewed from a mental health context, the term "rational" relates to the standard economic model.) Rational addiction models explain dynamics in addictive behavior aligned with clinical findings, such as tolerance, withdrawal, and "quitting cold turkey." These models also predict that not everyone will become addicted. For policy prescriptions, they suggest that sales and excise taxes will be effective in discouraging starting and encouraging quitting, but also that those taxes need to be high in value and persistent (19). Rational addiction could explain evidence of the effectiveness of high tobacco and alcohol taxes (29).

Rational addiction models can, moreover, describe not only habituation to unhealthy substances, but also to healthy products and behaviors (e.g., physical activity) (19). In the case of food preference formation, such as for skim milk (30) or strong-tasting food, these models' inferences about human behavior appear consistent with psychological evidence (31). For nonalcoholic beverages, the evidence for habituation appears stronger for milk than for

sugar-sweetened beverages (30). The emerging evidence of addiction among persons who excessively use computer games (32) or social media (33) suggests opportunities to extend these models to sedentary behaviors.

Changes over time in individuals' impatience or risk aversion also modify discount rates and how sensitive consumption today is to uncertain future outcomes (e.g., changes in future wealth or health status). This contradicts the standard model. Evidence about how much individuals need to be compensated for waiting varies across the life course, and with education, income, or wealth. Regarding risk, evidence shows individuals are risk averse in the short horizon, but more risk tolerant in the long run (27). Working out whether changes in impatience versus changes in risk aversion are at play is empirically challenging, but important because they have different policy implications (34). Evidence to date on discount rates in the health domain has focused on tobacco use (35, 36), but obesity-related evidence is emerging (37).

Hyperbolic discounting models can explain certain behaviors of consumers, with discount rates that differ when looking at the short term versus long term (time-inconsistent), particularly individuals' voluntary choices to commit to or lock in future consumption (19) (e.g., buying an annual gym membership). These models demonstrate that, counter to the assumptions of the standard model, it is not always better to have a larger set of consumption choices. These models provide rationales for governments to intervene to create commitment mechanisms that the private sector may not provide on its own (e.g., protecting from borrowing against retirement savings (38)), or to limit the available choices (e.g., with bans, restrictions) (38). *Quasi-hyperbolic discounting models* are a particular form (37) that additionally show how modest disincentives (e.g., taxes) or nudges (e.g., reward incentives) in the near term may shift behavior (38).

Dual-self models of impulse control are another way to model changing impatience. They explain individuals' impulse control challenges, including obesity-related behaviors (27). Taking from psychology and neuroscience insights about multiple selves, dual-self models show how a long-run, rational

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2   When the price of a taxed product increases, consumption of substitutes increases, while consumption of complements (e.g., bread used with sandwich fillings) decreases. Conversely, when a product is subsidized to lower its price, consumption of its substitutes will decrease, and consumption of its complements will increase.

deliberative self is challenged to control the behavior of a more impulsive short-run self in each time period. Because short-run self-control is costly, and gets more costly the greater the cognitive load, the individual will make impulsive, impatient choices that the deliberative self would not (19, 27). Commitment mechanisms can be beneficial in assisting the long-run self to constrain impulsive day-to-day choices (19). Dual-self models can also explain why the contexts in which products are offered matters: the greater the cognitive load, the more likely the individual will make an impulsive choice. This explains why contextual "nudges" to move consumer choices in supermarkets, or simplified front-of-package labeling, could work, and why government intervention into marketing contexts may be warranted. Early evidence shows consistency between obesogenic behavior and dual-self models (39-41). Evidence of specific cognitive constraints and limits, especially on intake and processing of complex information, are motivating innovative nudge interventions (42, 43).

Children challenge the standard rational economic model. Psychological evidence finds that children's food preference formation is influenced by exposure, associations with a positive event, and indications of liking by a significant other (peer, older child, teacher, parent) (31). Attempts to emphasize the beneficial consequences or to use rewards to influence food choices backfire (31). Influences outside the family are important in preference formation: parent-child correlations in liking for foods are very low, from as early as 4 years of age, when compared to correlations in values and attitudes (31). As such, the social and nutritional context plays an important role, and parents cannot be assumed to be making consumption decisions on their children's behalf.

Evidence from Chilean elementary students shows increased cognitive ability may reduce bias in children's choices, implying education policies that improve problem-solving ability may be protective (44). However, these are not likely to address obesogenic preferences established earlier.

Cawley (45) argues that "because children are not what economists call 'rational consumers'—they cannot evaluate information critically and weigh the future consequences of their actions—the

government may step in to help them make better choices about obesogenic products." Neuroscience and neuropsychology evidence on executive functions affirms that "rationality" is undergoing development until early adulthood (46). That evidence may justify government interventions in the marketing and availability of obesogenic products to children and adolescents, similar to the ones for tobacco and alcohol.

Private sector and civil society

Individuals are not the only economic actors who may make societally suboptimal decisions. Firms, whether in the private or nonprofit sector, will make choices to maximize their own well-being. Engaging the private sector and civil society in obesity solutions can be better anchored by evidence about how they contribute to the problem or benefit from solutions.

Externalities arise when firms share the costs and benefits of investing in a healthy workforce with their employees. They may not consider the obesogenic impact of workplaces, especially if they do not view their relationships as long term or if costs today of health promotion are high. Evidence shows that economic upswings are periods of high NCD mortality in developed economic regions (e.g., northern Mexico (47)), suggesting a role for government intervention in the workplace.

Externalities can also arise when producers of unhealthy products use marketing and product design to take advantage of individuals' constraints in making healthy choices, whether in information (48) or impulse control. Industrial organization is a field of economics that looks at the structure of firms and markets, including pricing and product design. Modern agrifood markets do not reflect traditional assumptions of perfect information, homogenous goods, and small firms (49). Producers use information (e.g., labeling, advertising), pricing, product design and size (49), and store location or layout (40, 41) to influence choices. These factors could promote obesity. Also, dominant producers may be incented to influence public perceptions through media or funded research ("deep capture") (50). Figure 3a and Figure 3b show how firms will underproduce healthy products and overproduce unhealthy ones when they do not experience the full societal benefits or costs of their production. There is evidence showing that supermarket and fast food location impacts obesity (51), but limited research on other producer/seller decisions (52). Further, self-regulation by producer-controlled marketing associations has become the norm (49). Government intervention to bring firms'

FIGURE 3. Loss of societal welfare (well-being) due to externalities in firms' production choices[a]
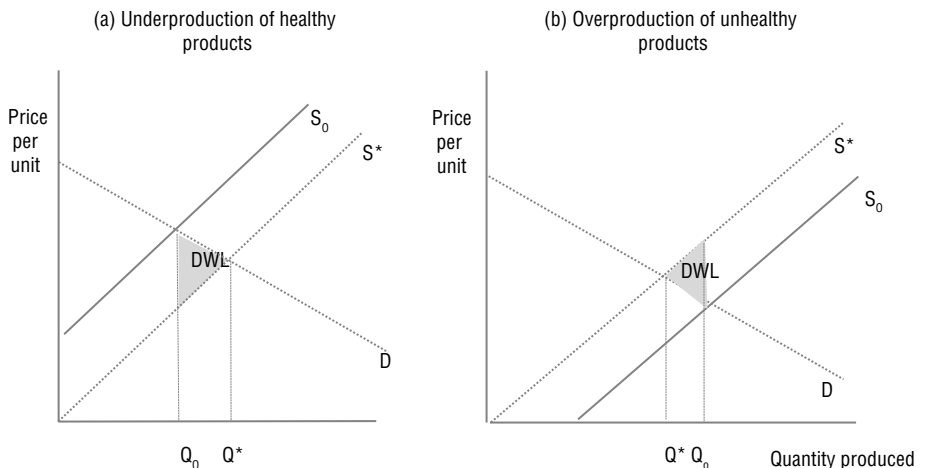
Source: Prepared by authors following standard neoclassical theory.
[a] Firms' equilibrium production is not socially optimal when firms' private valuations do not match societal ones: (a) underproduction of healthy products; (b) overproduction of unhealthy products, with societal deadweight loss (DWL) in welfare; societally valued supply curve (S*) and optimal equilibrium quantity Q*; firms' own value supply curve (S$_O$) and suboptimal quantity produced (Q$_O$); demand curve (D). In (a), Q$_O$ < Q*; in (b), Q$_O$ > Q*.

valuation of costs and benefits in line with societal ones may be justified to increase overall well-being.

Governments

Government measures for nonhealth sectors may unintentionally promote obesogenic behavior. One documented example in the Americas is that domestic agricultural subsidies distort relative prices, lowering the cost of calorie-dense foods and making healthy foods less affordable (14, 53). However, simple reversal of such measures might not return markets and consumption patterns to their initial conditions (53). In the Caribbean, trade liberalization has led to decreased local production, increased food imports, and changes in food choices (54). Measures to mitigate adverse obesity-related impacts of nonhealth sector policies may be warranted.

Changing market contexts

Looking at economic rationales one by one can beg the question of why obesity trends increased so sharply (55). An answer lies in the profound changes in market and social contexts in recent decades, to which the economic rationales described above are sensitive. Cawley's narrative review of obesity's causes, consequences, and solutions explores these changes (56). In Latin America, globalization, urbanization, and rising incomes are associated with changing diet and physical activity habits. For example, there are increasing intakes of total fat, animal products, and sugar, and rapid declines in the intake of cereals, fruit, and some vegetables (57). Globally, several multicountry reviews have examined pathways for impact. Regarding economic growth, a review of 175 countries found that the benefits of rising gross domestic product (GDP) on body mass index plateau at GDP per capita > US$ 3 000, and that lower income inequalities and more regulated markets appear protective against obesity in countries with GDP > US$ 30 000 per capita (58). Liberalization and globalization of agricultural markets has impacted incentives to producers; altered nutritional quality and content; and increased the variety and quantity of food available (59). On technology-induced change, an analysis of 244 Demographic and Health

Surveys found that overweight is associated with urbanization and car and television ownership generally; with greater calorie intake in middle-income countries; and with shifts away from agricultural employment in low- and middle-income countries (60). One study found globalization's social dimensions, specifically "information flows" and "social proximity," account for more of rising obesity than do its economic dimensions (i.e., trade and foreign investment) (61). To the extent that national and global development and macroeconomic and trade policies and frameworks have contributed to these changing contexts, consideration of measures targeted at mitigating their adverse obesity-related impacts may be justified.

DISCUSSION

There is growing recognition that "shortcomings in economic evidence weaken society's ability to invest wisely and also reduce future demand for this and other types of evidence" (12). Dialogues to enhance the uptake of economics in public health have taken place in Canada (11), the United States (12), and through workshops convened by PAHO. By using economic evidence, policymakers and practitioners can both strengthen the case for action on obesity and encourage economists to enrich the evidence base and apply theory to inform effective policy innovation, as illustrated by Figure 1. A new Economics of Obesity Special Interest Group established by the International Health Economics Association demonstrates academic economists' engagement in policy-relevant applications (62).

This paper is not exhaustive in its exploration of economic rationales, but rather intends to provide an entry point for policymakers and to identify opportunities for further research. Table 1 relates relevant economic theories to potential policy interventions.

We found potentially important underexplored areas of economic research. Compared to tobacco (e.g., (63)), obesity has a scant peer-reviewed literature in industrial organization, pricing, and product design. (Searching the EconLit database using the keywords "industrial organization" or "product design" and "obesity" yielded few results. "Pricing and obesity" results mainly

concerned taxation or "food deserts.") Additionally, sociology and psychology offer complementary perspectives on the evolving socioeconomic context for obesity. While behavioral economics is incorporating insights from these disciplines, we found limited progress in applying relevant economic models of learning or mechanism/contract design to health-related interventions or policy questions. Also, recent evidence about the social influences on individuals' obesity-related consumption preferences during adulthood (64) suggests further refinements for economic models of choice.

Interested readers can find more expansive reviews of the existing literature in work by Cawley and Ruhm (18), Kenkel and Sindelar (19), and Cawley (56). Kessler looks at obesity-relevant applications in four major topic areas: reward incentives, information and salience, context and framing, and social forces (42). Monroy examines applying behavioral economics to eating behavior within a Latin American context (38). Unnevehr (65) reviews food and health from an agricultural economics' perspective, including the policy implications of price elasticities.

Conclusions

In sum, championing and mobilizing action across all sectors of society is better supported when its public health rationale includes causes and evidence that speak to diverse economic actors. Economics research is policy-relevant and compelling to nonhealth actors. Integration of a broader scope of economic theory and evidence into the case for obesity action is needed.

This article provides a brief narrative review of key economic rationales for action on obesity and considers Americas-specific evidence. It seeks to motivate public health practitioners to incorporate a broader scope of economics into their analysis, and researchers to enrich the evidence base. Important gaps in economic analysis of obesity include industrial organization as well as region-specific assessments of the key market failures and constraints on rationality. There is significant and extensive evidence of changes in the market context and demographics associated with changes in dietary and physical activity patterns, including for

TABLE 1. Relating theoretical economic models to evidence for Latin America and the Caribbean and to potential interventions

Economic model type, (reference(s))	Difference from standard economic model of perfect markets, (reference(s))	Evidence for Latin America and the Caribbean, with first author, year, (reference)	Theoretical options for intervention, (reference(s))
Information market failure model (18)	Incomplete information	NA[a]	Public information (18, 19) (e.g., mass media advertising); disclosure requirements (18) (e.g., labeling (19)); advertising bans (18)
Market failure models (18)	External costs and benefits	Colchero, 2017 (26)	Sales and excise taxes (18); eliminating/avoiding subsidies of unhealthy products (18, 53)
Habituation and rational addiction models (18, 19, 29)	Individuals' preferences depend on past consumption	NA	High and persistent sales and excise taxes (18, 19); restricted availability (bans, point-of-purchase restrictions) (19)
Hyberbolic discount rate models (19, 37)	Risk and consumption preferences change over time	Monroy, 2017 (38)	Commitment mechanisms (19); reducing product diversity, bans (19)
Quasi-hyperbolic discount rate models (37)	Risk and consumption preferences change over time	Monroy, 2017 (38)	Nudges (e.g., reward incentives, modest subsidies or taxes) (19); commitment mechanisms(19); reducing diversity of available products(19); bans (19)
Dual-self models of impulse control (19, 27)	Risk preferences changing; self-control and cognitive processing costly	NA	Commitment mechanisms (19, 27); (dis-)incentives and price interventions (taxes, subsidies, reward incentives, small payments, restrictions on price or volume promotions) (19); cognitive load interventions (reminders, labeling, point-of-sale interventions) (40, 41); reducing availability (e.g., locations with limitations on unhealthy foods) (19)
Bounded rationality	Rationality not fully developed (e.g., children) (45)	Benjamin, 2013 (44)	Education promoting development of executive function and problem-solving ability (18, 44); restrictions on marketing and availability (18, 45)
Information "deep capture" (50)	Asymmetric information and dominant producers/sellers	NA	Public information (18); research dissemination (18); regulation of health messaging (19); disclosure requirements (19)
Industrial organization location models (51)	Geographic concentration of sellers is not constant	NA	Incentives for supermarket placement (51)

Source: Authors' review.
[a] NA = not applicable; obesity-related evidence for Latin America and the Caribbean was not found in the course of the authors' searches.

the Americas, particularly due to globalization, urbanization, and rising income levels. These changing environments can help explain why economic rationales, which were not as crucial in the past, justify intervention now.

Disclaimer. The views expressed in this manuscript do not necessarily reflect those of the Government of Canada, and may not necessarily reflect the opinion or policy of the *RPSP/PAJPH* or PAHO.

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RESUMEN

Integrar la economía en los fundamentos de la acción multisectorial en materia de obesidad

La obesidad es un ejemplo contundente de los retos que implica el defender y movilizar una respuesta que abarque a todo el gobierno y toda la sociedad. En este artículo se aborda la necesidad de contar con fundamentos económicos para respaldar la pertinencia de la intervención gubernamental en materia de obesidad, a fin de incorporar la pericia y los recursos de sectores ajenos al sector de la salud. En el artículo también se examina brevemente la teoría económica y la evidencia que podrían sustentar un fundamento multisectorial integrado para la acción, a la vez que se destacan las oportunidades para ampliar la integración de la evidencia económica en la Región de las Américas.

Palabras clave

Obesidad; modelos económicos; conductas saludables; economía de la salud; salud pública.

RESUMO

Integrar aspectos econômicos à fundamentação para ação multissetorial em obesidade

A obesidade é um bom exemplo do desafio de defender e mobilizar uma resposta que envolva o governo e a sociedade como um todo. Este artigo aborda a necessidade de fundamentação econômica para fortalecer o argumento para a intervenção do governo na obesidade visando atrair mais conhecimento especializado e recursos dos setores externos à saúde. O artigo analisa resumidamente a teoria econômica e as evidências que poderiam embasar uma fundamentação multissetorial integrada para ação e destaca as oportunidades para ampliar a integração das evidências econômicas nas Américas.

Palavras-chave

Obesidade; modelos econômicos; comportamentos saudáveis; economia da saúde; saúde pública.

Review

Development of an investment case for obesity prevention and control: perspectives on methodological advancement and evidence

Olga V. Milliken[1] and Vivian L. Ellis[1]

ABSTRACT   *This paper opens a discussion on the main features of an investment case for obesity prevention and control, by scanning available evidence on existing approaches and by highlighting contextual considerations and evidence for Latin America and the Caribbean. We call on researchers and analysts in the field to update and broaden existing methods of economic analyses to better reflect the multisectoral nature of an investment case for obesity prevention and control. We also identify research gaps and further work required to advance methods and evidence towards investment cases throughout the Americas.*

Keywords   Cost-benefit analysis; obesity; investments; health economics; health policy; Americas.

