Estimated health impact, cost, and cost-effectiveness of taxation on unhealthy packaged foods in the Philippines: a modelling study

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Summary

Background In 2018, the Philippines implemented a tax on sugar-sweetened beverages. A broader tax on unhealthy foods is being considered. We aimed to estimate the effect of a tax on unhealthy packaged foods.

Methods In this modelling study, we used a multiple-cohort, proportional multistate life table model to estimate the effect of a 20% tax on packaged foods exceeding WHO thresholds for sodium or sugar, excluding beverages already taxed. Using nationally representative nutrition, sales, and Global Burden of Diseases, Injuries, and Risk Factors Study data, we projected changes in sodium and sugar intake and related health outcomes (cardiovascular disease and type 2 diabetes) and economic outcomes (health-care costs, tax revenue, and implementation costs) over 20 years, comparing Filipino adults aged 25 years and older in 2020 (reference population) with the same population under the intervention with reduced intakes from the tax, assuming 100% pass-through to prices. Cost-effectiveness was estimated from extended health-care and government perspectives and stratified by wealth quintile.

Findings Compared with the base-case scenario (ie, the status quo), the tax was estimated to avert 2775 deaths (95% uncertainty interval 2685–2853), 13 632 incident ischaemic heart disease events (13 153–14 029), 5287 ischaemic strokes (5090–5445), and 21 763 type 2 diabetes cases (21 532–22 006) over 20 years, generating 326 253 health-adjusted life-years (321 577–330 434). The tax could be cost saving from the government perspective and cost-effective from the health-care perspective, with an estimated 2·37 billion Philippine pesos (PHP; 2·32–2·42) in health-care savings, PHP 647·99 billion (646·42–649·45) in tax revenue, and PHP 12·96 billion (12·93–12·99) in implementation costs over 20 years. Estimated health gains were concentrated among people in middle-income groups, whereas tax revenue increased with income.

Interpretation A nutrient-based tax on unhealthy packaged foods could reduce diet-related disease burden and generate sustained tax revenue in the Philippines. These findings support nutrient-based food taxes as a cost-effective strategy to reduce disease burden, and raise revenue in low-income and middle-income countries.

Funding Resolve to Save Lives funded by Bloomberg Philanthropies.

Lancet Public Health 2025; 10: e824–34

Published Online August 25, 2025 https://doi.org/10.1016/S2468-2667(25)00191-4

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Introduction

Long-term consumption of energy-dense, ultra-processed food is associated with obesity and non-communicable diseases, including type 2 diabetes, cardiovascular disease, and cancer.[1] Non-communicable diseases cause 70% of global deaths, with over three-quarters occurring in low-income and middle-income countries (LMICs),[2] driven partly by dietary shifts and increased availability of processed foods high in sodium, sugar, and unhealthy fats. In LMICs, poor diet contributes more to mortality from non-communicable disease than tobacco, alcohol, or physical inactivity.[3]

Governments are increasingly adopting policies to promote healthier diets.[4] WHO recommends taxing alcohol, tobacco, sugar-sweetened beverages, and unhealthy foods as cost-effective interventions.[5,6] Although taxes on sugar-sweetened beverages are widely adopted, broader taxes on processed foods high in sodium or sugar remain rare.[7] Studies from high-income and middle-income countries (eg, the UK, Australia, New Zealand, the USA, Mexico, and South Africa) suggest that food taxes can cost-effectively reduce the burden of non-communicable diseases and health-care costs (appendix p 14). However, most evidence focuses on single nutrients or food categories. Comprehensive nutrient-based approaches remain understudied, especially in LMICs, where dietary patterns, food systems, and economic conditions differ from high-income settings.[8,9]

Nutrient profiling models (NPMs) offer a way to design targeted fiscal policies for improving diets.[10] By classifying foods based on nutritional composition, NPMs enable broader and precise taxes for unhealthy products,[10] facilitate industry compliance, and improve

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See Online for appendix

Research in context

Evidence before this study

Taxes on sugar-sweetened beverages have been widely implemented and shown to improve dietary behaviours, particularly in high-income countries. Price increases on unhealthy products can reduce disease risk and encourage industry reformulation, with health benefits often accruing in populations with lower income. However, broader food taxes targeting unhealthy packaged foods remain rare. The potential health and economic impacts of such policies are unclear, limiting their adoption. We searched MEDLINE, PubMed, and Scopus from database inception to March 6, 2025, using the terms "sodium" OR "sugar" AND "cost-effectiveness" AND "tax" AND "Philippines" without language restrictions. We identified one relevant study (our own), which outlined key considerations for modelling such a tax but did not estimate its health or economic impact. Although no studies have examined nutrient-based food taxes in the Philippines specifically, studies from other countries suggest that taxes on unhealthy foods typically can be cost saving or highly cost-effective. However, most existing studies focus on sugar-sweetened beverages or specific food categories rather than comprehensive nutrient-based approaches, and evidence from low-income and middle-income countries (LMICs) remains scarce.

Added value of this study

To our knowledge, this is the first study to estimate the health and economic impact of a tax on packaged foods high in sodium or sugar in an LMIC and the first in Asia. Using a multiple-cohort, proportional multistate life table model, we found that a 20% tax on packaged foods high in sodium or sugar could prevent approximately 2800 deaths and 41 000 cases of cardiovascular disease and type 2 diabetes over 20 years, while generating approximately US$46 million in health-care cost savings, $13 billion in tax revenue, and $250 million in implementation costs. The tax was projected to be cost-effective from an extended health-care perspective and highly cost saving from a government perspective. The concentration of health gains in middle-income groups, and the smallest gains among the wealthiest populations, suggest the policy has the potential to help reduce health inequalities.

Implications of all the available evidence

Our findings support expanding fiscal policies beyond existing taxes on sugar-sweetened beverages to broader nutrient-based taxes on unhealthy packaged foods, providing additional health and economic benefits. Although few such policies have been implemented, mainly in high-income settings, this study suggests they can also be cost-effective in LMICs. Given the increasing diet-related disease burden, governments, particularly in LMICs, could consider such taxes to improve population health, reduce health-care costs, and generate revenue.

consumer understanding. Few countries (eg, Hungary and Colombia) have applied NPMs for taxation, although WHO now encourages this approach.[6,10]

We aimed to model the potential health and economic impact of a tax on unhealthy food in an LMIC, using the Philippines as a case study.[11] Since 1990, the prevalence of non-communicable diseases in the Philippines has doubled and non-communicable disease-related deaths have tripled, partly due to increasing consumption of processed foods.[3] The Government has enacted food policies,[12] including a tax on sugar-sweetened beverages, and has considered expanding this tax to include unhealthy packaged foods. In 2019, the National Tax Research Center assessed the feasibility of taxing foods high in salt, sugar, and fat,[13] and, in 2023, the Departments of Finance and Health jointly proposed a tax on prepackaged foods lacking nutritional value.[14] Although such taxes have not been legislated or implemented, internal policy discussions are ongoing. Despite this ongoing policy interest, the potential health and economic impact of a nutrient-based food tax in the Philippines has not been quantified, limiting the evidence base available to inform decision making. Economic modelling can support alignment between health and fiscal goals, consistent with the Philippine Development Plan (2023–28).[9] Therefore, we aimed to estimate the potential effect of a tax on unhealthy packaged foods high in sugar or sodium in the Philippines, evaluating its effects on diet, health, equity, and economy, and its cost-effectiveness.

Methods

Study design

In this modelling study, we constructed a multiple-cohort, proportional multistate life table (Markov) model to estimate the health effect, costs, and cost-effectiveness of a tax on unhealthy packaged foods in the Philippines (appendix pp 7–8, 31–32),[11] based on our previous model of a tax on sugar-sweetened beverages implemented in the Philippines in 2018.[15] The model converts changes in sodium and sugar intake into cardiovascular disease and type 2 diabetes morbidity and mortality via the intermediary risk factors of systolic blood pressure and BMI. We simulated the adult Philippine population (aged ≥25 years) in 5-year sex-and-wealth-specific cohorts (appendix p 15). We compared a reference population with stable total sodium and sugar intake reflecting pre-policy consumption, and an intervention population with identical characteristics but lower sodium and sugar intake due to industry reformulation and consumer response to the tax. We calculated differences in cardiovascular disease and type 2 diabetes incidence and deaths, life-years, and health-adjusted life-years (HALYs) over 5, 10, and 20 years. We evaluated cost-effectiveness from an extended health-care perspective (including health-care costs and policy implementation costs) and a government perspective (adding tax revenue and excluding out-of-pocket health-care costs). We inflated all costs to 2019 values and applied a 3% annual discount rate for costs and HALYs (appendix pp 7–8).[16] Key inputs and assumptions are summarised in table 1, with full model documentation in appendix pp 7–8 and the CHEERS 2022 checklist in appendix pp 4–6.

No patients were involved in formulating research questions, conducting analysis, or interpretation and writing of results. Patient consent was not required for this modelling study. Ethics approval was obtained from Nanyang Technological University Institutional Review Board (IRB-2021-929).

Modelled tax

We modelled a 20% excise tax on all packaged foods exceeding category-specific sugar or sodium thresholds in the WHO Western Pacific Regional Office (WPRO) NPM (appendix pp 8–9, 16).[25] For categories without WPRO thresholds, we used WHO South-East Asia Regional Office NPM thresholds.[26]