As the obesity epidemic has been spreading rapidly across the Americas, national governments and regional and international organizations have called for action from the whole of society (1–4). To answer these calls, jurisdictions are seeking comprehensive investment cases that would articulate the benefits and costs of an intervention strategy across various economic actors and the factors that could affect its implementation. For example, the United Nations Interagency Task Force on the Prevention and Control
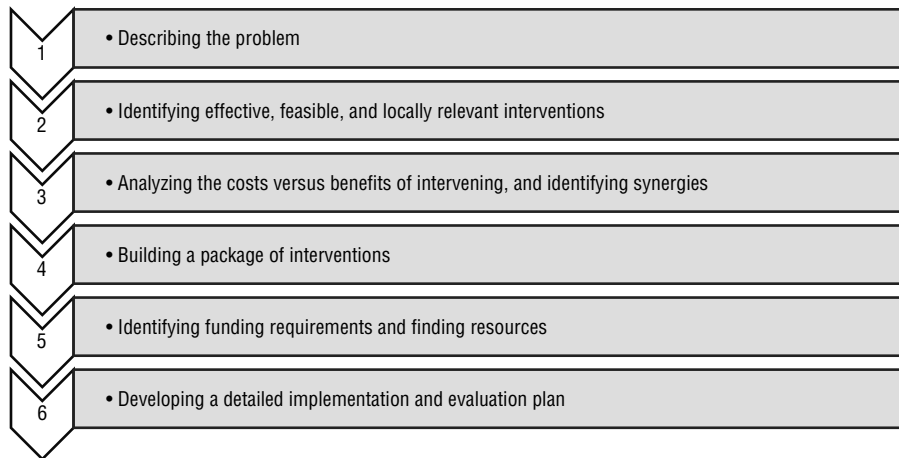
of Noncommunicable Diseases has been working with countries around the globe to prepare investment cases for prevention and control of noncommunicable diseases (NCDs) and their risk factors (5).

An investment case presents reasoning for an action and includes a strategy to achieve a stated objective. Drawing from recent efforts to formulate investment cases (5–7), we find that a public health investment case generally includes six steps: 1) describing the problem within a given country, including determinants and risk factors and public health and economic impacts; 2) identifying effective, feasible, and locally relevant interventions for analysis; 3) providing analysis of the costs versus benefits of intervening, and identifying synergies

among interventions; 4) building a package of interventions based on the second and third steps as well as other criteria such as distributional consequences and acceptability among stakeholders; 5) identifying the funding requirements and finding resources; and 6) developing a detailed plan for implementation and evaluation of results. Figure 1 summarizes this process.

The objective of this paper is to discuss how various economic methods for valuing costs and benefits can be applied to obesity-targeted interventions (the third step listed above). The paper also summarizes major evidence towards the development of an investment case for obesity prevention and control in line with the third and fourth steps.

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FIGURE 1. Process to develop an investment case for obesity action

1 • Describing the problem

2 • Identifying effective, feasible, and locally relevant interventions

3 • Analyzing the costs versus benefits of intervening, and identifying synergies

4 • Building a package of interventions

5 • Identifying funding requirements and finding resources

6 • Developing a detailed implementation and evaluation plan

Source: Prepared by authors.

In addition, research gaps in methods and evidence are underscored, and ways forward are proposed.

It should be noted that this paper is not a systematic literature review, but rather a scoping review of methodologies and the evidence supporting them.

METHODS OF ECONOMIC EVALUATION OF INTERVENTIONS

Social cost-benefit analysis as a conceptual framework

Economic analyses can assess whether a policy response is required from the efficiency perspective. For example, the analyses can identify market failures in efficient resource allocation, as well as whether such failures are amenable to intervention (8). Further, economic evaluation, both prospective and experiential, can inform on a range of interventions. Note that in this paper we refer to an economic evaluation as either a prospective or retrospective "comparative analysis of alternative courses of action in terms of both their costs and consequences" (9).

A social cost-benefit analysis (SCBA) is a general economic framework used to examine which interventions, or intervention package, bring the highest socioeconomic return. Under SCBA, social welfare (well-being) is some measure of the well-being of all individuals in the economy. As individuals maximize their own overall well-being, rather than health alone, SCBA takes a broad perspective, under which societal health-related goals are balanced with that of the consumption of goods and services, including food, beverages, and physical activity.

In the most comprehensive case of SCBA, costs and benefits are presented in monetary units, allowing various benefits to be added together and compared with costs associated with the intervention(s). Also, using common currency allows analyses of benefits to various economic actors, including central ministries and nonhealth stakeholders. Lifetime costs and benefits are usually discounted to a base year, to assess the present value of total multiyear benefits and costs. An intervention to address obesity is desirable from a society's viewpoint if the present value of total benefits outweighs that of the intervention costs (9).

Health benefits can be described as: 1) a direct contribution to well-being (intrinsic value of health); 2) greater productivity; 3) greater longevity; and 4) greater engagement in society, including volunteering (10). A range of methods to value health or life can be employed, including a value of statistical life (VSL) approach under either a revealed preference or a contingent valuation (willingness to pay) method. In principle, a VSL approach measures all four of those health benefits.

Costs of an intervention include implementation costs, but also economic losses attributable to an intervention (such as financial losses to a food industry or job layoffs due to a labeling regulation or due to a tax). Also, resources saved in health care, enhanced productivity, etc., that are attributed to the intervention are subtracted from costs (9).

As a gold standard of economic evaluation, a comprehensive SCBA has high information requirements that may not be achievable in each practical application. Particularly, the search for methods to value benefits of improved health is ongoing, underscoring the difficulties of this task (11). The value of health cannot be directly assessed from market prices, and likely is best derived from a combination of an assessment of individual preferences and professional opinion (9, 10). When valuation information is incomplete or estimates vary widely, sensitivity analysis can assess the robustness of the SCBA.

Applications of social cost-benefit analysis

Based on a general SCBA framework, various applications and protocols have been developed, such as cost-utility analysis (CUA), cost-effectiveness analysis (CEA), and social return on investment (SROI) (9, 12, 13) (Table 1). These represent versions of an SCBA that forgo comprehensiveness for tractability, standardization, or verifiability. However, by simplifying, such applications can introduce bias or ignore broad impacts.

Cost-effectiveness and cost-utility analyses. CEAs/CUAs of obesity prevention and management interventions dominate the field. They allow the comparison of costs and benefits of an intervention with that of a status quo or of a different intervention. In a health-related CEA, benefits are often measured in life years saved or changes in body mass index (BMI). In a CUA, quality-adjusted life years (QALYs) or disability-adjusted life years (DALYs) are used, which compared to a CEA, adds the quality-of-life dimension into the outcome (14). As CEAs and CUAs evaluate benefits in units of health rather than placing a society's value on these units, these analyses only account indirectly for the first and third benefits mentioned above. Also, CUAs and CEAs cannot formally integrate the second and fourth benefits.

In general, CEAs and CUAs work well when a single sector's perspective is used and intervention effects are contained within this sector, such as replacing an existing pharmaceutical with a more potent one. Despite their wide usage for in-health-sector analyses, these methods are not commonly used by other sectors (e.g., agriculture, environment, transport), even for decisions related to human health (15–17).

TABLE 1. Characteristics of methods to inform an investment case for obesity prevention and control

Method	Main objective	Intervention costs	Intervention benefits	Formulation of analysis results	Strengths	Weaknesses
Social cost-benefit analysis (SCBA)	To assess if an intervention is worth the investment.	C_1^a	W_1^b	If $W_1 + S^c - C_1 > 1$, the intervention is worth the investment.	Can account for multisectoral benefits and broader benefits in general resulting from the intervention; decision to invest is based on an objective score; can inform resource allocation beyond the health sector.	No standard/accepted approach for valuing intervention benefits.
Cost-effectiveness analysis (CEA)	To compare costs vs. benefits of an intervention with the costs vs. benefits of the status quo or another intervention; interventions are compared within the health sector, as benefits have to be measured in the same units.	C_2^d	E^e	If $(C_2 - S)/E >$ acceptable threshold (budget constraint) (e.g., US$ 50 000/year of life saved), then the intervention is better than the alternative.	Intervention benefits are easy to obtain and are readily quantifiable.	Cannot account for multisectoral intervention benefits; uses a subjective ratio for decision-making; cannot account for benefit spillovers.
Cost-utility analysis (CUA)	Same objective as for CEA.	C_2	U^f	If $(C_2 - S)/U >$ acceptable threshold (budget constraint) (e.g., US$ 50 000/QALY), then the intervention is better than the alternative.	Intervention benefits are relatively easy to obtain.	Same as CEA.
Social return on investment (SROI)	Same objective as for SCBA; also to show the value of investments to stakeholders.	C_1	W_2^g	If $W_2/C_1 > 1$, the intervention is worth investing in.	Same strengths as for SCBA.	The SROI approach to public health interventions is not well established. There is no standard approach to value benefits; multiple data sources are required to increase trustworthiness of intervention benefit estimates; benefit attribution effect is likely subjective; financial proxies are not verified.
Sector and macroeconomic impact analyses	Estimate the impact of an intervention on sectors and economy.	Costs incurred by the sector as a result of the intervention.	Benefits to the sector as a result of the intervention.	NA^h	Can inform on multisectoral intervention benefits in SCBA.	NA

Source: Prepared by the authors based on (9, 12, 13).

[a] C_1 = broad costs, including intervention cost to health and other sectors, and other costs associated with the intervention, e.g., cost to informal caregivers; costs are expressed in monetary units.

[b] W_1 = valued health and other benefits from the intervention; benefits are expressed in monetary units.

[c] S = savings in health and other sectors resulting from the intervention; savings are expressed in monetary units.

[d] C_2 = narrow costs, usually only intervention cost; costs are expressed in monetary units.

[e] E = health outcomes resulting from the intervention, e.g., years of life saved or changes in body mass index (BMI).

[f] U = quality-adjusted life years (QALYs) or disability-adjusted life years (DALYs) or other health outcomes that combine quantity and quality of life gained or saved as a result of the intervention.

[g] W_2 = monetized health and nonhealth outcomes (social, economic, and environmental) of the intervention; outcomes are monetized using financial proxies and stakeholder's opinion.

[h] NA = not applicable.

Compared to the SCBA, CEA/CUA frameworks can neither account for multisectoral benefits evaluated by different metrics (e.g., dollars, QALYs, days of sick leave, years of education) in a single measure nor directly compare the costs against the benefits of an intervention to determine whether the intervention is worth pursuing. Instead, the decision regarding whether the intervention improves upon the status quo is based on a comparison with a *subjective* threshold of cost-effectiveness (e.g., acceptable number of dollars spent per QALY). The implications of the arbitrary nature and narrow focus of cost-effectiveness thresholds have been discussed elsewhere (9).

Social return on investment. Compared to CEA and CUA, the SROI approach has the capacity to measure broader socio-economic and environmental benefits of interventions. Benefits to intervention beneficiaries as well as to relevant stakeholders are measured using financial proxies (13) and are compared to costs of intervening. SROI is much less commonly used for interventions in public health (12) than are CEA and CUA, and the SROI method for public health is not yet well established. Issues remain regarding whose benefits should be accounted for, the choice of financial proxies to monetize benefits, and the attribution of effects/benefits of the intervention (12).

Macroeconomic analyses

Macroeconomic models, in particular general equilibrium or partial equilibrium models, can assess sectoral and

economy-wide costs and benefits resulting from obesity prevention interventions. They are well suited for forecasting the economy-wide or sectoral effects of interventions (18). Examples of such effects include job losses as a result of a shrinking demand for unhealthy products, impacts on trade and agriculture due to a shift in demand for certain foods, and a healthier workforce.

AVAILABLE EVIDENCE OF COSTS AND BENEFITS

Evidence of the economic cost of obesity

Although economic cost estimates alone are insufficient for developing an investment case for obesity prevention and control, they can describe the size of the pre-intervention impact of obesity as well as the potential savings as a result of intervention strategies. Unfortunately, evidence describing the economic cost of obesity for the Americas is sparse, with the exceptions of Canada and the United States of America (19). Further, the information is largely limited to impacts on health care expenditures. The most recent systematic review suggests a wide range of estimates of obesity-attributed health care costs in Latin America, from 0.1% to 14% of total health care expenditures, depending on the country and study. For example, this estimate was 3.2% for Brazil in 2013 and 2.1% for Chile in 2014 (20). For Canada, the most recent estimates are 1.7% (21) and 2.6% (22), whereas for the United States, the range is 5% to 10% (23).

The worldwide available evidence on productivity losses due to premature mortality and sickness absences attributed to obesity indicates that these are at least as high as health care expenditures due to obesity (24). Few of these estimates are available for the Americas, with the exception of Canada and the United States (25). Two studies for Mexico estimate productivity losses at 0.11% and 0.42% of gross domestic product (GDP), while a study for Argentina puts the figures at 0.02% of GDP (20). Other economic effects of obesity, such as impacts on social protection programs, human capital development and education, employment, and nonpaid work, have received only cursory attention (10, 26).

Addressing obesity is a particular challenge for countries that, until recently, have targeted undernutrition. As the epidemiological transition progresses through the Americas, many countries are now experiencing a double burden of malnutrition, where stunting and micronutrient deficiencies take place together with increasing obesity rates (27). A 2017 study by the Economic Commission for Latin America and the Caribbean (ECLAC) and the World Food Program (WFP) found that in Ecuador and Mexico, respectively, the economic burden of malnutrition (lost productivity, reduced schooling, and elevated health care expenditures) is 4.3% and 2.3% of GDP. In these two countries, the burden of malnutrition is comprised mostly of losses due to stunting, which remain 1.5 to 3 times higher than that due to overnutrition/overweight. In contrast, the ECLAC/WFP study found that, while stunting is considered eradicated in Chile, the country faces a rising economic burden of overnutrition/overweight, representing 0.2% of GDP (28). Moreover, adverse obesity outcomes may be worsened by associated deficiencies of iron, vitamin B12, vitamin D, and other micronutrients (29, 30), impacting disease progression and health care costs.

Although alarming, the obesity cost estimates presented above do not in themselves guide decisionmakers to an acceptable, feasible, efficient policy response. Further, the cost estimates cannot be directly translated into benefits or resource savings due to obesity interventions, but these estimates can inform assessments of potential savings.

Evidence of cost-utility and cost-effectiveness analyses and of valuations of benefits

Once the decision to intervene in order to correct market inefficiencies is made (8), policymakers need a list of interventions to choose from to create a package of measures. Such interventions have to be both effective and provide good value for money (be efficient) in a particular context. As described above, CEAs/CUAs are often used to assess the efficiency of a single intervention compared to an alternative. In general, only health-related benefits are considered, thus the perspective is essentially of a health sector, despite a general recognition that obesity needs to be addressed beyond the health sector. McKinnon et al. (31) provide the most recent systematic

review of CEA/CUA of obesity prevention worldwide, while Lehnert et al. (32) review evidence for countries of the Organization for Economic Cooperation and Development (OECD). Others have conducted systematic reviews of economic evaluations (mostly CEAs/CUAs) of childhood obesity-related interventions (33–35). Interventions included in those reviews (31–35) were in the areas of community and built environment, nutrition-related policy/education changes, the school environment, and social marketing and media. Many studies in the reviews found beneficial economic outcomes of interventions. However, while many studies reported in the reviews modeled long-term impacts, most of the experienced-based assessments were from trials or observational studies over a relatively short horizon. Evidence of the long-term impact of interventions remains a research gap.

Countries of Latin America and the Caribbean (LAC) have been planning and piloting population-wide and targeted policy responses to obesity (36, 37). However, rigorous evaluations of effectiveness of those LAC obesity prevention and control measures have been sparse. Emerging evidence includes evaluations of a tax on sugar-sweetened beverages in Mexico (38), school-based programs in Latin America (39), obesity treatment interventions for children in Latin America (40), and physical activity interventions (41). Given the sparseness of evidence, earlier comprehensive nationwide studies, such as the 2010 CEA study by OECD and the World Health Organization (WHO) (42) for Mexico and Brazil, used global evidence on intervention effectiveness rather than evidence specific to the Americas. Similarly, the WHO menu of cost-effective interventions on noncommunicable diseases given in Appendix 3 of the Global Action Plan for the Prevention and Control of Noncommunicable Diseases 2013–2020 (43) is based on the global evidence of intervention effectiveness, for the most part in developed countries (44), rather than region- or country-specific evidence.

Further information on effectiveness and on intervention efficiency as provided by SCBA, CEA, or CUA is needed. Currently, CEA/CUA evidence for LAC countries is extremely limited (2, 4, 36, 45, 46).

The importance of valuing the benefits of obesity treatment and prevention in

monetary units has been recognized, particularly to enable multisectoral analyses. However, only a few examples of such valuations exist, including for the United States (47), Germany (48), and Taiwan (49). As for valuing benefits of healthy populations in general, several approaches have been offered ("full income," "value of lost output," and "value of life"), and their applications are emerging (50). Outside the health sector, guidance exists to incorporate and value health impacts using a diversity of methods within the SCBA framework, e.g., willingness to pay (16, 51).

Complementary economic evidence

A limited number of projects worldwide have attempted to evaluate impacts of nutrition-related policies on GDP and economic sectors. Mukhopadhyay and Thomassin (52) studied the impact of changes in Canadians' diet on Canada's export and import of meat, dairy products, and fruits and vegetables. The OECD (53) examined the impact of a reduction in sugar on the agriculture sector and trade. Srinivasan et al. (54) quantified and valued the consumption impact of implementing WHO dietary norms. A World Economic Forum (WEF) report (50) provides examples of case studies that applied an SROI approach, including a grant for nutrition improvement in Singapore and its effect on coronary diseases. With this nutrition grant, benefits in QALYs were monetized using GDP per capita.

These various complementary studies illustrate how a broader scope of analysis could provide evidence to inform obesity-related multisectoral intervention decisions.

Designing an intervention package

Economic analyses of single interventions are useful, but they do not in themselves provide guidance for a national strategy for obesity prevention and control. To turn the rising tide of obesity, a comprehensive assessment of an intervention package in various settings and contexts is required, including potential synergies among chosen interventions and their scalability to a subnational or national level.

Several studies provide economic analysis of an intervention package at a national level with different degrees of

methodological robustness. Table 2 provides summaries of these studies (42, 55–60). These studies recognize that a package should include both population-level and targeted interventions. Targets usually include children, obese individuals, or populations with low socioeconomic status. Considered intervention packages include health education, regulation, fiscal measures, individual counseling, medical treatment of obesity, healthy eating, and physical activity interventions in schools and worksites. Typically, assessed interventions require significant upfront investments, but only achieve impact after several years, such that at least five years of experience is needed for them to reach an acceptable level of cost-effectiveness. Interventions with the most favorable cost-effectiveness ratio at the population level are outside health care (42, 55, 56). Individual-level interventions on their own may take decades to reach a favorable cost-effectiveness ratio due to difficulties in reaching a large proportion of the population. In contrast, interventions in the environments that shape obesogenic behaviors (e.g., food labeling) have a modest individual effect, but are societally cost-effective because a modest effect is aggregated over an entire population, and implementation costs are relatively low.