	Stratification	Values	Source	Note
Baseline dietary intake	Age, sex, wealth quintile	Appendix pp 21–24	2018–19 Expanded National Nutrition Survey[17]	Mean intake was adjusted for misreporting using inflation factors calculated separately for each age–sex–wealth group, based on the ratio of reported energy intake among adequate reporters versus all participants. Adequate reporters were identified using revised Goldberg cutoffs, incorporating basal metabolic rate, physical activity level, and variability in intake and energy requirements. Across groups, the median inflation factor was 1·23 (IQR 1·19–1·28), indicating that adequate reporters consumed approximately 23% more energy than the group average. Adjusted intake values of 36 food subcategories (ie, 18 categories stratified by taxation status) were used in the main analysis. For each model iteration, we drew random values of mean intake from each subcategory assuming normal distributions.
Price elasticity of demand	Wealth quintile	Appendix p 17	2018–19 Expanded National Nutrition Survey[17]	Own-price and cross-price elasticities for 18 food categories were estimated using the Quadratic Almost Ideal Demand System model, stratified by income quintile. Each category included both taxable and non-taxable foods, resulting in a total of 36 subcategories. Cross-price elasticities were estimated within each category reflecting potential substitution between taxed and untaxed products in that category (eg, taxed *vs* untaxed snacks), rather than across unrelated food groups, This reflects the assumption that consumer substitution in response to price changes is more likely to occur within the same category than across categories. In cases where stable estimates could not be calculated (eg, due to a small number of foods or sparse consumption) we used an inverse-weighted pooled average from categories with stable estimates. Because the food consumption data were available at the household level, we assumed that price elasticities were uniform across age–sex groups within each income quintile and remained constant over the 20-year analysis period. For each model iteration, we drew random values for each price elasticity parameter from a normal distribution.
Packaged food intake trends	None	Appendix pp 9–11, 18	Euromonitor Passport (2008–19)[18]	Annual percentage changes were estimated using per capita purchase data from Euromonitor Passport (2008–19), excluding 2020–22 due to potential COVID-19-related disruptions. Euromonitor food categories were mapped to corresponding categories in the Nutrient Profile Models of the WHO Western Pacific region and WHO South-East Asia Regional Office for use in the main analysis. For each model iteration, we drew random values of category-specific trends from a normal distribution.
Population size	Age, sex	Appendix p 15	Philippines Statistics Authority[19]	Values are for the year 2020.
All-cause mortality	Age, sex	Appendix p 15	Philippines Statistics Authority[20]	Values are for the year 2021. Due to limited availability of income-stratified mortality data, we assumed that mortality rates were uniformly distributed across wealth quintiles in the base case.
Type 2 diabetes, ischaemic heart disease, ischaemic stroke incidence, prevalence and case-fatality rates	Age, sex	Disease-specific rates	GBD[3]	Age–sex-specific incidence, prevalence, and mortality rates for each disease outcome for 2019 are from the GBD and used the DisMod II software package to derive internally consistent estimates of baseline incidence, prevalence, and case fatality. Similar disease rates across all wealth quintiles were assumed due to limited stratified data.
Systolic blood pressure change per 1 g sodium reduction	Age, systolic blood pressure	Appendix p 12	Mozaffarian et al (2014)[21]	The prevalence of hypertension and the mean (SD) of systolic blood pressure by age–sex–income group was obtained using data from the 2018–19 Expanded National Nutrition Survey.[17] The projected sodium reduction was translated into changes in systolic blood pressure, accounting for age and hypertension status. A weighted average systolic blood pressure change for normotensive and hypertensive individuals in each age–sex–wealth group was calculated and used to compute the counterfactual mean systolic blood pressure. The counterfactual SD of the systolic blood pressure was calculated by regressing baseline SD values over baseline means. For each simulation, a draw was made from the distributions of current mean systolic blood pressure for the specific age–sex stratum and the reduction in sodium consumption, the effect of a 100 mmol/day sodium reduction on systolic blood pressure when mean individual age is 50 years, and the average effect of sodium reduction on systolic blood pressure for each 1-year increase in age.
BMI change per 1 g sugar reduction	None	Appendix p 12	Hall et al (2011)[22]	We estimated the change in bodyweight based on the change in sugar consumption and calculated the change in BMI for each group by combining the estimated weight change with average height values. For each model iteration, we drew random values of category-specific sugar reduction from a normal distribution.
Relative risk for ischaemic heart disease, ischaemic stroke per 10 mm Hg systolic blood pressure	Age	Appendix p 19	GBD[23]	For each iteration (n=1000), random draws of age-specific log relative risks were made.

(Table 1 continues on next page)

	Stratification	Values	Source	Note
(Continued from previous page)				
Relative risk for type 2 diabetes, ischaemic heart disease, and ischaemic stroke per 5 kg/m² BMI	Age	Appendix p 19	GBD[23]	For each iteration (n=1000), random draws of age-specific log relative risks were made.
Health-care costs	Disease	Appendix p 20	Philippines Health Insurance Corporation[15]	The Philippines Health Insurance Corporation provided the national average annual cost for hospital admissions for type 2 diabetes, ischaemic heart disease, and stroke. The mean annual costs for these three admissions were used as a cost per prevalent case as we lacked further data on health-care utilisation at primary care. Health-care cost savings were estimated by multiplying averted cases by mean hospitalisation costs for type 2 diabetes, ischaemic heart disease, and stroke, adjusted to 2020 using a 2·4% annual inflation rate. Costs were assumed uniform across groups but disaggregated by wealth quintile using out-of-pocket payment shares based on Philippines Health Insurance Corporation coverage.
Government policy implementation costs	None	2% of tax revenue	Authors' assumption	In the absence of estimated policy implementation costs from the Philippines, we assumed that the implementation costs would equal 2% of tax revenue as was suggested by Lee and colleagues.[22] While modelling national taxes on sugar-sweetened beverages for the USA, they based their assumptions on evidence from local USA taxes on sugar-sweetened beverages, while noting that the 2% could be an overestimation if scaling up the tax to a national level led to efficiency gains.

GBD=Global Burden of Diseases, Injuries, and Risk Factors Study.

Table 1: **Key inputs and assumptions**

We assessed the eligibility of foods for taxation based on the 2018–19 Expanded National Nutrition Survey (ENNS)[17] food codes, linked to the Philippine Food Composition Tables (PhilFCT).[27] Foods were classified as packaged based on expert review of ENNS food codes and grouped into 18 WPRO NPM categories (appendix pp 8–9, 16).

Beverages are already taxed under the existing sugar-sweetened beverage tax in the Philippines and were excluded from the evaluated broader food tax. In the main analysis, we assumed a 100% pass-through to consumer prices (appendix pp 8–9). For foods exceeding NPM thresholds by 50% or less, we assumed that manufacturers would reformulate products within 4 years to avoid taxation. For foods exceeding thresholds by more than 50%, reformulation was assumed not to be feasible (appendix pp 8–9).

Although the WPRO NPM includes thresholds for saturated fat, we modelled only sodium and sugar due to data limitations in the ENNS[17] and PhilFCT,[27] which did not have reliable saturated fat values for many packaged foods, whereas sodium and sugar data were more complete and consistently reported (appendix pp 8–9).

Dietary impact

We calculated the mean (SD) of usual intake, adjusted for misreporting, of 36 food subcategories (18 categories stratified by tax status at baseline) by age–sex–wealth groups from the 2018–19 ENNS,[17] using food code-level data linked to PhilFCT[27] (appendix pp 9–11).

We used the quadratic almost ideal demand system (QUAIDS) to estimate the own-price and cross-price elasticity of demand for each of the 36 food subcategories for each quintile using the food intake and price data from the 2018–19 ENNS[17] (appendix pp 11, 17). The QUAIDS model accounts for how consumers allocate their expenditure across multiple goods in response to changes in prices and income, and it allows for flexible, non-linear spending patterns across income levels.

We projected future intake in the base case assuming continued growth in packaged food consumption, based on historical purchase trends (appendix pp 9–11, 18).[18] In the tax scenario, we applied the same trend but incorporated intake changes based on predicted price increases and income-specific own-price and cross-price elasticities of demand. Sodium and sugar intake from packaged foods was calculated by multiplying predicted intake by expected nutrient content, using consumption-weighted means updated annually to account for reformulation.

We conservatively assumed that the projected increase in sodium and sugar intake from packaged foods (due to increasing consumption over time) would be offset by proportional reductions from other sources (eg, discretionary salt or home-prepared foods), resulting in no net change in total sodium or sugar intake in the base-case scenario.

Health impact

We used the 2018–19 ENNS[17] to calculate hypertension prevalence and mean (SD) of systolic blood pressure and BMI by age–sex–wealth groups. We converted the estimated reduction in sodium and sugar into changes in systolic blood pressure and BMI, respectively (appendix pp 7–8, 12). We used relative risks from literature to calculate subsequent changes in disease risk (appendix p 19) and used shifts in risk factor distributions to calculate potential impact fractions (appendix pp 7–8, 12–13). We modelled reductions in cardiovascular disease and type 2 diabetes incidence over 5, 10, and 20 years using multistate cohort life tables, comparing reference and intervention populations (appendix pp 7–8). Baseline age–sex specific incidence, prevalence, and mortality for each disease outcome were obtained from the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2019 dataset.[3] Internally consistent estimates were generated using DisMod II (appendix pp 7–8). Wealth quintiles are presented from 1 to 5, with quintile 1 being the poorest and quintile 5 the wealthiest. We assumed similar disease rates across all wealth quintiles due to limited stratified data. We calculated HALYs using disability weights from the GBD 2019 estimates of years lived with disability and disease prevalence.[28] We conducted heterogeneity analysis by sex–wealth groups to account for sex differences in disease epidemiology and wealth-related differences in tax and cost burden.

Economic impact and cost-effectiveness analysis

We estimated health-care cost savings by multiplying prevalent cases by annual hospitalisation costs per prevalent case,[15] inflated to 2019 (appendix pp 13, 20). Because stratified health-care cost data by wealth quintile were unavailable, we applied the same mean cost per prevalent case across all groups, reflecting national estimates pooled across hospitals and patients. We varied out-of-pocket share using published estimates from the national health insurance programme, PhilHealth, where the proportion paid out of pocket is income-dependent, ranging from 20% among the poorest quintile to 83% among the wealthiest.[29]

We calculated annual tax revenue by multiplying projected per capita consumption of taxed foods with per-unit tax and projected population after tax implementation, for specific cohort and year. We assumed government implementation costs equal to 2% of tax revenues, based on findings from local taxes on sugar-sweetened beverages in the USA.[24] We expressed all estimated costs in 2019 Philippine pesos (PHP) and US$, with an exchange rate (July 1, 2019) of PHP 51·23 per $1.[30]

We calculated incremental cost-effectiveness ratios (ICERs) as the ratio of incremental net cost to incremental HALYs gained, with both costs and HALYs discounted at 3% annually. We defined cost saving as a negative net cost and cost-effectiveness as having an ICER not greater than the Philippines-specific threshold of PHP 64 282 (95% CI 32 810–81 501) per HALY gained, equivalent to $1105.[31]

Sensitivity analysis

We conducted probabilistic and deterministic sensitivity analysis. For probabilistic analysis, we conducted 1000 simulations incorporating random variation for baseline food intake, underlying trend in packaged food intake, food price, price elasticity, relative risks for diseases, BMI, systolic blood pressure, and predicted annual tax payment per person. We report the 2·5th and 97·5th percentiles of the resulting distribution as bounds of the 95% uncertainty interval [UI]. We conducted five deterministic analyses with varying tax rate, dietary intake, reformulation feasibility, and pass-tax pass-through rate (appendix p 13).

Role of the funding source

The funder of the study had no role in data collection, data analysis, or the decision to submit for publication. Authors affiliated with the funder contributed to the study design, data interpretation, and writing of the report.

For **DisMod II** see https://www.epigear.com/index_files/dismod_ii.html

Results

At baseline, mean sodium intake from 18 packaged food categories ranged from approximately 600 mg/day to approximately 1000 mg/day among men, and from approximately 600 mg/day to approximately 900 mg/day for women (appendix pp 21–22). Ready-made and convenience foods, bread, bread products, and processed meat, poultry, and fish contributed to more than half of sodium intake (appendix p 33). In general, the sodium intake was higher among younger and wealthier groups (appendix pp 21–22). In general, baseline mean sugar intake was also higher in younger and wealthier groups, and ranged from approximately 20 g/day to approximately 60 g/day in men and approximately 25 g/day to approximately 40 g/day among women (appendix pp 23–24). Excluding already taxed beverages, yogurts, sour milk, and cream accounted for about two-thirds of sugar intake (appendix p 34).