A diverse package of complementary population-level interventions in obesogenic environments offers the most promising investment scenario for most country contexts. To support this, however, more evidence of a long-term effect of population-level interventions is needed. Further, global tobacco control experience shows that comprehensiveness and synergies are crucial for effectiveness (61). However, most integrated assessments for obesity action consider an overall effect of an intervention package as a sum of individual intervention effects, without consideration of cross-effects or synergies. We found only one study (42) that formally modeled a synergy effect.

Even if an intervention is effective at preventing obesity at reasonable cost (cost-effectiveness), other criteria influence decision-making. As preventive interventions are aimed at having a long-lasting effect, the majority of studies in Table 2 assess sensitivity of CEA results to the sustainability of an intervention effect. Also, the CEA/CUA-based studies in Table 2 apply criteria of equity,

acceptability to stakeholders, feasibility of implementation, and scalability of interventions to a national level. Formal quantitative applications exist to incorporate these criteria in economic analysis (e.g., in the ACE study (56), a CEA was undertaken specifically for indigenous populations), or to apply afterwards. In most instances, however, when other criteria were formally considered, it was in the form of a qualitative assessment by a stakeholder committee. It is noteworthy that guidelines in areas outside health (such as with environment and public service programs) suggest clear, explicit approaches to incorporate equity into analysis (16, 51).

DISCUSSION

The landscape of studies concerning the investment case for obesity is dominated by CEA/CUA. Some of these analyses are broader than others in terms of the number of interventions assessed and the criteria for intervention ranking. Significant methodological differences across the studies that we reviewed (even among CUAs/CEAs) prevent a comparison of results. Thus, studies that assess a variety of interventions using the same approach are the most useful. Among CUAs that analyzed packages of intervention for national contexts, some analyses, such as Cecchini et al. (42) and ACE-Obesity (56), are based on rigorous epidemiological models incorporating uncertainty. Other CUA studies, such as McKinsey Global Institute (59), rely on intervention evidence from systematic reviews or from comprehensive studies. Several LAC countries have launched comprehensive packages of antiobesity interventions (4, 62). However, the evidence on these interventions' effectiveness is sparse, and economic analyses of the packages as a whole, including their synergetic effect, are as yet limited.

The scope of an investment case for obesity prevention and control is large, and many methodological and evidence gaps exist. Moving forward will require a concerted effort of researchers, evaluators, and surveillance experts. In the process of developing intervention and research projects, early involvement by economists and other social scientists is needed in order to collect relevant economic data and ensure rigorous economic analysis. Table 3 summarizes two things: 1) gaps in current methods and

TABLE 2. Economic analysis of comprehensive scalable packages of interventions for obesity prevention and control: summary of cost-effectiveness analysis (CEA) and cost-utility analysis (CUA) studies

Project (reference(s))	Objective	Method	Intervention type	Costs	Benefits	Results	Timeframe (yr)	Equity analysis	Intervention synergies[a]	Other criteria for intervention ranking
Obesity Prevention (42)	To evaluate cost-effectiveness of obesity prevention interventions in Brazil, Canada, England, India, Mexico, Russia, and South Africa and compare multi-intervention strategies with single interventions.	Generalized CUA based on Chronic Disease Prevention (CDP) Model by OECD/WHO	Prevention packages, including physician counseling, mass media, school-based, worksite, fiscal policies, and regulation	Implementation cost net of health care cost savings	DALYs[b]	Health education, regulation, fiscal measures, and physician counseling have favorable cost-effectiveness (CE) level. Multiple strategies bring the best effectiveness and do not jeopardize CE. Interventions with the most favorable CE are outside health care. Regulation of food advertising to children can be more effective and efficient than can school-based health promotion.	100	Yes (analyses by socioeconomic group are permitted by the model, but were not undertaken due to data limitation)	Yes	POP,[c] EFF,[d] ST[e] (assumptions embedded in the CDP model), UC[f]
ACE-Obesity (children and adolescents) and ACE-Prevention (Obesity) (55, 56)	To assess evidence on effectiveness and cost-effectiveness of obesity prevention and treatment interventions in Australia.	CUA based on epidemiological BMI-DALY transition model	ACE-Obesity: Thirteen interventions, mostly school-based, also childcare, primary care, hospital, and community-based; media and marketing. ACE-Prevention (Obesity): nine interventions, including nutrition labeling, unhealthy food tax, diet and exercise for adults. In both projects, interventions are classified under primary (e.g., education program) and secondary prevention (e.g., school-based program for obese children) and treatment (e.g., pharmacotherapy).	Implementation cost, including to parents net of health care cost savings, including carer's time	DALYs	Primary preventive interventions, including that target obesogenic environment, are cost-saving. Several cost-effective interventions for obesity treatments exist for both children and adults.	100	Yes (stakeholders' assessment)	No	AC,[g] EFF, F,[h] ST, UC, "side effects" (health, economic, environmental, etc.)

(Continued)

TABLE 2. (Continued)

Project (reference(s))	Objective	Method	Intervention type	Costs	Benefits	Results	Timeframe (yr)	Equity analysis	Intervention synergies[a]	Other criteria for intervention ranking
ACE-Obesity NZ (57)	To evaluate evidence on effectiveness and cost-effectiveness of population-based initiatives to prevent obesity and related diseases in New Zealand.	CUA, based on (55, 56); cohort simulation for BMI and disease risks, but no comorbidity.	Ten intervention scenarios selected for CEA based on intervention type (e.g., activity, education), and setting and population group (age, ethnic, general)	Implementation cost net of health care cost offsets	QALYs[i]	General health screening as well as activity and behavior modification for primary school children (Switch-Play) are most CE. NZ-based interventions need evaluation for long-term outcomes.	100	Yes (ethnic group scenarios)	No	EFF, F, UC
CHOICES (58)	To assess evidence on effectiveness, cost-effectiveness, and the reach of interventions to reduce childhood obesity in the United States.	CUA, based on (54), Markov cohort microsimulation for cost and BMI change.	A tax on sugar-sweetened beverages; a subsidy reduction of targeting children ads of unhealthy products; a state policy increasing physical activity at schools; and a state policy on sedentary behavior and nutrition in child educational settings.	Implementation costs	Net costs or BMI, QALYs, and DALYs for adults	Over 2015-2025, three out of four interventions will bring net savings over 10 years. Great variation in cost-effectiveness and reach as interventions are scaled up to national level.	2 and 10	Yes (stakeholders' assessment)	No	POP, EFF, UC, F
McKinsey Global Institute (59)	To catalog interventions and develop initial assessment of their cost-effectiveness, and assess scaling up for the United Kingdom.	CUA, effectiveness evidence is rated	44 interventions chosen	Implementation costs	DALYs	A package of interventions is required to fight obesity. Almost all are cost-effective. A global investment to address obesity is only one-quarter of obesity burden.	100	Yes	Yes	EFF, SC[j]
Pricewaterhouse Coopers Australia (60)	To assess a cost of obesity in Australia and present analysis of costs and benefits of intervention package by obesity class.	Cost-savings analysis based on a high level literature scan. Costs include that to health care sector, selected productivity losses, and taxes forgone, using bottom-up approach by obesity class.	A large set of interventions (personal, education, environment, and medical) (from (55, 56, 59)) based on cost-effectiveness, feasibility, and strength of evidence.	Implementation costs from the literature and expert opinion	Savings in costs and government subsidies	A package of intervention breaks even after 6 years, positive benefit/cost ratio of 1.7 discounted to 2015 (from 2025). Obesity class 2 benefits the most, and obesity class 1 the least.	10	Yes (analysis by obesity class)	No	EFF, F

Source: Prepared by the authors based on their literature review.
[a] Were intervention synergies analyzed in a study? Intervention synergies refer to a cumulative benefit of an intervention package being greater than a sum of benefits from the same interventions implemented separately.
[b] DALYs = disability-adjusted life years.
[c] POP = population reached.
[d] EFF = evidence on intervention effectiveness reviewed systematically.
[e] ST = sustainability/durability of intervention effect.
[f] UC = uncertainty over the intervention effect is modeled.
[g] AC = acceptability of interventions by stakeholders.
[h] F = feasibility of implementation is considered.
[i] QALYs = quality-adjusted life years.
[j] SC = scalability of an intervention to a national level.

TABLE 3. Considerations and ways forward in methods and evidence for economic analysis of obesity prevention and control

Considerations	Ways forward
Methods	
Quality-adjusted life years (QALYs) do not capture what nonhealth stakeholders value in health improvements. Given that obesity policies often concern nonhealth sectors, this is, at present, an important weakness of a cost-effectiveness and cost-utility analyses (CEAs/CUAs) as applied to public health.	Develop consistent approaches to value benefits of interventions in a common currency acceptable to all sectors of the economy. Two approaches to valuing statistical life (VSL) are common and can potentially be adopted for valuations of antiobesity interventions, and public health interventions, in general. These are revealed preferences and contingent valuation approaches.
QALY metrics focus on the at-risk individual. Obesity, particularly childhood obesity, and related interventions often impact families and other caregivers. These effects are not currently captured by QALY metrics and are generally not accounted for in CEA/CUA.	Incorporate effects on families and other caregivers (as applicable) into intervention benefits.
Impacts on socioeconomic and other inequalities have been recognized as important criteria when ranking interventions. Currently, distributional consequences of an intervention and how it impacts various population groups are, with few exceptions (e.g., (56)), rarely accounted for. Improvements in terms of QALYs are assumed to be the same across the whole population, and QALY metrics are based on the general population.	Develop approaches to incorporate equity considerations into investment cases for obesity.
A need for a transparent ranking based on chosen criteria, beyond effectiveness and efficiency of an intervention package, has been identified by several comprehensive studies (e.g., (42, 56)).	Develop new or modify existing approaches to consistently rank interventions upon chosen criteria. These could then provide a foundation for an integrated investment case model that draws epidemiological outcomes from existing models, applies economic (efficiency) considerations, and ranks interventions according to specified criteria.
QALYs are computed on a life-time basis, but the evidence on effectiveness of interventions is often short term.	Due to the fact that benefits of most obesity interventions occur over a long time, trial-based studies with a short-term follow-up need to be supported either by a longitudinal cohort study or a modeling framework, which simulate long-term epidemiological outcomes of interventions. This permits accounting for long-term benefits of interventions on obesity, as well as assessing how uncertainty in the sustainability of the benefit affects CEA results.
Recent advances in behavioral economics have implications for a conceptual framework of social cost-benefit analysis (SCBA) and its applications (8). Behavioral economics is exploring the behavioral implications of relaxing various traditional assumptions about individual choice. When individuals' preferences for products or activities, risk aversion, or discount rates are not constant through time, traditional discounting of future net social benefits under SCBA can give incorrect results. For example, QALY calculations are not consistent with hyperbolic discounting by an individual. (Hyperbolic or "present-based" discounting refers to preferences for immediate gratification or to extreme short-term aversion to risk, where the discount rate drops sharply when looking at the long horizon.)	How the two discounting rates can be reconciled is an open area of research (8).
Many observational studies, particularly in the past, have been measuring associations rather than causal effects, e.g., between physical activity and body mass index (BMI). It is clear that the attribution of the effect is required to appropriately measure the effect of various factors and of interventions on obesity and health.	Various techniques, including lagged variable and instrumental variable approaches, exist to devise a causal effect. For example, these have been applied in studies examining the effect of BMI on individual's wages (63).
Evidence	
Globally, including in Latin America and the Caribbean (LAC), epidemiological data and economic data are both limited, which impedes economic analyses and evidence-based policy planning.	Improve data and data collection infrastructure to enable evidence on: 1) health risks over time; 2) health care and other costs associated with living with a particular disease and comorbid conditions; 3) effectiveness of interventions in isolation or as comprehensive packages for specific countries/regions; 4) sustainability of intervention effects over time; 5) cost-effectiveness of interventions.
Cumulative effects of multi-intervention strategies could be very significant. However, little evidence exists on synergies. Most estimates of impact are calculated as a sum of effects of individual interventions.	As countries introduce packages of interventions, economic analyses have to take account of the synergetic effect of the package and take care in the attribution of an observable effect to a particular intervention from the package.
In several LAC countries, evidence on economic costs of obesity is scarce or estimates vary widely.	Expand economic analysis and methods to capture broader costs of obesity, including costs to various economic actors and types of costs (e.g., health care, productivity, to human capital).
Economic evidence emerges on the impact of nutrition-based policies, as shown in Table 2 (complimentary analyses). Economic analyses of industrial policies that have significant effect on access and availability of healthy and unhealthy foods are needed.	Expand economic analysis of industrial policies that have significant health effects, e.g., agriculture, agri-food, and trade policies.
It has been recognized that various interventions have to be implemented in concert to have a significant effect. The list of interventions should be broad enough for various actors to choose from to implement in their particular context.	Expand the potential list of policies/instruments (and research on their effectiveness) to include: 1) incentives provided by various nonhealth policies and regulations, e.g., workplace policies; 2) policies and regulations at macro, micro, regional, and local levels; and 3) behavioral incentives (such as commitment mechanisms), changing defaults, and simplifying information (e.g., front-package traffic-light labeling) to make healthy choices easier.

Source: Prepared by the authors based on their literature review.

evidence that impede the development of comprehensive investment cases for obesity prevention and control and 2) ways forward (8, 42, 56, 63).

On the methodological side, developing applications of existing methods for the monetary valuation of benefits will be essential to gain multisectoral support for obesity prevention and control. Although we found no studies that monetized health and other benefits of a comprehensive intervention package to address obesity, valuations of benefits from reduced obesity have been attempted (47–49), and associated methods are part of government agencies' guidelines for economic analyses (16, 51).

The subsection above on designing an intervention package outlines criteria other than economic efficiency that are important for decision-making. Among these are equity considerations, including the impact on the most vulnerable populations; feasibility and scalability of an intervention at a population level; and acceptability to various stakeholders. Transparent and consistent approaches for integrating these considerations into an investment case are required to improve decision-making and gain multisectoral buy-in. Here, guidelines and practical applications used by other sectors could be helpful for developing approaches with broad acceptance.

On the evidence side, progress is impeded by a lack of data and data infrastructure. This is shown not only by limited economic analyses of strategies implemented to address obesity throughout the Americas, but also by a paucity of evidence on intervention effectiveness in general, and on the cost of obesity to economies within LAC in particular. Evidence needs to be expanded to include prospective and retrospective economic evaluation of intervention packages, and to incorporate the broader costs of obesity, including impacts on diverse economic actors. While there may be opportunities for researchers to better utilize existing datasets, national authorities will likely need to invest in integrating economic data into public health surveillance infrastructure or surveys, including linkage or collection of new economic data, to support evidence-based policies. In the interim, countries can learn and extrapolate from their regional neighbors and adapt successful interventions to their context.

In practice, an investment case will differ from one jurisdiction to another, based on the perspective of analysis and the data in hand. Moreover, the choice of the most effective policy suite for a specific national context will be determined by a number of factors. These include the country-specific epidemiological profile, structure of the economy, dependence on trade, evidence on market failures, and distributional issues.

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RESUMEN

Formulación de argumentos a favor de la inversión para la prevención y el control de la obesidad: perspectivas sobre el progreso metodológico y la evidencia

Este artículo abre un debate sobre las principales características de los argumentos a favor de la inversión para prevenir y controlar la obesidad, al buscar evidencia sobre los métodos existentes y destacar las consideraciones relativas al contexto y la evidencia para América Latina y el Caribe. Instamos a los investigadores y analistas en el campo a que actualicen y amplíen los métodos existentes de análisis económico a fin de reflejar mejor la naturaleza multisectorial de los argumentos a favor de la inversión para la prevención y el control de la obesidad. También encontramos lagunas en la investigación y el trabajo adicional que se requiere para impulsar los métodos y la evidencia que respalden estos argumentos a favor de la inversión en toda América.

Palabras clave   Análisis costo-beneficio; obesidad; inversiones en salud; economía de la salud; política de salud; Américas.

RESUMO

Elaboração de um caso de investimento para prevenção e controle da obesidade: perspectivas sobre o progresso metodológico e evidências

Esta análise visa trazer à discussão as principais características de um caso de investimento para prevenção e controle da obesidade ao examinar comprovações sobre os enfoques existentes e destacar considerações contextuais e evidências para a América Latina e o Caribe. Fazemos um chamado aos pesquisadores e analistas no campo a atualizar e expandir a metodologia atual de análise econômica a fim de melhor refletir o caráter multissetorial de um caso de investimento para prevenção e controle da obesidade. Também identificamos lacunas de pesquisa e a necessidade de trabalhar mais para melhorar a metodologia e as evidências de casos de investimento nas Américas.

Palavras-chave   Análise custo-benefício; obesidade; investimentos em saúde; economia da saúde; política de saúde; Américas.

Pathways from trade to health

Teresa Cyrus[1]

ABSTRACT   *International trade has increased over time, both in volume and as a share of gross domestic product, and international trade agreements have proliferated. This rise in trade has many potential impacts on health outcomes. Trade raises living standards, allowing for greater spending on education and medical care, which improves health. However, trade may worsen intranational inequality, leading to increased stress and adverse impacts on mortality. Labor markets are affected by international trade, and the resulting changes in unemployment, working hours, and injury rates have an impact on health outcomes. Trade may induce adverse environmental impacts, such as increased pollution, leading to worsened health. Reductions in prices as a result of changes to trade policy may increase the consumption of unhealthy goods, including tobacco and processed foods, thus worsening the prevalence of noncommunicable diseases. Trade agreements may affect the ability of governments to legislate health-improving policies. Overall, international trade and trade agreements may have both positive and negative effects on health outcomes; government policy may be used to ameliorate any adverse effects of trade.*

Between 1960 and 2015, the worldwide average share of trade in gross domestic product (GDP) rose from 24% to 58% (1), and the volume of merchandise export flows grew from US$ 130 billion to US$ 16 trillion (2). As well, as of June 2017, the number of regional trade agreements in force stood at 296 (3), and every member of the World Trade Organization (WTO) was a signatory to at least one trade agreement. Rising GDP over the same time period has allowed greater resources to be devoted to curbing communicable diseases, but has also led to an increase in unhealthy behaviors that

have driven noncommunicable diseases (NCDs)—including cardiovascular diseases, cancer, chronic respiratory diseases, and diabetes—to the forefront of health agencies' awareness and efforts. According to the World Health Organization, noncommunicable diseases are now responsible for 70% of all deaths globally (4).

To what extent are trade and trade agreements responsible for NCDs? Does international trade have a positive or an adverse effect on health outcomes? Studies that have examined the direct impact of trade on health have used regression analysis without specifying the causal pathway. Levine and Rothman (5), Owen and Wu (6), and Stevens et al. (7) use cross-country data and find that trade

leads to improved measures of health, from infant mortality to life expectancy, at least for developing countries. Herzer (8) uses panel data methods to show a link between the trade share in GDP and life expectancy, and finds that trade is responsible for 12% of the annual rise in life expectancy in his sample of 74 countries; he finds a larger effect in lower-income countries.