Across 17 taxable categories (excluding already taxed beverages), 354 (75%) of 473 packaged food items exceeded nutrient thresholds (appendix p 25). The categories with the highest proportions of items exceeding nutrient thresholds were chocolate and sugar confectionery (76 [93%] of 82), savoury snacks (61 [92%] of 66), and cakes, sweet biscuits, and pastries (47 [89%] of 53), and the categories with the lowest proportions were ready-made and convenience foods (36 [55%] 65) and processed meats, poultry, fish, and similar (39 [53%] of 73). Foods above nutrient thresholds accounted for 90% of sodium and 98% or more of sugar intake from taxable categories.

Across age–sex–wealth groups, the tax reduced sodium intake by approximately 100 mg/day at year 20, corresponding to a 10% relative reduction, and reduced sugar intake by 3·8 g/day at year 20, corresponding to a 7% relative reduction (appendix pp 35–44).

Within 5 years, the tax was estimated to avert 353 deaths (95% UI 337–369), 4388 incident ischaemic heart disease events (4209–4546), 1617 ischaemic strokes (1550–1679), and 6073 new type 2 diabetes cases (5970–6174), resulting in 43 053 HALYs gained (41 966–44 076; table 2). Over 20 years, 2775 deaths (2685–2853), 13 632 incident ischaemic heart disease events (13 153–14 029), 5287 ischaemic strokes (5090–5445), and 21 763 type 2 diabetes cases (21 532–22 006) would be averted, with 326 253 HALYs gained (321 577–330 434; table 2).

Most benefits stemmed from consumer response to higher prices of taxed foods, with smaller effects from reformulation (appendix p 26). Sugar reduction yielded

	5 years	10 years	20 years
Incident events averted			
Total	12 078 (11 797 to 12 334)	21 768 (21 329 to 22 145)	40 681 (39 907 to 41 349)
Type 2 diabetes	6073 (5970 to 6174)	11 357 (11 205 to 11 510)	21 763 (21 532 to 22 006)
Ischaemic heart disease	4388 (4209 to 4546)	7570 (7291 to 7811)	13 632 (13 153 to 14 029)
Ischaemic stroke	1617 (1550 to 1679)	2841 (2731 to 2935)	5287 (5090 to 5445)
Deaths averted			
Total	353 (337 to 369)	1024 (985 to 1060)	2775 (2685 to 2853)
Type 2 diabetes	41 (39 to 44)	133 (128 to 137)	455 (446 to 463)
Ischaemic heart disease	282 (268 to 297)	804 (770 to 838)	2080 (2002 to 2152)
Ischaemic stroke	30 (27 to 32)	87 (80 to 92)	239 (225 to 252)
HALYs gained	43 053 (41 966 to 44 076)	126 678 (124 284 to 128 881)	326 253 (321 577 to 330 434)
Health-care cost, billion PHP	–0·31 (–0·32 to –0·30)	–0·93 (–0·95 to –0·91)	–2·37 (–2·42 to –2·32)
Tax revenue, billion PHP	257·04 (256·22 to 257·87)	418·53 (417·40 to 419·55)	647·99 (646·42 to 649·45)
Implementation costs, billion PHP	5·14 (5·12 to 5·16)	8·37 (8·35 to 8·39)	12·96 (12·93 to 12·99)
Health-care perspective			
Net costs, billion PHP	4·83 (4·81 to 4·85)	7·44 (7·41 to 7·47)	10·59 (10·53 to 10·65)
ICER, PHP per HALY gained	112 189 (109 341 to 115 252)	58 744 (57 588 to 60 012)	32 468 (31 965 to 33 049)
Probability of being cost saving*, %	0%	0%	0%
Probability of being cost-effective*, %	1%	70%	100%
Government perspective			
Net costs, billion pesos	–262·33 (–263·17 to –261·48)	–427·34 (–428·38 to –426·18)	–662·07 (–663·55 to –660·45)
ICER, pesos per HALY gained	Dominant	Dominant	Dominant
Probability of being cost saving*	100%	100%	100%
Probability of being cost-effective*	100%	100%	100%

Data are n (95% uncertainty interval) except where otherwise specified. HALY=health-adjusted life-year. ICER=incremental cost-effectiveness ratio. PHP=Philippine pesos. *Cost saving was defined as having a negative net cost and cost-effective was defined as having an ICER equal to or less than the cost-effectiveness threshold for the Philippines: USD$1105 per HALY (95% CI 564–1401) or PHP 64 282 per HALY (32 810–81 501).[31]

Table 2: **Estimated health impact, cost, and cost-effectiveness of the modelled food tax**

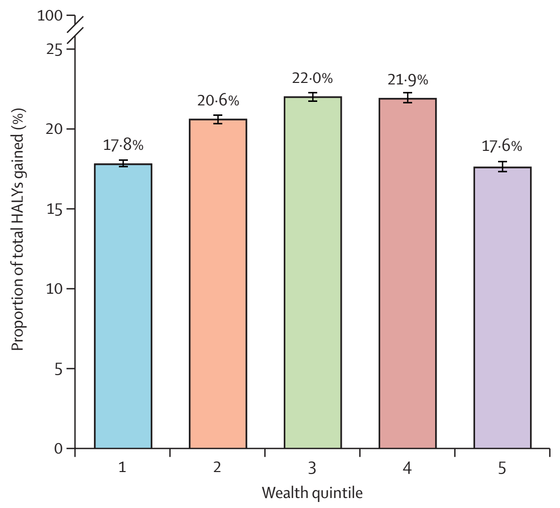

Figure 1: **Proportion of HALYs gained over 20 years, by wealth quintile**
A 20% gain in HALYs would be expected if HALYs gained were equally distributed across all wealth quintiles Wealth quintiles are presented from 1 to 5, with quintile one being the poorest and quintile five the wealthiest. The error bars represent the 95% uncertainty interval, defined by the 2·5th and 97·5th percentiles of the 1000 Monte Carlo simulations. HALYs=health-adjusted life-years.

greater overall health gains due to its dual effect on type 2 diabetes and cardiovascular disease, while sodium reduction led to larger benefits for cardiovascular outcomes (appendix p 27).