However, rather than trying to establish a statistical link between trade and health, a more useful way to examine this relationship is to explore the precise causal pathways by which these two variables are connected. This paper describes six main pathways, listed in Table 1, by which international trade flows and international trade policy have

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TABLE 1. Pathways from trade to health, and their potential mechanisms

Pathway	Potential mechanism
1. Trade affects health by raising living standards	Increased trade → growth in gross domestic product per capita → reduction in material deprivation → reduced mortality and increased life expectancy
2. Trade affects health by changing inequality	Increased trade → rise in income inequality → increased stress and reduced social cohesion → increased mortality and reduced life expectancy
3. Trade affects health through changing the labor market	Increased trade → increased unemployment and reduced earnings → worsened physical and mental health, higher injury rates
4. Trade affects health through changing the environment	Increased trade → increased pollution → increased mortality
5. Trade policy changes markets for particular goods	Tariff reductions → increased consumption of health-reducing goods → worsened health outcomes
6. Trade policy influences the regulatory space	Trade agreements → longer patent protection → increased pharmaceutical prices → worsened health outcomes

Source: Prepared by the author based on the study results.

been shown to impact health: 1) through changing living standards; 2) through increased inequality; 3) through impacts on the labor market; 4) through affecting the environment; 5) through changing markets for particular goods; and 6) through influencing the regulatory space.

TRADE AFFECTS HEALTH BY RAISING LIVING STANDARDS

Trade affects health by boosting the GDP, which allows for higher living standards. Empirical studies in the early trade and growth literature found evidence that trade causes growth in per capita income, but these cross-country studies were critiqued for their potential endogeneity bias. More careful work addressed these empirical concerns. For example, using an instrumental variable based on geography, Frankel and Romer find that a one percentage point rise in the trade share increases income per person by 2% (9). Lee et al. (10) control for endogeneity using a simultaneous equations system and identification through heteroscedasticity, and they find a small positive effect of openness on growth. Many recent studies continue to find that trade causes growth. For example, Eicher and Kuenzel show that a one standard deviation rise in their measure of exports increases growth in developing countries by one percentage point (11). However, while trade has not been shown to reduce growth, it is common to find that trade has no impact on growth. Durlauf et al. (12) find no robust effect of openness on growth in a sample of 57 countries.

A subset of the trade and growth literature focuses on resource-rich countries, with a common finding of a resource "curse." Van der Ploeg shows that, if a country's exports are primary goods, growth tends to be low if accompanied by low-quality institutions, such as corruption and poor rule of law (13). Sala-i-Martin and Subramanian argue that the way natural resources impair growth is typically through adversely affecting institutional quality (14).

The so-called "new new" trade theory, which uses firm-level data, provides convincing evidence that exposure to trade causes the least productive firms to exit, leading to welfare gains through a rise in aggregate productivity. Using data for the United States of America, Bernard et al. show that lower trade barriers cause aggregate productivity to rise (15). Pavcnik examines Chile's trade liberalization and finds that it led to increased aggregate productivity, at least partly due to productivity increases within plants (16).

Increased GDP allows for greater expenditures on the goods and services that improve health, most importantly education and medical care. In addition, a large body of literature shows that income and health outcomes are strongly linked. Pritchett and Summers examine the effect of GDP per capita on infant and child mortality and on life expectancy (17). To control for reverse causality, they use instrumental variables as their estimation technique, together with panel data covering 111 countries over a 25-year period. They find a robust relationship between GDP per capita and health outcomes: a 10% rise in per capita income is associated with a 2% to 4% drop in infant mortality. Biggs et al. examine data from 1960 through 2007 for 22 Latin American countries and find that a 1% increase in GDP per capita is associated with 0.06 more years of life expectancy and a 1% reduction in infant mortality; the effects are even larger if inequality is held constant (18). Clark uses panel data for 163 countries during the 1980-2005 period and shows that increases in GDP per capita raise life expectancy and reduce infant mortality, especially at low levels of development (19).

For low- and middle-income countries, a rise in trade and a corresponding increase in average income reduces material deprivation and improves health by lowering mortality and raising life expectancy. Between 1960 and 2015, for this group of countries, the trade share in GDP rose from 20% to 50%, while life expectancy at birth rose from 47 years to 70 years, and the infant mortality rate dropped from 154 to 35 per 1 000 births (1). These health gains have likely occurred by reducing the prevalence of communicable diseases; however, as countries grow richer, such health improvements may slow or even reverse due to NCDs.

TRADE AFFECTS HEALTH BY CHANGING INEQUALITY

The second pathway from trade to health is through changing inequality. Even if trade improves average incomes in a country, trade is unlikely to raise income for all workers. Trade theory, in fact, suggests that an increase in trade has differential effects on workers. Standard trade theory predicts that trade will lower the real wages of unskilled workers in industrial countries and raise the real wages of unskilled workers in developing countries, leading to a rise in income inequality in higher-income countries and a fall in inequality in lower-income countries.

There is evidence of rising income inequality since the early 1980s in developed countries. Roser and Cuaresma examine 32 developed countries over a 40-year period and show that, as predicted by trade theory, a one standard deviation rise in imports from developing countries leads to a 6% rise in the Gini index (20).

Contrary to the prediction of trade theory, there is also evidence of rising inequality in developing countries. Using data for 65 developing countries between 1980 and 1999, Meschi and Vivarelli show that trade with high-income countries worsens income inequality, possibly due to technology diffusion that increases the returns to skill (21). Helpman et al. show that rising inequality worldwide and increased dispersion among workers, plants, and firms are consistent with the "new new" trade theory that focuses on firm heterogeneity. Heterogeneity in terms of firm productivity leads to heterogeneity in terms of export performance, as only the more productive firms are able to export, and evidence shows that successful exporters pay higher wages (22).

If trade worsens inequality, or lowers real wages for some workers, then there may be effects on health due to stress or reduced access to health services, although evidence is mixed. Babones examines 134 countries over the 1970-1995 period and finds a strong correlation between changes in inequality, as measured by the Gini coefficient, and changes in population health, as measured by infant mortality and life expectancy: a rise in inequality of one Gini point is associated with a decline of 0.4 to 0.5 years in life expectancy (23). Cornia et al. show that inequality may impact mortality through a worsening of material deprivation, psychosocial stress, and social cohesion (24). Some studies, such as ones by Diez-Roux et al. (25) and Kim et al. (26), suggest that inequality is linked to increased mortality from cardiovascular diseases. Kondo et al. examine 19 cross-sectional studies and conclude that inequality may modestly decrease self-reported health status due to stress and the erosion of social cohesion (27). Pickett and Wilkinson, in a meta-analysis, find strong evidence that inequality is linked to worsened population health and well-being, possibly due to chronic stress (28).

However, many studies find no causal link from inequality to health. In an early survey, Deaton finds no evidence of a cross-country relationship between inequality and health outcomes (29). Herzer and Nunnenkamp find that income inequality has a negative effect on health in developing countries but, surprisingly, a positive effect in developed countries; they posit that inequality is associated with higher-quality health care systems that have spillover effects (30). Using tax data for 12 developed countries between 1903 and 2003, Leigh and Jencks find that the income share of the top decile is positively related to infant mortality and negatively related to life expectancy, but the relationship becomes insignificant once country and year fixed effects are included (31).

TRADE AFFECTS HEALTH THROUGH CHANGING THE LABOR MARKET

International trade affects workers in the labor market, with many possible implications for mental or physical health. A highly influential paper by Autor et al. uses data at the local labor market level in the United States to measure exposure to Chinese imports and finds that increased Chinese imports into the United States since 1990 have resulted in increased unemployment, reduced labor force participation, and reduced earnings (32). McManus and Schaur (33) and Lang et al. (34) use the Autor et al. technique to determine how import exposure affects worker health in local labor markets. McManus and Schaur find that workplace injuries and illness rates rise in United States manufacturing firms that compete with imports (33). Lang et al. find that increased imports from China worsen the mental and physical health of workers in the United States, not only directly but also indirectly, through interpersonal spillovers or through being displaced into unemployment (34). Colantone et al. analyze panel data from the United Kingdom and show that greater import competition leads to worsened mental health due to higher unemployment, lower wage growth, and a resulting increase in stress (35).

Pierce and Schott examine an exogenous shock to United States trade policy and find that United States counties that were more exposed to international competition from China had higher mortality rates, especially due to suicide (36). Their interpretation is that this was due to disruption in the labor market that caused higher unemployment and lower income. The increased mortality rates they uncover were concentrated among white males, and the counties that were more exposed to trade experienced larger declines in manufacturing employment, which had a greater impact on white males than on others. Hummels et al. use data from Denmark to show that higher exports lead to longer working hours, higher on-the-job injury rates, and increased hospitalizations for heart attack and stroke (37).

TRADE AFFECTS HEALTH THROUGH CHANGING THE ENVIRONMENT

The fourth way that trade may impact health is by affecting environmental outcomes, such as air and water pollution. The negative impact of pollution on individual health and well-being is well established in the health sciences literature. Economists have contributed to this understanding by using quasi-experimental techniques to control for nonrandom assignment as well as avoidance behavior. For example, utilizing data for the United States, Chay and Greenstone use the fall in manufacturing output during the 1980s recession to determine how total suspended particulates affect infant mortality (38). Currie et al. use the mother's physical address to assign pollution levels, employing maternal fixed effects models to translate declining carbon monoxide to higher birth weight and reduced infant mortality in the state of New Jersey (39). In the developing country context, Ebenstein uses water pollution data from China to show the link from water quality to digestive cancers (40), and Arceo et al. quantify the relationship between more stringent air quality regulations in Mexico City and the subsequent decline in neonatal and infant mortality (41).

In contrast to the environment-health link, the pathway from trade to the environment is not as clear-cut. Trade's impact on pollution can be divided into three areas: 1) the scale effect, measured by economic activity, which tends to raise pollution; 2) the technique effect, measured by per capita domestic income, which raises the demand for environmental quality and therefore tends to reduce pollution; and 3) the composition effect, measured by the capital-labor ratio, which may raise or lower pollution, depending on a country's comparative advantage.

Antweiler et al. find that GDP and the capital-labor ratio raise sulfur dioxide emissions, so the scale and composition effects indicate that trade harms the environment (42). However, the technique

effect works in the opposite direction. There is a negative relationship between per capita income and pollution, and this effect is strong enough to mean that, overall, freer trade is good for the environment. Frankel and Rose use cross-country data on three measures of air pollution to find a similar result, that trade openness reduces pollution (43). Copeland and Taylor survey the literature and conclude that there is evidence of an environmental Kuznets curve, with rising per capita incomes tending to improve environmental quality (44). They also assert that environmental regulations affect trade by influencing plant location, thus showing a pollution haven effect. The literature on the pollution haven effect is inconclusive, but research by Dam and Scholtens indicates that the quality of a country's institutions determines whether it will become a pollution haven: countries with poor institutions attract "dirty" companies (45).

While most researchers have not found a clear negative impact of trade on the environment, a recent study using Chinese data demonstrates the effects of trade on regional pollution levels. Bombardini and Li use air quality data from China to show that a rise in the pollution content of exports increases infant mortality from cardiorespiratory conditions (46).

In addition to affecting pollution, trade can influence natural resources, which could comprise trade in natural resources or trade in agricultural products made possible by resource conversion. Institutional quality is especially important. In a survey of the literature on trade and resources, Bulte and Barbier claim that trade openness may reduce welfare when institutions, such as property rights, are poor (47). For their part, Barbier et al. show that a rise in the agricultural export share raises agricultural land conversion when there is corruption in government (48).

TRADE POLICY CHANGES MARKETS FOR PARTICULAR GOODS

International trade agreements may affect the consumption of particular goods. Consumers respond to prices, and reductions in tariffs and quotas that lower prices therefore tend to increase consumption. If consumption of goods, including alcohol, tobacco, and processed foods, rises, then health is impacted through escalating heart disease, lung cancer, diabetes, and so on, as shown by Siegel et al. (49).

The World Health Organization states that, since 1980, there has been a doubling of obesity worldwide, and that, in 2014, 39% of adults were overweight and 13% were obese (50). Blouin et al. present several case studies showing how trade liberalization, by reducing the prices of unhealthy foods, may have led to a rise in obesity and chronic diseases in many developing countries (51). Clark et al. describe how the North American Free Trade Agreement facilitated exports of corn, soybeans, sugar, snack foods, and meat products from the United States to Mexico between 1994 and 2008; over the same period, the prevalence of overweight and obesity in Mexico rose (52). Miljkovic et al. find a positive and significant effect of trade on obesity in a panel data set covering 79 countries, with a 10% rise in trade openness being associated with a 2.9% increase in the prevalence of obesity, and with a larger effect in developing countries than in developed countries (53). Costa-Font and Mas also show a robust association between globalization and obesity in a study on 26 countries (54). They find that the effect works not through lower prices, but through a change in diet and lifestyle: a one standard deviation rise in the social aspect of globalization (such as changes in information flows and personal contact) is associated with a 13.7% increase in obesity.

While the research has focused on increased consumption of health-reducing goods, it is also possible that we could see lower prices and increased consumption of health-improving goods, such as fresh foods, medical devices, mobility aids, and fitness equipment, although little research has been done to date on measuring these effects.

TRADE POLICY INFLUENCES THE REGULATORY SPACE

Lastly, trade policy may influence the ability of governments to enact and enforce legislation that affects health. Modern trade and investment agreements lead to concern over investor-state dispute settlement provisions and regulatory harmonization initiatives that may provide challenges to existing or proposed health and safety regulations.

McNeill et al. discuss the asymmetries in bargaining power between small and large countries in these negotiations, which may lead to large concessions being made by smaller, poorer nations in order to secure access to larger, richer countries' markets (55).

In particular, trade agreements may lessen the ability of governments to restrict advertising or to enforce laws on plain packaging or the addition of warning labels, although trade laws require simply nondiscriminatory treatment. On the other hand, Drope and Lencucha describe how the development of international norms allows for such norms to become encoded into law over time, as with the Framework Convention on Tobacco Control (56).

The Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) requires WTO member countries to maintain 20 years of patent protection, although the 1995 TRIPS agreement was amended by a 2003 waiver, made permanent in 2017, allowing for the import of generic versions of patented medicines through compulsory licensing. Patents on pharmaceutical products comprise a trade-off between the need to provide incentives to firms to undertake the costly research and development required to bring new drugs to the market and the resulting higher prices of pharmaceuticals. Smith et al. discuss how higher drug prices may have negative health implications for those who cannot afford to buy needed drugs, especially those living in developing countries (57). Duggan et al. examine India's 2005 reform of its patent system to comply with TRIPS (58). They exploit variation in the timing of patent decisions and find that prices have risen on average by 3% to 6% after a patent for a molecule is granted, but they find no significant change in the drug quantities sold or in the number of firms selling pharmaceuticals in India.

The purported benefit of TRIPS is the impetus to increase innovation. Kyle and McGahan (59) examine patent protection in 192 countries over the 1990-2006 period, making use of variation in the timing of patent laws. They find that patent protection is associated with increased research and development in pharmaceuticals in rich countries but not in poor nations. Kyle and Qian (60) examine how the patent protection required by TRIPS has affected pharmaceutical markets in 60 countries between 2000 and 2013.

They find that TRIPS has led to higher prices, higher quantities sold, and a faster launch of new pharmaceutical products. They also find that countervailing policies were successful in that the rise in price due to patents is smaller in poor countries.

CONCLUSIONS

Since the Second World War, international trade has risen both in absolute terms and as a share of GDP, but this increased reliance on trade has had both positive and negative effects on health. The literature suggests that trade has raised average incomes, which has allowed for improvements in life expectancy and mortality through reducing communicable diseases. At the same time, however, evidence suggests that trade has contributed to the growth in intranational inequality seen in both industrialized and developing countries. In addition, this rise in inequality is linked to a worsening of stress and a decrease in social cohesion, adversely affecting

health and well-being. Recent evidence suggests that labor markets are impacted by both exports and imports, leading to worsening physical and mental health, as well as workplace injuries. While empirical studies clearly show that pollution adversely affects health, evidence is unclear as to whether trade worsens or improves the environment. By opening up markets and reducing prices, trade liberalization encourages the consumption of processed foods and other health-reducing goods. Finally, by forcing longer patent periods, trade agreements raise the prices of pharmaceuticals, which increases innovation but may worsen health outcomes in low-income countries. Overall, while globalization may have strong momentum, researchers and policymakers are recognizing the need for accompanying policy changes to protect the health of domestic residents.

There are many options for governments to support health outcomes with government policy. Policies to address the health effects of trade-induced income inequality or unemployment might

include government-funded health care, unemployment insurance, education spending, and worker training programs. If trade leads to increased workplace injuries, then the appropriate policy focus is on worker training and regulations to strengthen workplace safety legislation. Stricter regulations on air and water quality may ameliorate the effects of trade-induced pollution. If increased globalization is to blame for rising consumption of unhealthy products, then tax policy and consumer education can be utilized. Finally, governments must support their health agencies when trade policies and trade agreements are drafted, so that population health is brought to the forefront of negotiations as a primary concern.

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RESUMEN

Las vías del comercio a la salud

El comercio internacional ha aumentado con el transcurso del tiempo, tanto en volumen como en proporción del producto interno bruto, y han proliferado los acuerdos comerciales internacionales. Este incremento del comercio tiene muchas posibles repercusiones sobre los resultados en materia de salud. El comercio eleva los niveles de vida y permite un mayor gasto en educación y atención médica, lo cual mejora la salud. Sin embargo, el comercio puede empeorar la desigualdad intranacional, lo que genera mayor estrés y repercusiones adversas sobre la mortalidad. Los mercados laborales se ven afectados por el comercio internacional, y los cambios resultantes en materia de desempleo, jornadas de trabajo y tasas de traumatismos repercuten sobre los resultados en materia de salud. El comercio puede inducir efectos ambientales adversos, como mayor contaminación, lo que deteriora la salud. La reducción de los precios a consecuencia de los cambios en las políticas comerciales puede aumentar el consumo de productos poco saludables, como el tabaco y los alimentos procesados, lo que empeora la prevalencia de las enfermedades no transmisibles. Los acuerdos comerciales pueden afectar la capacidad de los gobiernos de legislar políticas que mejoren la salud. En términos generales, el comercio internacional y los acuerdos comerciales pueden tener tanto efectos positivos como negativos sobre los resultados en materia de salud, y se puede recurrir a las políticas gubernamentales para mitigar los efectos adversos del comercio.