The tax was estimated to save PHP 310 million (95% UI 300–320), approximately $6 million, in health-care costs over 5 years, and PHP 2·37 billion (2·32–2·42), approximately $46 million, over 20 years (table 2). Projected total tax revenue over 20 years was PHP 647·99 billion (646·42–649·45), approximately $12·6 billion, with around 40% of revenue accrual in the first 5 years and 65% within 10 years (table 2). Implementation costs over 20 years were estimated to be PHP 12·96 billion (12·93–12·99), approximately $253 million (table 2).

From the extended health-care perspective (considering health-care cost savings and government implementation costs), the policy's 20-year net costs were estimated to be PHP 10·59 billion (95% UI 10·53–10·65), approximately $207 million (table 2). At 20 years the tax was cost-effective (100% probability), with an ICER of PHP 32 468 (31 965–33 049) per HALY gained (approximately $634 per HALY; table 2).

From the government perspective (considering health-care cost savings, government implementation costs, tax

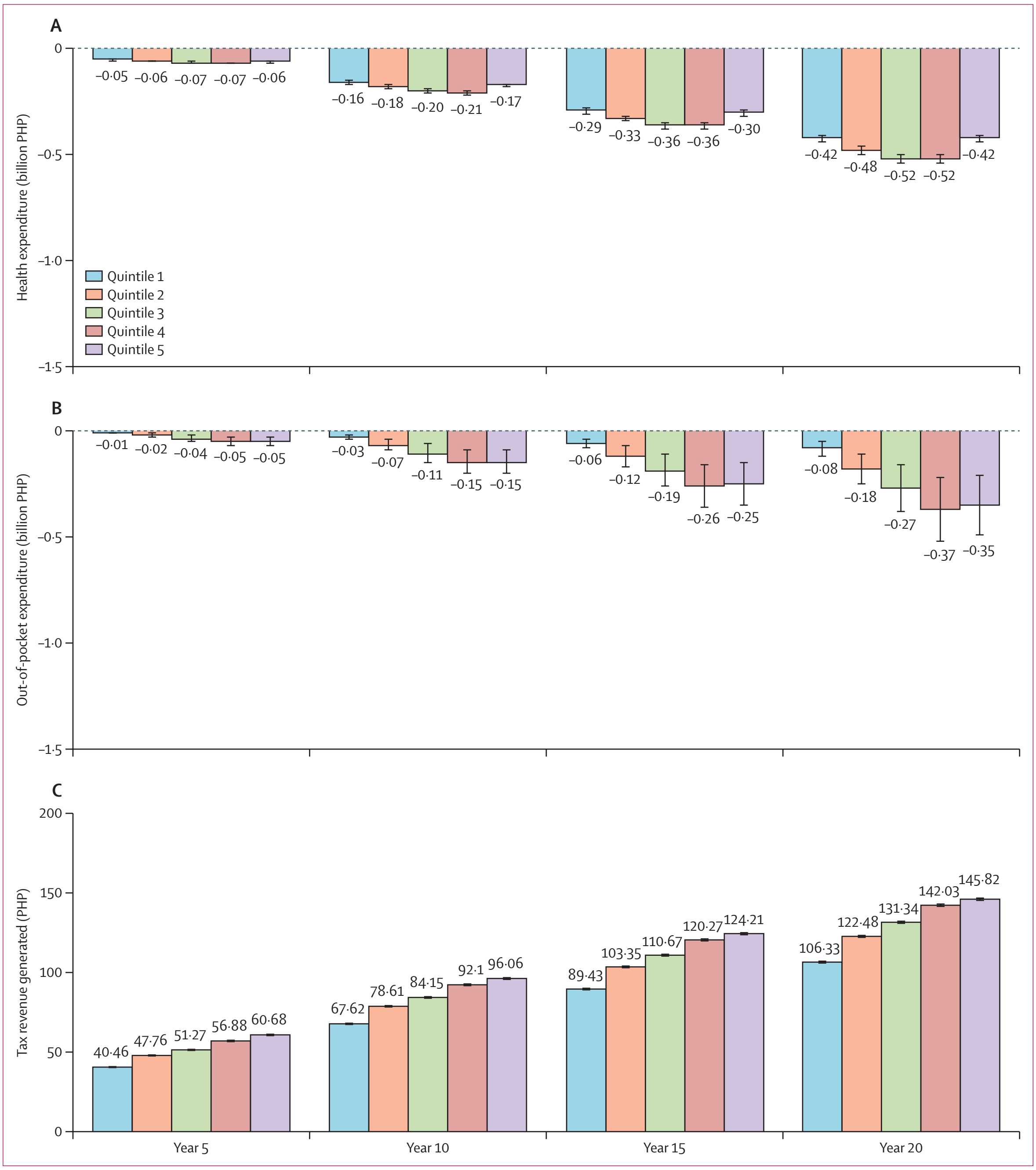

***Figure 2:* Distribution of economic effects by wealth quintile over 20 years**

(A) Total health-care expenditure averted. (B) Out-of-pocket cost savings. (C) Tax revenue generated, all stratified by wealth quintile. Wealth quintiles are presented from 1 to 5, with quintile 1 being the poorest and quintile 5 the wealthiest. The error bars represent the 95% uncertainty interval, defined by the 2·5th and 97·5th percentiles of the 1000 Monte Carlo simulations. PHP=Philippine pesos.

revenue, and excluding out-of-pocket costs), the 20-year net cost was estimated at PHP –662·07 billion (95% UI –663·55 to –660·45; approximately –$12·4 billion), with an estimated 100% probability of being cost saving (table 2).