Palabras clave

Internacionalidad; salud global; economía.

RESUMO

Trilhas do comércio à saúde

O comércio internacional se expandiu tanto em volume como em proporção do produto interno bruto, multiplicando os acordos comerciais internacionais. Este crescimento pode ter grande impacto na situação da saúde. O comércio eleva o padrão de vida e permite gastos maiores com educação e assistência médica, o que melhora o estado de saúde das pessoas. Porém, pode agravar as desigualdades dentro de um mesmo país, causando aumento no estresse e resultados adversos na mortalidade. O comércio internacional surte efeito nos mercados de trabalho produzindo mudanças na taxa de desemprego, jornadas de trabalho e índices de acidentes que repercutem na saúde. O comércio pode ter um impacto negativo no ambiente, como o aumento da poluição, com prejuízo à saúde das pessoas. A queda nos preços resultante de mudanças na política comercial pode aumentar o consumo de produtos prejudiciais à saúde, como cigarros e alimentos processados, elevando a prevalência de doenças não transmissíveis. Os acordos comerciais podem interferir com a capacidade dos governos de estabelecer políticas para proteger a saúde. O comércio internacional e os acordos comerciais podem ter repercussão positiva ou negativa na saúde e os governos precisam dispor de políticas para atenuar os resultados desfavoráveis.

Palavras-chave

Internacionalidade; saúde global; economia.

Special report

Advances in tobacco taxation: the case of Argentina*

María Elisabet Pizarro,[1] *Germán Rodríguez-Iglesias,*[1] *Patricia Gutkowski*[1]
Juan Altuna and *Belén Ríos*[1]

ABSTRACT

In May 2016, the executive branch of the Government of Argentina enacted Decree 626, which raised ad-valorem excise taxes on cigarettes from 60% to 75%, amounting to a 50% increase in their average retail price. This measure was promoted by Argentina's InterAmerican Heart Foundation (FIC Argentina) through a strategy that included conducting local research to assess the measure's viability and impact; drafting a policy proposal; working in coordination with other national and international civil society organizations; pursuing collaborative advocacy activities with key members of the national executive branch; and implementing a communications strategy. The uniqueness of each economic, social, political, and institutional context in the countries of the Region of the Americas makes it necessary to adapt policy proposals to local conditions. This experience by FIC Argentina serves as a roadmap for other organizations in the Region that seek to promote increases in taxes on tobacco products or other policies designed to protect public health by adapting international recommendations and local evidence to each country's specific context. This article presents a series of lessons learned that may prove useful in other countries.

Keywords   Tobacco products; taxes; health policy; Argentina.

Background on tobacco control in Argentina

Argentina is one of the few countries in the world that has not ratified the WHO Framework Convention on Tobacco Control (FCTC) (1). Ratification has been hampered by persistent multisectoral interference from the tobacco industry (mainly local governments and tobacco-growing sectors). The most frequent arguments against the FCTC are that it would hurt regional economies and increase illicit trade. Despite this, in 2011 the National Congress passed Law No. 26,687 which is aligned with the principal measures recommended by the Convention. This law includes implementation of 100% smoke-free environments in all indoor public spaces and workplaces, a comprehensive ban on tobacco advertising, promotion and sponsorship, and the inclusion of health warnings on 50% of the display area of cigarette packages.

The law, whose regulations were adopted in 2013, marked historical progress for the country in terms of tobacco control. For more than 40 years prior to that, all bills that included effective measures for tobacco control had been systematically blocked in the National Congress (2). But the National Tobacco Control Law did not establish tax measures to increase the price of tobacco products, nor were measures adopted at that time to raise taxes on cigarettes as a public health measure.

Health costs, price elasticity, and the affordability of tobacco products

Before the law, tobacco use in Argentina caused more than 44,000 deaths per year and the national government spent more than 33 billion pesos every year treating diseases caused by smoking (12% of the total health expenditure) (3). In this context, an increase on cigarette prices became an essential public health measure. A study of demand showed that a 10% increase in the real price of cigarettes could reduce total cigarette consumption by around 3% (4).

Before the 2016 tax increase, the price of a pack of cigarettes in Argentina was one of the lowest in the Region of the Americas (figure 1). In April 2016, the average price of a pack of cigarettes was ARS$25.88 ($US 1.80) (5), with total tax revenue representing 68.41% of the average sale price of a pack of cigarettes.
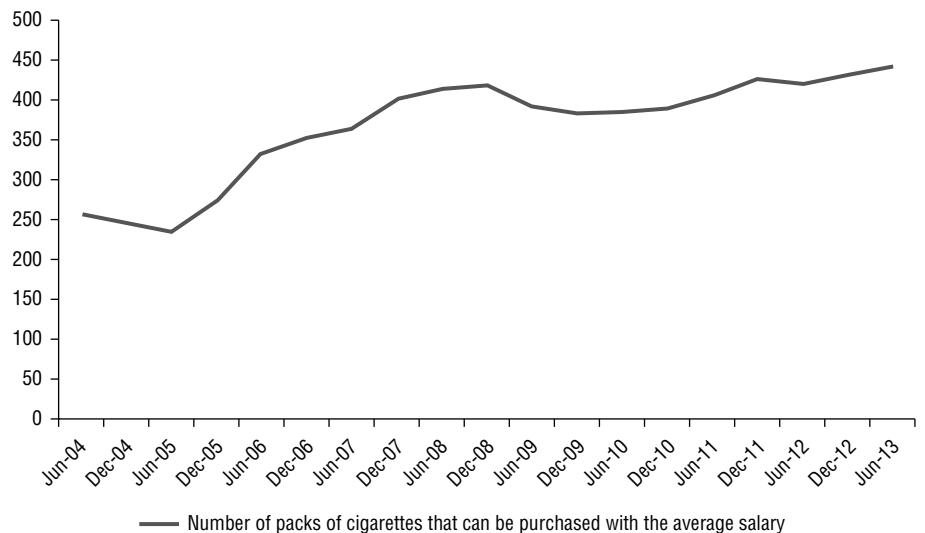
According to the World Health Organization (WHO) recommendations on taxation, in order to have the desired impact on tobacco use, taxes specific to tobacco should account for at least 70% of the sale price (6). Although tax revenue in Argentina was nearing the level recommended by WHO, the country had the most affordable cigarettes in the Region and they were becoming even more affordable. According to Ministry of Agriculture data, between 2004 and 2013 the nominal price of cigarettes increased in Argentina, but when adjusted for inflation, the real price was flat or even decreased. And according to research by Argentina's InterAmerican Heart Foundation (FIC Argentina[2]), cigarettes became twice as affordable during that period: while in mid-2005, 100 packs of cigarettes cost 42% of the average monthly Argentinian salary, by mid-2013, 100 packs only cost 22% of the average monthly salary. This means that in June 2005 one could purchase 236 packs of cigarettes with the

FIGURE 1. Price in $US (official exchange rate) of a pack of cigarettes in several countries of Latin America, 2014
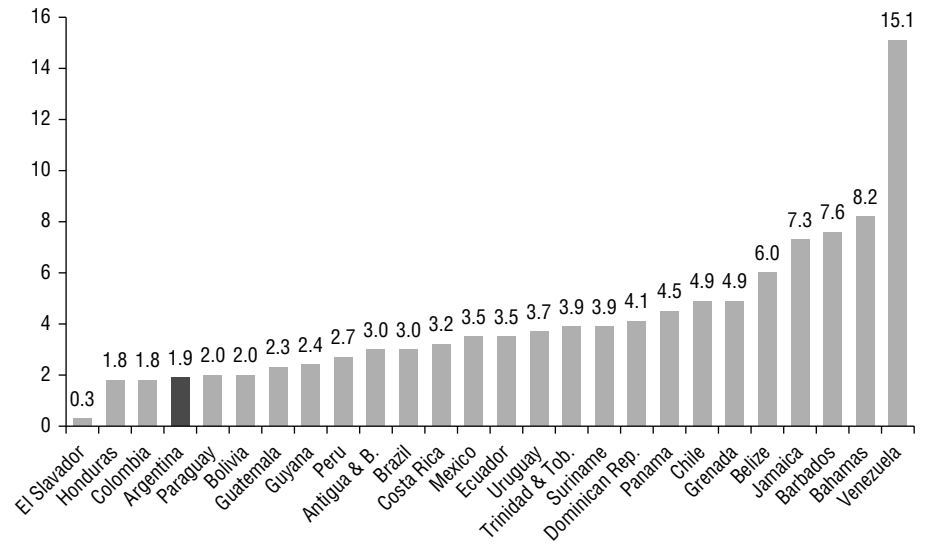
Source: prepared by the authors based on reference 7.

FIGURE 2. Affordability of cigarettes: evolution of the quantity of packages that could be purchased with an average monthly salary over the last decade in Argentina

— Number of packs of cigarettes that can be purchased with the average salary

Source: prepared by the authors based on references 5 and 8.

[2]   FIC Argentina is a non-governmental non-profit organization founded in 2008 to promote public policies and social change to protect the right to health by reducing chronic non-communicable disease. Together with FIC México, FIC Jamaica, and FIC Bolivia, it is affiliated with the InterAmerican Heart Foundation (IAHF), an organization created in 1995 in the United States of America, which shares its mission. It is funded through international cooperation projects and donations. It does not receive funding from any corporations whose main activity is the manufacture or sale of tobacco products, weapons, unhealthy food, or alcoholic beverages. It does not accept donations from any corporation, business or institution that has proven relationships with such companies.

average monthly salary, while in June 2013, one could purchase 442 packs (figure 2) (personal communication with Rodríguez Iglesias G, González Rozada M, Champagne B, and Schoj V on evolution of the real price and affordability of cigarettes in Argentina over the last decade).

Preparing the strategy: research and working groups

In this context, in which cigarettes were becoming increasingly affordable, in 2013 the FIC Argentina team began to work with a project financed by Fogarty-NIH. They began receiving training to develop local research to analyze the viability and impact of a possible tax increase on tobacco products, and to develop an evidence-based policy proposal for a fiscal measure that could effectively protect the health of the population.

Argentina has a complex tax structure that taxes cigarettes through four ad valorem taxes—a value-added tax (VAT),

an Additional Emergency Tax (IAE), Internal Taxes (II), and a Special Tobacco Fund (FET)—which subsidize the production of tobacco and benefit the entire supply chain (which contains a small specific excise component).

Understanding the complex tobacco tax structure in Argentina required a detailed analysis of the viability of tax increases to identify which tax would have the greatest impact on prices without causing a decline in other tax revenue. To this end, a working group was convened with economists from local and international academic institutions that have vast experience in tobacco economics. They researched different aspects of the issue (cigarette price elasticity and demand, affordability, tax collection, illicit trade, etc.), and debated what would be the best way to promote an increase in cigarette taxes.

Once the research was conducted and the experts were consulted, it was decided that the most viable policy proposal was to promote an increase in the Internal excise taxes, since these are part of the tax-sharing system (i.e., revenue distributed between provinces and the central government). An increase in this tax would necessarily increase the sales price (the tobacco industry would not be able to absorb the cost) and it would not cause a reduction in the collection of other taxes. On the contrary, it would cause the entire tax structure to increase. This complex tax structure is not exclusive to Argentina. Each country in the Region should be analyzed not only in terms of its tax structure and the potential impact on reduced consumption and increased revenue, but other economic and social aspects as well, such as the impact on employment and regional economies. Consideration should also be given to the political viability of each potential measure.

FIC Argentina strategy for promoting taxes on tobacco products

As a result of four years of research and work with a group of experts, a policy proposal was drawn up which included the estimated health and tax revenue impacts. Informational materials were also produced, the research was published, and work was done to make FIC Argentina a point of reference on tobacco taxation.

Based on this capacity-building effort and with the support of the Campaign for Tobacco Free Kids (CTFK), in 2014 FIC Argentina began to develop a political advocacy strategy to increase taxes on cigarettes. FIC worked, first of all, with the national Ministry of Health and a national legislator (the Chair of the Health Committee in the Chamber of Deputies). At this stage, the national legislators were made aware of the issue through presentations on the research and materials developed, which showed the need to increase the price of cigarettes to curb the tobacco epidemic.

Despite the efforts by civil society to encourage increases on the price of cigarettes, politics thwarted progress. There was a presidential election in Argentina in 2015, which kept the political agenda focused on other issues, especially in the National Congress.

The new administration took office in December 2015 and made increased tax collection a priority. In this context and before the end of the year, the national Ministry of Finance contacted FIC Argentina to consult about a possible tax increase on tobacco products. From late 2015 through the first few months of 2016, FIC Argentina advised the Ministry of Finance on the advisability of raising excise taxes on cigarettes. FIC presented the research findings, the estimated impact of the measure, and the advantages of raising this tax rather than others.

Despite the advice provided by FIC Argentina, the Ministry of Finance was secretive about the strategy it was going to follow for raising the price of cigarettes, and even suggested the possibility of raising the Additional Emergency Tax (IAE).[3] This would have yielded reduced revenue from other taxes and a consequently negative reaction from the tobacco-producing provinces. Given this uncertainty, between January and April of 2016 a peripheral strategy was developed to lobby the Chamber of Deputies, the Ministry of Health, and the President's Chief of Staff to promote increases to excise taxes. This option was not only the most effective one for increasing the

retail price of cigarettes, it was also unlikely to generate opposition in the tobacco-producing provinces.

Finally, after several months of work with policymakers and the mass media, Decree 626 was enacted in May 2016, increasing Internal ad-valorem taxes on cigarettes from 60% to 75%. This was an effective way to increase the sales price, protect health, and increase tax revenue for both the central and provincial governments. With this tax increase, the average price of a pack of 20 cigarettes increased by 50%, and tax pressure went up to 79.1%.[4] This measure went into force on 31 December 2016 and was renewed through Decree 15/2017 through 31 December 2017.

The decree represented a milestone for Argentina in terms of tobacco control policies, since it increased the retail price of cigarettes and significantly reduced their affordability.

Communications strategy to promote the tax increase and counter the tobacco industry

A communications strategy was developed to promote the increase in tobacco taxes in Argentina. Its main objectives were to: a) put the need for developing a fiscal policy on the public agenda; b) establish FIC Argentina as an authoritative voice on economic matters; and c) step up direct pressure on policymakers through the communications media. To this end, an effort was made to have all key communications activities deliver one key message: taxes on tobacco products are not simply an economic measure, but an effective health policy to reduce tobacco consumption and prevent young people from starting tobacco use. It sought to link the economic agenda with the health agenda.

To meet the proposed objectives, communications efforts focused on producing and disseminating newsworthy content with local data that would generate interest in the media, simplifying the language and messages, presenting an array of topics and approaches to keep the issue at the forefront, and using

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[3] Cigarette taxes in Argentina are based on their price when leaving the factory, plus taxes collected through II and FET. The IAE is not considered when calculating the II and FET. That is, if the IAE increases, that would not affect tax revenue per pack from II and FET. However, since increases in IAE increase prices and reduce revenue, the total amount collected for these two taxes decreases.

[4] The increase of the nominal value of the excise tax (II) from 60% to 75% is applied to a base comprised of the factory price plus the revenue collected from other tobacco taxes. Since the II is part of the tax base for which other tobacco taxes are calculated, the price increase it generates is around 50%.

multiple channels of communication to reach the largest audience possible. Several press activities were deployed between 2014 and 2016, each accompanied by a social network strategy.

These communication efforts succeeded in placing the topic on the media agenda and catching and keeping the attention of policymakers. The messages also reached the tobacco industry, which responded in the press through its front groups (such as their trade associations and some cigarette vendors) in an attempt to stop the tax hike. One of their main arguments against the tax was that it would cause an increase in the illicit cigarette trade. This tactic was nothing new, as it had been used in several countries of the Region and around the world. For example, after the 2010 increase in cigarette taxes in Mexico, an industry front group called "Partnership against Illegal Products" launched a mass media campaign to boycott the measure using this same argument.

The content developed for journalists not only countered industry's argument, but also explained the need to raise taxes to protect public health. This was presented from different angles, such as: the increasing affordability of tobacco products in Argentina; a request from several civil society organizations that the government raise taxes; the population's support for the policy (as revealed in an opinion poll); the potential impact of an increase in tobacco excise taxes on consumption and revenue; and debunking the myths propagated by the tobacco industry.

The strategy successfully kept the issue on the media agenda and more than 100 pieces were published in visual and digital media as well as TV, radio, and news agencies. Many of these were published by the leading Argentinian newspapers (such as *La Nación* and *Clarín*), digital dailies (Infobae), and news programs on the most widely viewed channels (Telefé, Channel 13, public TV, etc.). The media strategy extended its reach through Facebook and Twitter campaigns aligned with the press messages and adapted to the language of the social networks.

Extensive coverage was achieved, due in large part to the multiplicity of approaches, research- and local data-based content, simplified language, and messages that resonated with audiences.

Lessons learned

Below are some of the main lessons learned from these tactics:

- It is crucial to find opportunities to raise awareness and exchange information on tax matters with civil society organizations, so that policymakers become involved and participate in the drafting of fiscal policies.
- Networking with strategic partners in national and international civil society maximizes the impact of advocacy work.
- Training journalists and the public (through a continuous process of producing and disseminating information using different communications channels) makes issues visible and helps win public support.
- If the studies and documents are prepared with scientific rigor, the organization can become a voice of authority on fiscal policy, much like the Ministry of Finance. To achieve the objectives, it is also important to have an alternative plan in case the first proposal is rejected.
- A nongovernmental organization with a mission to protect health can promote a tax policy and turn it into a high-impact public health measure.

Future actions

The success achieved through these tax policies are significant because they have had a positive impact on public health in Argentina. However, to continue progressively reducing tobacco use rates and preventing children and young people from taking up tobacco use, work should continue toward the passage of a national law.

The greatest challenge now is to increase taxes through a law that includes certain essential criteria to make the policy effective in the medium and long term, such as a government mechanism to update prices so that inflation and income growth cannot reduce the health impact of the policy. The policy should also narrow the price gap between brands and be applied to all tobacco products (the decree only affects cigarettes) in order to prevent substitution with cheaper brands or other products (such "roll your own" tobacco). Finally,

the State must back up this measure with adequate control and enforcement, separate from the tobacco industry, in order to protect tax collection and prevent industry and its front groups from manipulating data.[5]

In conclusion, it should be emphasized that achieving the passage of Decree 626/2016 (updated by Decree 15/2017 until 31 December 2017), it was strategically important to have designed a tax proposal that reduced affordability, was viable, and included the different key stakeholders in a country ranked as the world's fifth leading producer of tobacco.

On the other hand, although the election campaign slowed the process of increasing tobacco taxes, FIC Argentina continued to conduct research and raise awareness among policymakers. This was essential for consolidating the organization's reputation not only as a public health reference point, but also as an authority on tobacco excise taxes. Furthermore, the change of administration and its need to increase tax revenue created an opportunity to promote the proposal.

It was also essential for the work teams to build capacity and knowledge with a multidisciplinary approach, allowing us to generate local scientific evidence and strengthen advocacy. Furthermore, networking and preparing a proposal that enjoyed the consensus of other civil society organizations was essential for putting this item on the public agenda and promoting the measure.

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5   Authors' note: this article was written while Decree 626/16 was in force. In October 2017 an amendment to the excise tax law was announced that would change the cigarettes and tobacco products component. In December of 2017, the National Congress passed Law 27,470 which amends the excise tax law, lowering the tax levied on cigarettes from 75% to 70%, with a minimum tax of 28 Argentine pesos (ARS), and increasing the tax levied on other tobacco products.

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RESUMEN

Avances en impuestos del tabaco: el caso de Argentina

En mayo de 2016, el Poder Ejecutivo de Argentina sancionó el decreto 626, que aumentó los impuestos internos de los cigarrillos de 60% a 75%, lo que implicó un aumento de 50% en su precio medio de venta al público. Esta medida fue impulsada desde la Fundación Interamericana del Corazón (FIC) Argentina a través de una estrategia que incluyó el desarrollo de investigaciones locales para determinar la viabilidad y el impacto de la medida, la elaboración de una propuesta política, el trabajo en red con otras organizaciones de la sociedad civil nacionales e internacionales, acciones de incidencia colaborativa con referentes del Poder Ejecutivo Nacional y la implementación de una estrategia de comunicación. La particularidad de cada uno de los contextos económicos, sociales, políticos e institucionales de los países de la Región de las Américas requiere que las propuestas políticas se adecúen a la realidad local. La experiencia de trabajo desarrollada por FIC Argentina sirve como guía para otras organizaciones que en la Región buscan impulsar aumentos de los impuestos al tabaco u otras políticas destinadas a proteger la salud pública, adaptando las recomendaciones internacionales y la evidencia local al contexto de cada país. En este artículo se comparte una serie de lecciones aprendidas que pueden servir en otros países.

Palabras clave   Productos de tabaco; impuestos; política de salud; Argentina.

RESUMO

Avanços na tributação dos cigarros: o caso da Argentina

Em maio de 2016, as autoridades do poder executivo da Argentina sancionaram o Decreto 626 que determinou um aumento da tributação interna dos cigarros de 60% a 75%, implicando em um aumento de 50% no preço médio de venda ao consumidor. Esta medida foi apoiada pela Fundação Interamericana do Coração (FIC) Argentina que adotou uma estratégia que abrangeu a realização de pesquisas locais para determinar a viabilidade e o impacto de tal medida, a elaboração de uma proposta política, o trabalho em rede com outras organizações nacionais e internacionais da sociedade civil, ações colaborativas com representantes do poder executivo nacional e a implementação de uma campanha de comunicação. As particularidades dos contextos econômicos, sociais, políticos e institucionais de cada país da Região das Américas exigem que as propostas políticas se adéquem à realidade local. A experiência de trabalho realizado pela FIC Argentina serve de modelo a outras organizações que defendem o aumento da tributação dos cigarros e outras políticas de proteção da saúde pública, com a adaptação das recomendações internacionais ao contexto de cada país e o uso das evidências locais. Este artigo expõe uma série de ensinamentos que podem servir a outros países da Região.

Palavras-chave   Produtos do tabaco; impostos; política de saúde; Argentina

An economic perspective on the causal explanations for the socioeconomic inequalities in health

Lori J. Curtis[1]

ABSTRACT

Socioeconomic inequality, or the socioeconomic status (SES) gradient, is arguably one of the most-studied phenomena in health. The gradient in health is apparent in objective and subjective measures, across virtually all countries, and is evident at individual and population levels. There is no longer much debate over the relationship between SES and health. However, exact causal pathways remain elusive. Advocating for strong policy to reduce or eliminate the SES-health gradient necessitates understanding the causal pathways, from intervention to outcome. While economists are not convinced that there is a clear enough understanding of the causal pathways of the SES-health gradient, they have produced a substantial body of work from which to move forward. The article briefly discusses the theoretical underpinnings used by economists as a basis for the study of the causal pathways for the health gradient. That presentation is followed by a concise overview of some of the evidence that economists have produced. The paper concludes with a discussion of how current economic evidence may be used to help policymakers advocate for interventions to limit the SES gradient in noncommunicable diseases.

Keywords Health inequalities; economics.

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Socioeconomic inequality, or the socioeconomic status (SES) gradient is, arguably, one of the most-studied phenomena in health. The gradient in health is apparent in objective and subjective measures (1), across virtually all countries (2), and is evident at individual and population levels. There is no longer much debate over the relationship between SES and health. However, exact causal pathways remain elusive (2-4). Advocating for strong policy to reduce or eliminate the SES-health gradient necessitates understanding the causal pathways (2) from intervention to outcome. Economists are not convinced that there is a clear enough understanding of the causal pathways of the SES-health gradient, but they have produced a substantial body of work from which to move forward.

Evans, Wolfe, and Adler (2) present a brief but excellent review of the evidence amassed by economists on the relationship between income and health, including discussing some advantages of alternative proxies for SES (e.g., income, wealth, occupation, and education) and each proxy's usefulness in identifying the elusive causal associations between SES and health. They point out that, in general, education levels are established relatively early in life and thus may be less influenced by health than other proxies and are therefore a better proxy. According to Deaton (5), many economists have attempted to tie the SES gradient in health to education (human capital). Simply put, more-educated people better understand their health, health information, and health care systems, and they are more productive at using available resources to generate health (6). Higher levels of human capital lead to higher incomes and more consumption. The interaction between better health knowledge and income increases the consumption of healthy inputs, such as nutritious food, exercise, and appropriate health care—thus leading to better health.

Moreover, higher education has been linked to fewer negative health behaviors, such as smoking, sedentary lifestyle, poor nutritional status, and obesity. The relationship between education and health behaviors, particularly negative ones, and health has become a focus in the search for causality (7, 8). However, researchers often find that the health behaviors pathway accounts for only a proportion of the SES variation in health. For example, Tubeuf et al. (8) and Brunello et al. (9) find that lifestyle factors explain about one-third of the health variation. Given the issues, economists' attempts to identify a causal pathway between income and/or education and health have resulted in mixed results (2-5, 9, 10).

The difficulty in demonstrating causal links intensifies because reverse causality and endogeneity are particular problems in the study of the SES-health relationship (5). As previously discussed (7, 8), the primary premise is that higher SES leads to better health. However, it is possible that the causal path runs from health to SES. For example, lower health status could restrict education, human capital accumulation, and/or labor market participation, thus leading to lower education and/or income (reverse causality). Alternatively, unobserved characteristics may influence both education and health decisions, so the effects of one on the other cannot be estimated consistently (5, 11). Economists have attempted to identify unobserved characteristics within socioeconomic strata that may drive health differences (8, 12-15). These characteristics include access to health care (utilization is typically assessed with surveys that have no measure of when care was needed and not received, or the reasons); differential productivity in the use of health information or health care; differential vulnerability; such environmental factors as pollution or chemical exposure (13-15); and cumulative effects (i.e., individuals from lower socioeconomic situations experience more health shocks than those from higher socioeconomic situations) (16-20).

This short paper presents a brief discussion of the theoretical underpinnings used by economists as a basis for the study of the causal pathways for the health gradient. This is followed by an overview of some of the widely cited economic research in this area. The overview is organized by the causal pathways that have been studied: SES → health; SES → health behaviors → health; health → SES (reverse causality); and unobserved factors → SES and health (unobserved heterogeneity). There is next a brief discussion of evidence available in the Americas and for noncommunicable diseases (NCDs) specifically, followed by some conclusions and policy discussion.

The paper is not meant to be an exhaustive or systematic review, but instead to provide an overview of some of the well-cited, highly regarded evidence that economists have produced. The overview covers studies examining secondary data using various methodologies, as well as reviews of such studies. It is anticipated that this presentation of economic evidence will lead readers to investigate further how current methodologies may be used to develop new frameworks and expand the use of economic theories and econometric tools to effectively advocate for the prevention of NCDs, including developing policies within and beyond the health sector in the Americas and other world regions.

THEORETICAL UNDERPINNINGS

Standard economic theory tells us that individuals choose to consume goods and services based on their preferences, budget constraints (e.g., different incomes and prices), and beliefs in the impact of their actions (if the assumption of full information is not invoked).

Most economic theories on the relationship between SES (typically proxied by income and/or education) and health expand the standard theory based on one of the seminal papers written by Becker (21, 22), Grossman (6), and/or Rosenzweig and Schultz (23). The authors add differences in productivity, household production, and unobserved characteristics to the standard framework. Basically, the models maximize utility (happiness, well-being), which is created by consuming goods and services (G&S) and health. The G&S may positively influence health (healthy food, etc.) or negatively do so (cigarettes, etc.). As well as purchasing final goods in the market (e.g., a healthy meal), individuals may use their time to convert (via a production process) goods purchased in the market (intermediate goods (e.g., ingredients to make the healthy meal)) into final consumption goods (the healthy meal) and health. The ease of the production process (productivity) depends on the individual's level of education and other unobserved factors (e.g., family background, genetics, intelligence). The amount of goods purchased in the market and the time available for production depends on prices, wages, labor market participation, income, and wealth.

Although empirical studies often avoid laying out explicit theoretical models, the general framework underpins much of the research. The theoretical models (6, 21-23) implicitly direct researchers to focus on the pathways between SES, health inputs (e.g., health care, health insurance (if public health insurance is not available to all), health behaviors (positive and negative), and unobserved factors (unobserved heterogeneity (e.g., genetics, intelligence, environment, etc.)), and health outcomes. Expansive literatures have evolved on the SES → health pathways, including the SES → health behaviors → health pathway.

PATHWAYS INVOLVING THE SOCIOECONOMIC STATUS (SES) GRADIENT

SES → health

Excellent overviews on the relationship between SES (income (2) and education (10, 14)) and health are available. Evans, Wolfe, and Adler (2) conclude that "despite much work on the mechanisms that lie behind the gradient (24), we cannot fully account for the observed disparities in health across income." As previously stated, education has been used as a more robust instrument for SES than income (2). An often-cited paper by Cutler et al. (13) uses multiple nationally representative cross-sections of survey and administrative data from the United States of America to show that for non-Hispanic whites the educational gradient in mortality (from cancer and cardiovascular disease (CVD)) has grown over time and that this cannot be explained by changes in key behavioral risk factors. The returns to education (conditional on health behaviors) and changes in returns to health behaviors

are important and increasing, and they are stronger for males than females. The impact of smoking strengthened over time for both men and women, as have the consequences of severe obesity for females. Results suggest that complete elimination of disparities in behavioral risks across education groups would likely not decrease the differentials in mortality substantially (approximately 7% to 25%). Although influential, the study uses cross-sectional data. This type of data is strongly criticized in the literature for its inability to identify causality.

The shortcomings of cross-sectional data propelled the use of natural experiments to study causal relationships. Natural experiments occur when circumstances outside the control of the researcher (e.g., the introduction of a public policy such as compulsory schooling reform) lead a subset of a population to be differentially exposed to a hypothesized causal factor (i.e., education). Significant differences in outcomes across exposed and unexposed populations can indicate a causal path between the exposure and the outcome. A substantive review of the schooling reforms literature is offered by Meghir et al. (15). A strong positive relationship between education and health is found in the United States in data from the early to mid-1900s (25). However, the same data produces more muted results when state-specific time trends are included with the policy reforms or when larger datasets (which identify individuals rather than cohorts) are employed (26). Given that results differ when using data from the same country, it is not surprising that conclusions examining compulsory schooling reforms are mixed when using data from different countries and time periods. Positive results are found in Denmark (27) and England and Northern Ireland (28) by some researchers, while others find negligible or negative results in Sweden (15) and the United Kingdom (29). Results are strongly dependent on where and when the data originate (perhaps pointing to differences in institutions across countries, sample sizes, and populations (15)) and the empirical analyses employed (26).

Cross-country comparisons also produced inconsistent results. Using countries with changes in mandatory leaving age as an instrumental variable in a dynamic health equation, Brunello et al. (9) find an additional year of education decreases self-reported poor health by 7% for females and by 3% for males. Health behaviors explain approximately one-quarter to one-half of the effect. Moreover, Cutler and Lleras-Muney (6) show that income, health insurance, and family background explain about one-third of the education gradient in health, and that cognitive ability explains about one-fifth of it. They demonstrate a pathway running from education to cognitive ability to healthier behaviors to health. Discounting, risk aversion, or time preferences account for none of the gradients in health behaviors. There is some evidence that the social environment (healthier for the better educated) accounts for about one-tenth of the education/health gradient.

The mixed results found in the literature spurred researchers to identify better ways of identification. Studies using samples of monozygotic (identical) twins to control for unobserved factors (e.g., family and genetic backgrounds shared completely by identical twins) were thought to be a solution. These studies suggest that causal impacts of schooling on health outcomes and behaviors are much smaller than suggested by other studies (although some of the studies were criticized for small sample sizes). Amin, Behrman, and Spector (30) used multiple twin registries in the United States and found, like many other studies, that schooling is significantly associated with numerous health outcomes and behaviors. However, no causal relationship could be identified between schooling and better health behaviors after controlling for unobserved factors. Twin studies have found that higher education is positively related to self-reported health (10, 31) and negatively related to the number of chronic conditions (31), but causality has been more difficult to assign.

A multidisciplinary review of the literature (32), which includes many of the studies discussed in this paper, claims that there is a sufficient body of evidence to suggest that schooling is causally related to improvements in health outcomes, and that raising the incomes of the poor leads to improvement in their health outcomes. However, that review also notes that the findings are crude and that more specific questions need to be asked, such as what type of education matters for health or whether there is a difference between the health impacts of temporary income shocks versus changes in long-term income. Other reviews of the evidence tend to support the need for further evidence.

Health → SES (reverse causality)

There is a plethora of literature on the relationship between childhood health and outcomes in later life. The hypothesis is that the causal pathway runs from child (poor) health to (lower) SES. Households with lower SES cannot, or do not know how to, provide proper nutrition to mothers and children, leading to poor health. Children in poor health (often measured by height or low birthweight) tend to obtain lower levels of education and worse labor market outcomes over their life (7, 8, 33, 34). In a natural experiment, Almond (35) showed strong negative education, health (physical disability), income, and SES effects for cohorts in utero during the 1918 influenza pandemic compared to those conceived before or after the pandemic. In a British cohort study, children born with low weights were found to pass fewer qualifying exams (33). Studies on twins in Norway (36) and the United States (37) showed that low birthweights led to significantly lower height, IQs, education, and earnings. Height was also a strong predictor of obtaining higher education in Sweden (38) and the United States (34). This empirical evidence suggests that part of the positive gradient between education and health originates in the effect of childhood health on educational attainment. The quantitative importance is still

questioned, but it appears that reverse causality can explain, at most, a small proportion of the observed gradient (7).

Other hypotheses regarding reverse causality in the SES-health gradient exist but are less well examined than the child health hypotheses. Individuals in poor health may have lower productivity and higher rates of absenteeism, which results in lower labor force participation, wages, and incomes. Studies in this area tend to measure the consequences of specific diseases on productivity or aggregate economic consequences of productivity loss (39, 40). An alternate explanation is that those with lower life expectancies (poor health) may have higher discount rates. They thus invest less in their future and subsequently have lower education, human capital, and income, as well as higher levels of risky behavior (41-43). Finally, it is possible that high health care costs due to poor health lead to lower disposable incomes, particularly in the absence of health insurance (44).

Unobserved factors → SES and health (unobserved heterogeneity)

As demonstrated in the movement to twin studies to examine the education-health link, failure to identify a causal link between SES and health behaviors and/or health led researchers to the explanation that unobserved characteristics within socioeconomic strata drive health differences (9, 13, 15, 30, 31). The unobserved differences are thought to include genetics, family background, access to health care, differential productivity in the use of health information or health care, differential vulnerability, differential exposure to environmental factors (risky work, unsafe neighborhoods, chemical exposure, air and water quality, etc.) (7, 16), and cumulative effects (e.g., individuals, particularly children, from lower socioeconomic situations experience more health shocks than those from higher socioeconomic situations) (16-20, 33, 34). Again, no conclusive evidence has been produced, and where evidence for a causal link is found, the impact seems small.

THE SES GRADIENT IN HEALTH AND THE AMERICAS AND NONCOMMUNICABLE DISEASES

Few economic studies were identified that focused directly on the SES gradient in NCDs in general or in the Americas. Meghir et al. (15) did examine cancer and CVD mortality rates, but the study population was non-Hispanic whites in the United States. A recent overview of systematic reviews (45) found evidence that supports an association between socioeconomic inequalities and NCDs and risk factors for NCDs, but the overview noted that the evidence is incomplete and is limited by poor methodological quality.

Most well-known studies in the literature use data from the United States or countries of Europe, due to the availability of good-quality data, research

capacity, and good publication outlets. The few studies identified that focus on countries in Latin America or the Caribbean tend to be descriptive in nature and are less well known (46-49). An exception is the evaluation of a Mexican program called Progresa (and later Oportunidades), which provided cash transfers to families if their children attended school or medical appointments to receive preventive care (e.g., vaccinations) (50). The assessment found that doubling cash transfers was related to a decrease in stunting, a decrease in body mass index, a lower prevalence of being overweight, and an increase in height for age (50). The experiment was copied in some areas of the United States, but the results were not duplicated (2, 50).

Health data are available in the Americas. Almeida and Sarti (46) discuss cross-sectional datasets collected in Brazil, Chile, Colombia, Jamaica, Mexico, and Peru that could be used to move the study of health and health care inequities forward in the Americas. An analysis of the Costa Rican Longevity and Healthy Aging Study surprisingly found an SES gradient in self-reported health status and healthy years of life but an inverse gradient in CVD and mortality (51). This led the authors to conclude that modern negative health behaviors among high-SES groups in Costa Rica may be reversing CVD risks and thus mortality risk by SES groups.