In the analysis of heterogeneity by subgroups, sodium intake reductions were greatest among upper wealth quintiles, whereas sugar reductions were higher in lower wealth quintiles (appendix pp 41–44), reflecting baseline consumption and price responsiveness (higher baseline sodium intake in higher income groups and higher price-sensitivity for sugar-rich foods in lower-income groups as shown in the appendix (pp 17, 21–22).

Health gains were highest in middle wealth quintiles (figure 1; appendix pp 28, 45) and lowest in the richest quintile, which gained 639 (95% UI 578–700) fewer HALYs than the poorest quintile over 20 years (appendix p 28). Health-care cost savings were highest in middle wealth quintiles (figure 2A). Out-of-pocket cost savings were highest for the wealthiest quintile, reflecting their higher share of out-of-pocket costs (figure 2B). The tax collected increased with increasing wealth quintiles, with the wealthiest quintile contributing to nearly 40% more (146 *vs* 106 billion PHP over 20 years) in payments than the poorest quintile (figure 2C).

Women had greater HALY gains than men (177 735 HALYs gained [95% UI 175 043–180 216] *vs* 148 518 [145 740–151 084]) largely due to greater reduction in type 2 diabetes incidence. However, more type 2 diabetes deaths were averted among men than among women (appendix pp 29–30).

In the sensitivity analyses, the tax was highly cost saving across all sensitivity analyses and over all evaluated time horizons from the government perspective (figure 3). From the extended health-care perspective, tax was cost-effective in all scenarios after 10 years (appendix p 46). Assumptions on tax and pass-through rates had the greatest effect on results, with the 50% pass-through scenario producing the least benefit and the 40% tax rate scenario generating the greatest health and economic benefits (figure 3, appendix p 46).

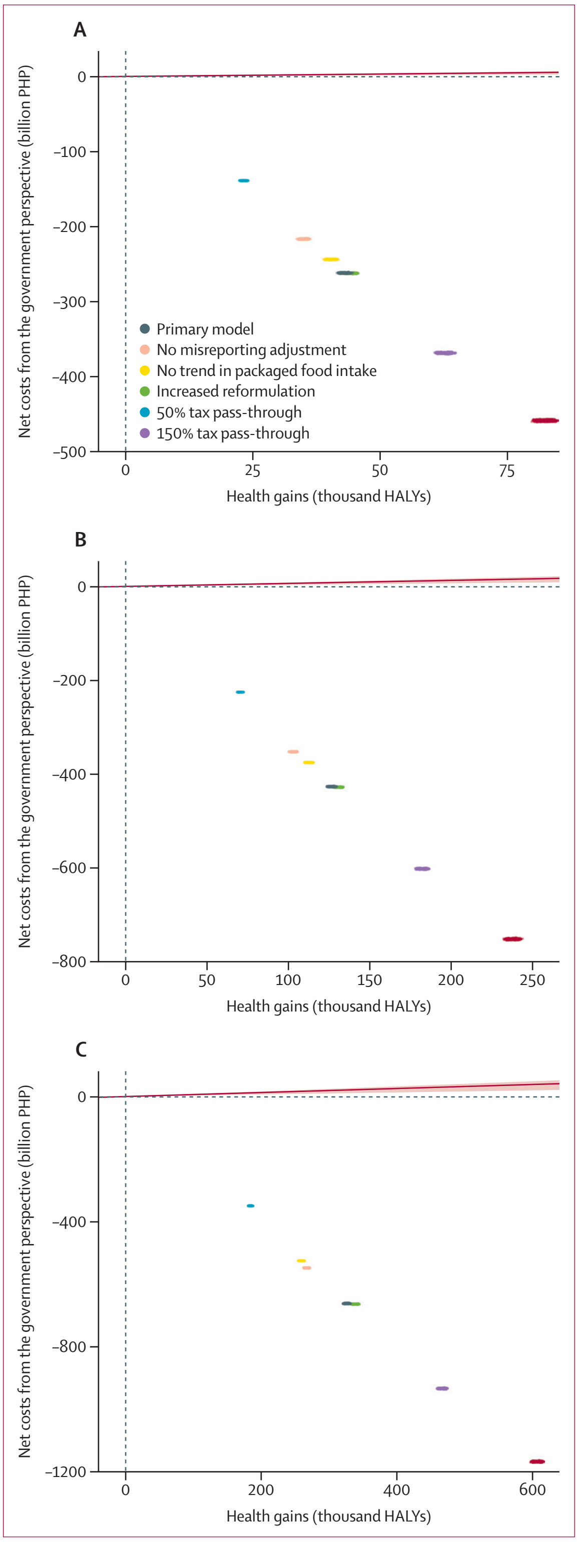

Figure 3: Cost-effectiveness plane showing net costs and HALYs gained from a government perspective under base-case and sensitivity scenarios
(A) Net costs and HALYs gained over the first 5 years. (B) Net costs and HALYs gained over the first 10 years. (C) Net costs and HALYs gained over 20 years. Each point represents a scenario-specific estimate of net cost and HALYs gained. The dotted line indicates the Philippines' cost-effectiveness threshold (PHP 64 282 per HALY gained [95% CI 32 810–81 501]). Points in the upper right quadrant but below the threshold represent scenarios that are cost-effective, and scenarios with positive health gains and negative net costs are considered cost saving. HALY=health-adjusted life-year. PHP=Philippine pesos.