DISCUSSION

The SES gradient in health is, arguably, one of the most-studied and well-accepted phenomena in health. It is apparent in objective and subjective measures, across virtually all countries, and it is evident at individual and population levels. There is no longer much debate over the relationship between SES and health. However, the literature presented in this piece indicates that exact causal pathways remain elusive. The most promising evidence suggests that child health influences education and thus outcomes in later life (reverse causality), although the magnitude of the effect is still questioned. As well, family background, including income, influences child health, with effects accumulating over the lifespan (income → health). However, despite more than two decades of research, investigators do not fully understand what *causes* the observed disparities in health across SES. The lack of consistent results across studies could be due to differences in data (including sample sizes), methodologies, institutional settings, unobservables, or a combination of these factors. What is evident is that there is likely no one factor that drives the gradient. Income, education, health care, health behaviors, and other factors have impacts on the gradient. However, the measured impacts of individual factors are often not as large as anticipated.

Economists in public health intervention research are attempting to design research that can examine how multiple intertwined factors (e.g., education, income, the experience of poverty, available health

care resources, etc.) produce individual and interacted health impacts. However, at this point, in light of the mixed results in the literature, policymakers are left with the tough decision of which, if any, of the factors might produce desired results in their populations, given the available resources.

Researchers often call for governments and policymakers to assist in the provision of better longitudinal data to further the research, either through funding or by allowing access to administrative data. Longitudinal data would, for example, help to identify better measures of permanent income, of long-term versus transitory shocks to income and health, and of short-term versus long-term experiences of poverty. It is now possible and becoming less expensive to collect better data on what historically were unobservables (e.g., genetic or family characteristics). These types of improvements in data may assist in the identification of the elusive causal pathways of the health gradient.

Making administrative data (such as registries of mortality, cancer, CVD, and other diseases) available and linking these databases to other administrative databases (such as tax and education files) might provide much improved data to study the links between socioeconomic status and NCDs. Health and sociodemographic data are being collected in some countries of Latin America and the Caribbean, and some interesting experiments have been undertaken (e.g., Progresa/Oportunidades).

Building interest in funding more experiments and/ or collecting better data would help increase the research capacity in the Americas and elsewhere. In turn, better research capacity could provide several benefits. It would enable researchers to apply the economic theories and methodologies that have been used in many of the studies cited in this piece. It would help to identify new methods to detect the causal pathways needed to address SES inequalities in health. And, it would provide policymakers with the information needed to make evidenced-based policy decisions in the Americas and elsewhere.

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RESUMEN

Una perspectiva económica sobre las explicaciones causales de las desigualdades socioeconómicas en materia de salud

La desigualdad socioeconómica, o el gradiente según la situación socioeconómica, es posiblemente uno de los fenómenos más estudiados en el campo de la salud. El gradiente de la salud es evidente en mediciones objetivas y subjetivas, en prácticamente todos los países y tanto a nivel individual como poblacional. Ya no se debate mucho la relación entre la situación socioeconómica y la salud. Sin embargo, las vías causales exactas siguen siendo difíciles de definir. A fin de promover políticas enérgicas que reduzcan o eliminen el gradiente socioeconómico de la salud, es necesario entender las vías causales, de la intervención al resultado. Si bien los economistas no están convencidos de que se conozcan suficientemente las vías causales del gradiente socioeconómico de la salud, han producido un volumen sustancial de trabajo a partir del cual avanzar. En este artículo se comentan brevemente los fundamentos teóricos usados por los economistas como base para estudiar las vías causales del gradiente de salud. Luego se brinda un panorama conciso de algunos de los datos científicos generados por los economistas. El artículo concluye con una discusión de cómo pueden usarse los datos científicos económicos actuales para ayudar a los responsables de formular políticas a proponer intervenciones que limiten el gradiente socioeconómico en materia de enfermedades no transmisibles.

Palabras clave   Desigualdades en la salud; economía.

RESUMO

Uma perspectiva econômica da explicação causal para as desigualdades socioeconômicas em saúde

A desigualdade socioeconômica, ou o gradiente socioeconômico, é possivelmente um dos fenômenos mais estudados em saúde. O gradiente em saúde é evidente nas medidas objetivas e subjetivas em praticamente todos os países e é evidente ao nível do indivíduo e de população. Já não existe muito debate sobre a relação entre nível socioeconômico e saúde, mas as exatas vias causais continuam mal definidas. Defender uma firme política para reduzir ou eliminar o gradiente socioeconômico em saúde requer conhecer as vias causais, da intervenção ao resultado. Por não estarem convencidos de que existe um entendimento claro razoável das vias causais do gradiente socioeconômico em saúde, os economistas produziram um volume substancial de estudos que servem de base. O artigo aborda resumidamente os princípios teóricos para embasar o estudo das vias causais do gradiente em saúde e apresenta de forma concisa o panorama das evidências geradas pelos economistas. Por fim, se discute como as evidências econômicas atuais podem ser empregadas para ajudar os responsáveis pelas políticas a defender intervenções visando reduzir o gradiente socioeconômico nas doenças não transmissíveis.

Palavras-chave   Desigualdades em saúde; economia.

Affordability of beer and sugar-sweetened beverages in 15 Latin American countries*

Guillermo Paraje[1] and Pablo Pincheira[1]

ABSTRACT

Objective. The objective of this study was to look at trends in the affordability of beer and sugar-sweetened beverages (SSBs) in 15 Latin American countries.

Methods. The data correspond to government statistics on price indices for beer and SSBs, the consumer price index, and the monthly nominal wage index. The methods involved performing an econometric analysis, using time series to measure the expected rate of increase in the absolute affordability indicator (using nominal prices) or the relative affordability indicator (using general prices) for SSBs and beers.

Results. In nine of the 15 countries analyzed, the affordability of SSBs or beer (whether absolute or relative) has shown a statistically significant increase. In the case of SSBs, absolute affordability increased in five countries (Chile, Colombia, Costa Rica, Ecuador, and Uruguay) and decreased in Mexico. In the case of beer, it increased in Colombia and Ecuador, remained unchanged in Argentina, Brazil, Chile, Costa Rica, and Uruguay, and dropped in Mexico.

Conclusions. Although most countries levy taxes on beer and SSBs, the effect of such taxes on price has not been enough to reduce the affordability of these products in all countries in the sample. Taxes should be modified to make these beverages less affordable and have an impact on their consumption.

Keywords Health economics; alcoholic drinks; sugar-sweetened beverages; Latin America.

The negative health impacts of consuming alcoholic drinks and sugar-sweetened beverages (SSBs) have been reliably established in the literature. Alcohol use is associated with physical disorders involving damage to various organs (1-3), psychological disorders associated with excessive consumption and violent behavior (4), traffic accidents (5), unwanted pregnancies, and sexually transmitted diseases, among others (6, 7). Recent estimates show that the consumption of pure alcohol per adult in the Region of the Americas is higher than the world average, causing a high burden of disease: 4.7% of deaths and 6.7% of healthy years of life lost (YLL) can be attributed directly to alcohol use (8).

In the case of the SSBs, the situation is similar. Consumption is directly linked to an increase in bodyweight and caloric intake, even beyond the direct effect of these beverages (due to the effects of reduced satiety) (9). Furthermore, it is directly associated with deaths and healthy YLL caused by cardiovascular diseases, cancers, and diabetes. The percentage of healthy YLL directly associated with sugary beverage consumption in Latin America (1.4% of total healthy YLL) is double the world average and is higher than in any other region (10).

Total consumption both of beer and carbonated SSBs (respectively, the alcoholic and sugar-sweetened beverage most consumed in the Region) has grown in per capita terms. Between 2002 and 2016, for example, total beer

consumption in 13 countries of the Region (Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, the Dominican Republic, Ecuador, Guatemala, Mexico, Peru, Uruguay, and Venezuela) grew at an average annual rate of 2.9%, well above the average annual rate of population growth (1.2%) (11, 12). Only Venezuela saw negative average annual growth in beer consumption; in the rest of the countries the increase ranged from 1.7% (Argentina) to 10.4% (Guatemala).

The average annual consumption of sugar-sweetened beverages in these 13 countries grew at a rate of 1.7% between 2002 and 2016. Only Venezuela had negative average annual growth; among the other countries, Ecuador had the lowest average annual growth (0.03%) and Uruguay had the highest (9%) (11).

As is the case with all goods, two key variables explain consumption of these beverages: their relative price and the real income of consumers. All other things being equal, if these beverages have a higher relative price, this should discourage consumption, while, for normal goods, higher (lower) real consumer income increases the demand for them. If consumer income rises proportionately more than the price of a beverage, its affordability increases (for example, fewer minutes of work are needed to purchase a unit of beverage) and, according to the existing evidence for alcohol (13, 14) and tobacco (15), demand increases. There are no known studies that have measured this effect on sugary beverage consumption, but it seems reasonable to assume that relation is also found for this group of goods.

The magnitude of the relative change in consumption resulting from changes in prices and income depends on price elasticities and income on the demand side. The few studies conducted in Latin America show that alcoholic beverages are inelastic (although price elasticity depends on the specific alcoholic beverage), while SSBs are elastic (16-21). Much less is known about income elasticity, although the existing evidence in the Region suggests that both types of beverages are normal goods (16, 21). This would suggest, among other things, that taxes applied to these beverages would have an impact on their consumption, and that this would be more significant in the case of SSBs (22, 23).

A sizable number of Latin American countries tax alcoholic drinks and SSBs, but it is not known if these taxes have been effective in reducing the affordability of these goods. The main objective of this study was to use an econometric analysis of time series to study the trends in the affordability of beer (as a proxy for alcoholic beverages) and carbonated drinks (as a proxy for SSBs) in a group of countries in the Region. In the 15 countries of the Region for which Euromonitor International compiles data, beer consumption represents, on average, 85% of all alcoholic beverages, while carbonated drinks represent 77% of all SSBs (11).

Materials and methods

The compiled data correspond to official statistics on price indices for beer and SSBs/carbonated beverages, the general consumer price index (CPI), and the nominal wage index in 15 Latin American countries. This study analyzed the tax-related situation of alcoholic and SSBs in 15 countries: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Paraguay, Peru, and Uruguay. All of these countries tax alcoholic beverages and only two (Colombia and the Dominican Republic) do not tax SSBs. The series are all expressed in monthly frequency and come from national statistics institutes or central banks, as indicated in Table 1.

In most of the countries, beer and soft drink prices are taken from the index for these products included within the CPI. Argentina uses a similar component of the Wholesale Industrial Price Index (IPIM) due to serious doubts about CPI measurements since 2007 (24). There are no doubts in this regard about the IPIM. Peru uses nominal prices compiled by the National Statistics Institute and Informatics in the metropolitan Lima area.

With regard to wages, monthly information was found for only eight countries. In most cases, they correspond to general nominal wage indexes, with the exception of Costa Rica, for which a minimum wage index was obtained. Colombia has an average wage index in the manufacturing industry for two types of jobs (workers and employees), with data to December 2014, and another for the manufacturing industry as a whole, with data starting January 2014. This study uses a simple average of the two available indices until December 2014, then

continues with the data for the industry as a whole. Table 2 shows descriptive statistics for the data used, which include the number of samples of each index per country, as well as the mean, standard deviation, and median.

The method used involves measuring the expected rate of growth of the affordability indicator for SSBs and for beer in each of the 15 countries in the sample. For a specific country, the growth rate is defined as:

$$\gamma_t^A = 100 * \left[\frac{R_t - R_{t-j}}{R_{t-j}} \right] = 100 * \left[\frac{R_t}{R_{t-j}} - 1 \right]$$

where

$$R_t = \frac{W_t}{P_t}$$

indicates the monthly affordability of the good in question, defined as the ratio of the nominal wage (W_t) and the price of the good (P_t). In the absence of wage data, the affordability indicator is constructed as the ratio of the CPI to the price of the good. This is considered a relative affordability indicator. In our case, the value of j may be: j = 1, j = 6, or j = 12. In the first case, the monthly growth rate of affordability is analyzed; in the second, the semiannual rate, and in the third, the annual rate. The choice of a j-value for each country and beverage depends on two technical considerations: the need to eliminate seasonal components from the series and the need to work with seasonal affordability rates to avoid spurious results. In order to eliminate seasonal elements of an additive nature, it is natural to work with annual affordability rates. However, the Phillips-Perron unit root test does not rule out the null hypothesis of the unit root in all the annual series. It does, however, rule out the null hypothesis of the unit root in all the series of monthly affordability rates (j = 1) and in most of the semiannual series, at the usual levels of significance statistical. In light of this, we opted to work with annual affordability rates wherever the Phillips-Perron test rejected the existence of the unit root for these series. When it was not rejected, we opted to work with semiannual affordability rates, also provided that the existence of unitary root was rejected. Finally, if for a given country and beverage it was not possible to reject the

TABLE 1. Sources and type of data used for the study, by country, variable, and time period

Country	Variable	Data used	Start-End	Source
Argentina	Beer	Wholesale Domestic Price Index	Oct 2001-Oct 2015	INDEC
	General	Wholesale Domestic Price Index	Oct 2001-Oct 2015	INDEC
	Wages	Nominal Average Wage Index	Oct 2001-Oct 2015	INDEC
Bolivia	Beer	Consumer Price Index	Mar 2008-May 2016	INE
	General	Consumer Price Index	Mar 2008-May 2016	INE
Brazil	Beer	National Consumer Price Index	Mar 2002-Feb 2016	CIDER
	General	National Consumer Price Index	Mar 2002-Feb 2016	CIDER
	Wages	Nominal average income from main job	Mar 2002-Feb 2016	CIDER
Chile	Beer	Consumer Price Index	Jan 2009-May 2016	INE
	Sugar-sweetened beverages	Consumer Price Index	Jan 2009-May 2016	INE
	General	Consumer Price Index	Jan 2009-May 2016	INE
	Wages	Nominal Wage Index	Jan 2009-May 2016	INE
Colombia	Beer	Consumer Price Index	Jan 2009-Apr 2016	DANE
	Sugar-sweetened beverages and malts	Consumer Price Index	Jan 2009-Apr 2016	DANE
	General	Consumer Price Index	Jan 2009-Apr 2016	DANE
	Wages	Nominal average wage index (industry)	Jan 1990-Apr 2016	Bank of the Republic of Colombia
Costa Rica	Bottled beer	Consumer Price Index	Jul 2006-Jun 2016	INEC
	Sugar-sweetened beverages	Consumer Price Index	Jul 2006-Jun 2016	INEC
	General	Consumer Price Index	Jul 2006-Jun 2016	INEC
	Wages	Nominal minimum wage index	Jul 2006-Jun 2016	INEC
Ecuador	Beer	Consumer Price Index	Jan 2005-Jun 2016	INEC
	Sugar-sweetened beverages	Consumer Price Index	Jan 2005-Jun 2016	INEC
	General	Consumer Price Index	Jan 2005-Jun 2016	INEC
	Wages	General Wage Index	Jan 2003-Jun 2016	INEC
El Salvador	Beer	Consumer Price Index	Jan 2006-May 2016	Central Bank of El Salvador
	Sugar-sweetened beverages	Consumer Price Index	Jan 2006-May 2016	Central Bank of El Salvador
	General	Consumer Price Index	Jan 2006-May 2016	Central Bank of El Salvador
Guatemala	Beer	Consumer Price Index	Apr 2011-Jun 2016	INE
	Artificial refreshments	Consumer Price Index	Apr 2011-Jun 2016	INE
	General	Consumer Price Index	Apr 2011-Jun 2016	INE
Honduras	Beer in can	Consumer Price Index	Jan 2012-May 2016	INE
	Bottled refreshments	Consumer Price Index	Jan 201-May 2016	INE
	General	Consumer Price Index	Jan 201-May 2016	INE
Mexico	Beer	Consumer Price Index	Jan 2007-mar 2016	INEGI
	Bottled refreshments	Consumer Price Index	Jan 2007-Mar 2016	INEGI
	General	Consumer Price Index	Jan 2007-Mar 2016	INEGI
	Wages	Average per capita wage index	Jan 2007-Mar 2016	Bank of Mexico
Paraguay	Beer	Consumer Price Index	Dec 2007-Sep 2016	Central Bank of Paraguay
	Sugar-sweetened beverages	Consumer Price Index	Dec 2007-Sep 2016	Central Bank of Paraguay
	General	Consumer Price Index	Dec 2007-Sep 2016	Central Bank of Paraguay
Peru	White beer	Nominal price in Lima	Jan 1996-Nov 2016	INEI
	Sugar-sweetened beverages	Nominal price in Lima	Jan 1996-Nov 2016	INEI
	General	Consumer Price Index for Lima	Jan 1996-Nov 2016	INEI
R. Dominican	Bottled beer	Consumer Price Index	Jan 2011-Jun 2016	ONE
	Refreshments	Consumer Price Index	Jan 2011-Jun 2016	ONE
	General	Consumer Price Index	Jan 2011-Jun 2016	ONE
Uruguay	Beer	Consumer Price Index	Mar 1997-May 2016	INE
	Refreshments	Consumer Price Index	Mar 1997-May 2016	INE
	General	Consumer Price Index	Mar 1997-May 2016	INE
	Wages	Average Wage Index	Mar 1997-May 2016	INE

INDEC: National Statistics and Census Institute; INE: National Statistics Institute; SIDRA: IBGE automatic recovery system; DANE: National Statistics Department; INEGI: National Statistics and Geography Institute; INEI: National Statistics and Informatics Institute; INEI: National Statistics Office.

existence of a unit root for an annual or semiannual series, we worked with monthly affordability rates. This was the case with the Dominican Republic for SSBs and Guatemala and Honduras for beers.

In the interest of homogeneity, the tables show annualized values to facilitate interpretation and comparison

TABLE 2. Descriptive statistics for wage and price indices in each country

Country	Number of reports	Average	Standard deviation	Median	Minimum	Maximum
Carbonated beverages/sugar-sweetened beverages price index						
Chile	91	116.2	12.1	113.4	100.0	142.1
Colombia	90	120.4	10.1	124.2	100.0	136.2
Costa Rica	125	146.6	23.9	153.5	100.0	175.6
Ecuador	138	129.4	26.5	121.6	94.4	212.2
El Salvador	125	107.1	16.4	100.7	81.9	142.4
Guatemala	63	110.1	6.1	110.9	100.0	119.9
Honduras	53	111.8	7.5	115.6	100.0	125.5
Mexico	119	128.4	20.3	123.4	100.0	164.2
Paraguay	102	122.4	14.8	120.7	97.9	148.6
Peru	251	91.9	10.4	92.2	73.8	113.6
Dominican Rep.	66	105.7	2.3	105.4	100.0	109.3
Uruguay	232	150.5	61.9	129.5	83.0	302.5
Beer price index						
Argentina	169	371.5	138.6	369.5	98.0	665.6
Bolivia	99	161.1	34.6	166.6	100.0	208.0
Brazil	173	170.9	53.2	146.6	100.0	278.3
Chile	91	113.2	13.6	108.5	97.4	143.6
Colombia	90	113.3	4.8	114.1	100.0	120.8
Costa Rica	125	156.3	30.0	159.5	100.0	193.1
Ecuador	138	126.7	22.3	123.7	99.2	185.0
El Salvador	125	110.0	6.3	112.8	99.6	119.8
Guatemala	63	97.8	5.6	95.2	92.0	106.8
Honduras	53	106.1	4.8	107.2	100.0	114.1
Mexico	119	133.4	21.1	132.4	99.4	165.7
Paraguay	102	143.3	23.3	146.6	100.0	172.7
Peru	251	136.1	15.2	134.7	100.0	166.0
Dominican Rep.	66	121.4	16.2	121.7	100.0	146.1
Uruguay	232	257.7	120.4	229.0	100.0	537.9
General price index						
Argentina	169	403.7	202.6	348.7	98.4	914.1
Bolivia	101	128.8	16.5	128.5	100.0	157.5
Brazil	173	169.0	41.0	163.0	100.0	262.6
Chile	91	108.3	7.9	107.1	97.8	129.1
Colombia	90	111.8	8.1	111.0	100.0	131.8
Costa Rica	125	144.7	22.0	147.9	100.0	171.3
Ecuador	138	128.0	18.0	127.1	100.0	157.0
El Salvador	125	118.5	8.2	119.4	100.0	127.9
Guatemala	63	110.4	5.8	110.8	100.0	120.8
Honduras	54	112.4	6.6	113.8	100.0	122.2
Mexico	119	122.7	13.5	123.4	99.9	145.4
Paraguay	102	122.2	13.2	124.5	100.0	144.9
Peru	251	152.8	26.6	148.1	100.0	205.9
Dominican Rep.	66	112.7	5.5	114.4	100.0	119.6
Uruguay	232	244.6	106.4	224.4	100.0	485.4
Wage index						
Argentina	169	409.3	345.3	277.7	99.3	1423.0
Brazil	168	172.2	55.5	163.5	100.0	277.9
Chile	89	120.4	14.9	119.2	100.0	147.4
Colombia	89	131.3	14.7	128.1	100.0	163.1
Costa Rica	120	153.8	31.3	155.3	100.0	198.1
Ecuador	134	217.6	83.3	204.5	100.0	360.8
Mexico	118	130.3	17.2	128.3	99.9	182.5
Uruguay	231	256.3	141.5	197.8	100.0	599.8

between countries. (The tables with the unit root analysis are not shown in order to save space, but are available from the authors upon request.) Using a first-order Taylor expansion around x = 0, the growth rate of affordability can be estimated as:

$$\gamma_t^A \cong 100 * \left(\left[\ln \frac{R_t}{R_{t-j}} \right] \right)$$
$$= 100 * \left(\ln(R_t) - \ln(R_{t-j}) \right)$$

Based on the properties of the natural logarithm, it can be affirmed that:

$$\gamma_t^A \cong 100 * \left(\ln(R_t) - \ln(R_{t-j}) \right)$$
$$= 100 * \left\{ \left[\ln(W_t) - \ln(W_{t-j}) \right] \right.$$
$$\left. - \left[\ln(P_t) - \ln(P_{t-j}) \right] \right\}$$

OR, in summary:

$$\gamma_t^A \cong \gamma_t^W - \gamma_t^P$$

where:

$$\gamma_t^P = 100 * \left(\left[\ln(P_t) - \ln(P_{t-j}) \right] \right)$$
$$\gamma_t^W = 100 * \left(\left[\ln(W_t) - \ln(EW_{t-j}) \right] \right)$$

In other words, the affordability growth rate can be calculated as the difference between the logarithmic estimate of the growth rate of nominal wages and of the price of the beverages.

As it has already been pointed out, the affordability rate is usually estimated by considering the population's purchasing power (25, 26). However, monthly information on wages/income is not available for all countries; in these cases, the affordability rate is considered to be the inverse of the relative price of the good in question with respect to the average price of the goods included in the calculation of the CPI. In these cases, if the relative price of the good decreases over time, its relative affordability is considered to have increased. On the other hand, if the relative price increases, the conclusion is that its relative affordability has declined.

Under the assumption of stationarity for the series γ_t^A, its expected value does not depend on time, which means that it can be denoted simply as μ:

$$\mu \equiv E(\gamma_t^A)$$

Thus, statistical inference focuses on μ. A positive value for this parameter can be interpreted as greater affordability of the beverage in question. A negative μ parameter leads to the opposite result: the goods are less affordable for the population. Clearly, a null value of the parameter is interpreted as affordability that does not vary over time.

Formally, the analysis focuses on the following null hypothesis:

$$H_0 : \mu = 0$$

evaluated in contrast to the alternative:

$$H_A : \mu \neq 0$$

Unlike an independently and identically distributed sample, data from time series are characterized by a pattern of dependency that voids inference processes that omit this reality. Nevertheless, if the assumed stationarity of γ_t^A is complemented with the absolute additionability of its autocovariances, the result is the following version of the central limit theorem (27):

$$\sqrt{T}\left[\frac{1}{T}\sum_{t-1}^{T}\gamma_t^A - \mu\right] \xrightarrow{D} N(0, V^*)$$

where V * denotes the long-term variance of γ_t^A, and T denotes the sample size of the time series. If σ(T) denotes a robust estimator of V *, then, under the null hypothesis, T has an asymptotically standard normal distribution:

$$\frac{\left[\frac{I}{T}\sum_{t-1}^{T}\gamma_t^A\right]}{\sigma(T)/\sqrt{T}} \xrightarrow{D} N(0, 1)$$

Robust estimators of the long-term variance of a time series abound in the literature, although the proposed estimator by Newey and West (28) is recognized as a pioneer. This estimator requires the selection of a parameter of bandwidth, which in this study was selected following the suggestion of Newey and West (29).

A simple way of constructing this statistic consists of estimating a regression between the variable γ_t^A and a constant, taking into account that standard errors need a robust estimator of long-term variance, i.e., the statistic proposed

by Newey and West (28). The method used in this study includes a slight modification of this strategy, since it consists of estimating the following model for γ_t^A:

$$\gamma_t^A = \delta + \varepsilon_t - \theta\varepsilon_{t-12} \qquad (A)$$

where ε_t is white noise with zero expectation and constant variance. From the previous model, it follows that

$$\mu \equiv E(\gamma_t^A) = \delta$$

which means that inference on parameter μ is equivalent to inference on the intercept δ in the model used here. The reason for introducing the moving average $\theta\varepsilon\,e_{t-12}$ is to control, at least partially, certain seasonal effects common to price series, even when annual rates are used in these series (30). If such as seasonal effect is not relevant, parameter q would be expected to be close to zero and would not substantially affect the estimates. The equation (A) is estimated using conditional least squares, and the standard errors of the coefficients are constructed using the aforementioned estimator proposed by Newey and West (28).

Results

Table 3 shows the results of the estimate of equation (A) for the 12 countries for which monthly data were available for soft drink prices. Specifically, for each country, the table shows the estimated parameter δ in equation (A), its standard error (in parenthesis) and the corresponding t-statistic.

The results obtained are mixed. Of the six countries for which affordability was measured in terms of wages (the proper way to measure affordability), in five of them (Chile, Colombia, Costa Rica, Ecuador, and Uruguay) the null hypothesis was ruled out with a level of statistical significance of 5%, and the coefficient is positive, which implies increased affordability of SSBs. For Mexico, the null hypothesis is also ruled out, with a high level of statistical significance (1%), but the coefficient is negative, which implies reduced affordability. Both Ecuador and Uruguay show especially high increases in affordability rates: 6.37% per year in Ecuador and 3.54% in Uruguay.

In the rest of the countries, there are no data on wages, leaving only a suboptimal indicator of affordability, which we have named 'relative affordability'. In these countries, the obtained results are somewhat less conclusive. In El Salvador, Guatemala, and Honduras, it is not possible to rule out the null hypothesis that there were no changes in relative affordability. In the Dominican Republic and Peru, relative affordability increased in statistical terms (the null hypothesis is ruled out at 10% and the coefficient is positive). In Paraguay, the null hypothesis was ruled out in favor reduced relative affordability.

Table 4 is analogous to Table 3, but it shows the results of affordability for beers in all countries in the sample. A larger number of countries are considered for beer, but again, with mixed results. For the group of countries with available information on wages and where affordability can be measured

TABLE 3. Seasonally adjusted rate of annual growth in sugar-sweetened beverages affordability, by country

	Chile	Colombia	Costa Rica	Ecuador	El Salvador	Guatemala
Annual growth rate	1.27***	2.75***	1.50***	6.37***	-0.57	0.09
Standard error	(0.40)	(0.80)	0.31	(1.51)	(1.25)	(0.46)
t-statistic	3.17	3.43	4.81	4.23	0.45	0.19
	Honduras	Mexico	Paraguay	Peru	Dominican Republic	Uruguay
Annual growth rate	-0.83	-1.07***	-0.49 *	2.93 *	3.28 **	3.54 **
Standard error	(0.53)	(0.21)	(0.26)	(1.76)	(1.66)	(1.65)
t-statistic	-1.55	-5.05	1.92	1.66	1.97	2.14

Notes:
[1] Robust standard errors under heteroskedasticity and autocorrelation have been calculated in accordance with the Newey and West method (28, 29).
[2] For Chile, Colombia, Costa Rica, Ecuador, Mexico, and Uruguay, affordability is measured in relation to the wage index. For the rest of the countries, it is measured in relation to the Consumer Price Index.
[3] For Chile, Colombia, Ecuador, and Guatemala, the analysis was based on the semiannual growth rate. This means that the reported annual rate is simply double the semiannual growth rate. For the Dominican Republic, the analysis was based on the monthly growth rate. This means that the reported annual growth rate is 12 times the monthly growth rate.
[4]* $P < 0.10$, ** $P < 0.05$, *** $P < 0.01$.

TABLE 4. Seasonally adjusted rate of growth annual of the affordability in beers per country

	Argentina	Bolivia	Brazil	Chile	Colombia
Annual growth rate	4.73	-4.07***	0.10	0.65	4.09***
Standard error	(5.45)	(1.32)	(0.99)	(1.19)	(1.46)
t-statistic	0.87	3.08	0.10	0.55	2.80
	Costa Rica	Ecuador	El Salvador	Guatemala	Honduras
Annual growth rate	0.53	7.26***	0.50	5.26 **	1.42 *
Standard error	(036)	(1.50)	(0.62)	(2.64)	(0.80)
t-statistic	1.18	4.85	0.81	2.00	1.79
	Mexico	Paraguay	Peru	Dominican Republic	Uruguay
Annual growth rate	-1.18 *	-2.30	1.11	-5.04***	0.61
Standard error	(0.64)	(1.47)	(0.91)	0.40	(1.73)
t-statistic	-1.84	-1.57	1.21	-12.58	0.32

Notes:

[1] Robust standard errors under heteroskedasticity and autocorrelation have been calculated in accordance with the Newey and West method (28, 29).

[2] For Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Mexico, and Uruguay, affordability is measured in relation to the wage index. For the rest of the countries, it is measured in relation to the Consumer Price Index.

[3] For Argentina, Bolivia, Chile, Colombia, Ecuador, El Salvador, Paraguay, and Uruguay the analysis was based on the semiannual growth rate. This means that the reported annual rate is double the semiannual growth rate. For Guatemala and Honduras, the analysis was based on the monthly growth rate. This means that the reported annual rate is 12 times the monthly growth rate.

better, affordability was found to increase significantly in Colombia and Ecuador: in Colombia, at an annual rate of 4.09% and in Ecuador at 7.26%. In Argentina, Brazil, Chile, Costa Rica, and Uruguay, the affordability growth rate was not statistically different than zero, while Mexico showed a 1.18% reduction in annual affordability (with a level of statistical significance of 10%).

For the countries without a wage series (Guatemala and Honduras), there was an observed increase in statistically significant relative affordability (10% in both). In Peru and El Salvador, an increase in relative affordability was also observed, but not a statistically significant one. In Bolivia and the Dominican Republic, there was a statistically significant drop in relative affordability, and also in Paraguay, but without statistical significance.

Discussion

The increase in consumption of products with negative effects on health is a public health concern. The loss of healthy years of life and the increase in health expenditures associated with this consumption are reason for concern both in developed and developing countries. To the extent that the affordability of these goods is reduced, it can be expected, given the available evidence (13, 14), that

their consumption will decline. The results of this study show that, both in the case of beers and SSBs, the overall trend in the Region is toward increased or stable affordability. In 12 of 15 countries, the affordability of beer increased or remained unchanged in statistical terms; and this was also the case with SSBs in 10 of 12 countries. Based on the existing evidence (13-15), it is not surprising that, in most countries, there has been a steady per capita increase in the consumption of both goods.

Taxation is a policy that has proven effective in reducing consumption of this type of goods (31-33). However, while in the great majority of countries in the Region, sugary and alcoholic beverages are taxed, this study shows that the application of these taxes has, to date, been insufficient to significantly reduce their affordability.

It is clear that in certain countries these taxes have been implemented to increase revenue, rather than correct unhealthful behaviors. For example, countries such as Argentina, Peru, and Uruguay tax SSBs as well as healthy alternatives like bottled water. Other countries, such as Chile or Ecuador, have raised taxes on these beverages, but insufficiently and in the context of tax reforms motivated, again, by fiscal needs. Only in Mexico, where there is extraordinary consumption of these beverages, resulting in

enormous health costs (10), the 2014 tax increase seems to have been truly motivated by public concerns, since it was discussed and analyzed in the context of a series of complementary measures (restrictions on advertising, labeling, etc.). Although the tax increase has been relatively moderate (around 10% of the average price of SSBs), it may have been effective in reducing affordability. The analyzed sample also shows that Mexico is the country with the lowest growth in affordability.

If there is truly a desire to reduce consumption, it is recommended that the countries of the Region advance decidedly in the implementation of these taxes, using health criteria. As the case of tobacco has demonstrated, specific taxes (a per-unit amount, based on volume, quantity of critical nutrients, etc.) are the most effective way to modify behavior (34).

It would be desirable for taxes on SSBs to bear some relation to the amount of critical nutrients they contain (for example, added sugars). Thought could then be given to taxing beverages that have a specific component (monetary amount per gram of added sugar), thereby penalizing beverages that have the greatest amount of these components and encouraging consumers to replace them with healthier alternatives, while encouraging producers to reformulate them. None of the countries in this study have this type of tax.

For alcoholic beverages, consideration could be given to a specific tax per gram of alcohol, so that consumers are encouraged to reduce consumption of those with the highest alcoholic content, replace them with those of lower content, or stop consuming them altogether. Only three countries among those considered here have this type of tax: Colombia, Ecuador, and the Dominican Republic.

The way a tax works depends on the objective for which it is imposed. In the case at hand, the objective should be, primarily, to reduce the consumption of substances that are hazardous to health. Tax design is fundamental, and it must be aligned with this objective.

Conflicts of interest. None declared.

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RESUMEN

Asequibilidad de cerveza y bebidas azucaradas para 15 países de América Latina

Objetivos. El objetivo de este trabajo fue analizar la evolución de la asequibilidad de la cerveza y de las gaseosas para quince países de América Latina.

Métodos. Los datos corresponden a estadísticas oficiales de índices de precios de cerveza y gaseosas/refrescos, índice de precios al consumidor e índice de salarios nominales en frecuencia mensual. El método se basa en realizar un análisis econométrico, mediante series temporales, para medir el valor esperado de la tasa de crecimiento del indicador de asequibilidad absoluta (utilizando salarios nominales) o relativa (usando precios generales) de las gaseosas y de las cervezas.

Resultados. En nueve de los quince países analizados, la asequibilidad (absoluta o relativa), ya sea de bebidas azucaradas o cervezas, ha aumentado de forma estadísticamente significativa. En el caso de las bebidas azucaradas, la asequibilidad absoluta aumentó en cinco países (Chile, Colombia, Costa Rica, Ecuador y Uruguay) y disminuyó en México. En el caso de la cerveza, aumentó en Colombia y Ecuador, se mantuvo inalterada en Argentina, Brasil, Chile, Costa Rica y Uruguay, y se redujo en México.

Conclusiones. A pesar de que la mayoría de los países poseen impuestos a la cerveza y a las bebidas azucaradas, su efecto en los precios no ha sido suficiente para reducir su asequibilidad en todos los países de la muestra. Los impuestos deberían modificarse para reducir la asequibilidad de estas bebidas y afectar su consumo.

Palabras clave   Economía de la salud; bebidas alcohólicas; bebidas gaseosas; América Latina.

RESUMO

Acessibilidade a cervejas e refrigerantes em 15 países da América Latina

Objetivos. Analisar a evolução da acessibilidade a cervejas e refrigerantes em 15 países da América Latina.

Métodos. Os dados representam estatísticas oficiais dos índices de preços de cervejas e refrigerantes, índice de preços ao consumidor e índice mensal do salário nominal. A metodologia do estudo foi uma análise econométrica com séries temporais para avaliar a taxa esperada de crescimento do indicador de acessibilidade absoluta (com base no salário nominal) ou relativa (com base nos preços gerais) de cervejas e refrigerantes.

Resultados. Houve um aumento significativo da acessibilidade (absoluta ou relativa) a cervejas ou refrigerantes em 9 dos 15 países analisados. Com relação aos refrigerantes, houve um aumento da acessibilidade absoluta em cinco países (Chile, Colômbia, Costa Rica, Equador e Uruguai), com uma redução observada no México. Com relação às cervejas, houve um aumento da acessibilidade na Colômbia e Equador, não se observou mudança na Argentina, Brasil, Chile, Costa Rica e Uruguai e ocorreu uma redução no México.

Conclusões. Embora exista tributação para cervejas e refrigerantes na maioria dos países, o efeito nos preços não tem sido suficiente para reduzir a acessibilidade a estes produtos em todos os países da amostra estudada. É preciso reformar a tributação a fim de reduzir a acessibilidade e o consumo destas bebidas.

Palabras-chave   Economia da saúde; bebidas alcoólicas; bebidas gasosas; América Latina.