Discussion

To our knowledge, this study is the first to model the health and economic impact of a nutrient-based tax on unhealthy packaged foods in an LMIC, using the Philippines as a case study. Over 20 years, the tax was estimated to reduce sodium and sugar intakes from packaged foods, avert thousands of cardiovascular disease and type 2 diabetes cases and deaths, and generate substantial health gains and fiscal savings. The policy was cost-effective from an extended health-care perspective and cost saving from a government perspective. Although the number of deaths averted is small relative to national mortality, the policy delivers measurable health and fiscal gains in preventable, diet-related diseases at low cost.

Our study addresses a major evidence gap on the effectiveness of nutrient-based food taxes in an LMIC context. Most previous studies focused on sugar-sweetened beverages in high-income countries and typically examined either health or economic impacts.[7,8]

Several modelling studies, including from LMICs such as Mexico and South Africa, have shown that taxes on unhealthy foods or beverages can reduce cardiometabolic disease burden and be cost-effective or cost saving (appendix p 14). Our study extends previous models by simulating a broader, nutrient-based tax beyond sugar-sweetened beverages,[7] incorporating both reformulation and consumer response, applying income-stratified price elasticities, estimating outcomes by wealth group to assess equity implications, and basing the analysis in an LMIC setting. By targeting both sodium and sugar, which affect different risk pathways (sodium through blood pressure to cardiovascular disease and sugar through BMI to type 2 diabetes and cardiovascular disease), the policy might offer broader health benefits than taxes focused on a single nutrient. Including implementation costs and showing cost-effectiveness strengthens the policy case while the finding that tax revenue accrues primarily in early years offers new insights into the timing of fiscal returns from unhealthy food taxes, with implications for political feasibility and support.[32,33]

A key innovation is using the WHO NPM to define tax eligibility. NPMs provide evidence-based criteria to identify unhealthy foods and are already promoted by WHO to guide front-of-pack labelling, marketing restrictions, and procurement policies. In taxation, they allow nutrient-based measures that incentivise reformulation and reduce unhealthy food consumption. Our results show the feasibility and potential effect of NPM-based policies in an LMIC context.

The distributional effects of the policy suggest modest pro-equity effects. The greatest share of HALYs gained was concentrated in the three middle-income wealth quintiles, who benefited from meaningful reductions in both sodium and sugar. This pattern likely reflects a combination of nutrient-specific intake patterns and baseline risk factor levels, with higher-income groups experiencing larger sodium reductions (due to higher baseline intake), while lower-income groups had greater sugar reductions (reflecting stronger price responsiveness). As a result, the wealthiest quintile had the fewest health gains, despite bearing the largest tax burden. These findings suggest that appropriately designed nutrient-based taxes need not be regressive and might promote equity by delivering health benefits to those at greatest risk. This aligns with broader literature on the role of fiscal policies in advancing both health and financial protection.[8]

Although the tax targeted both sodium and sugar thresholds, its estimated effect was greater for sodium intake than for sugar intake. This is partly because the existing sugar-sweetened beverage tax already addresses a major source of sugar intake, limiting the additional effect of the modelled packaged food tax on sugar. Nonetheless, the intervention could still result in meaningful reductions in overall sugar intake, particularly given the increasing consumption of packaged foods. Because sugar is linked to both type 2 diabetes and cardiovascular disease, even modest reductions in intake translated into a substantial impact on overall disease incidence.

Our findings also highlight the robustness of the modelled policy under implementation constraints. For example, the tax generated substantial health gains and tax revenue even under a conservative 50% pass-through scenario. This finding is consistent with real-world evaluations in Mexico, where partial pass-through of a sugar-sweetened beverage tax, particularly for non-carbonated drinks, was still associated with substantial reductions in purchases.[34] These results suggest that nutrient-based food taxes can remain effective even when price transmission to consumers is incomplete, reinforcing their potential as a scalable intervention in LMIC settings.

Consumer response to price increases resulting from the tax was the primary driver of its estimated effect, whereas reformulation contributed more modestly. Notably, expanding the feasible reformulation range from 50% to 100% above the NPM thresholds had only a minor effect on health outcomes. This suggests that many taxed products exceed the thresholds by a wide margin, making reformulation less feasible under current conditions. To support reformulation, governments could consider gradually lowering nutrient thresholds over time, although the feasibility and effectiveness of this approach remain uncertain.

This study has several strengths. We used nationally representative dietary intake and price data linked to a local food composition database. We estimated long-term trends of nutrient intake and explicitly modelled effects on both reformulation and consumption. We stratified outcomes by sex and wealth quintiles and conducted several sensitivity analyses to assess the robustness of our findings.

Limitations of our study include reliance on food category-level nutrient data rather than brand-specific values, which might underestimate reformulation potential and substitution effects, such as switching to untaxed but equally unhealthy alternatives.[35] Saturated fat was excluded due to data limitations, but could be considered in future tax designs. Added sugar could not be modelled separately from total sugar due to data limitations. However, most taxed products belonged to categories high in added sugars (eg, cakes and chocolate), rather than packaged food categories low in added sugars (eg, fruits and vegetables). Therefore, reductions in total sugar intake likely reflect reductions in added sugars. Use of a single 24-h dietary recall and uniform misreporting adjustment across all food categories might have reduced sensitivity and underestimated usual intake. We assumed that any increase in sodium and sugar from packaged foods would be offset by reductions from other sources, resulting in no change in total intake.

If total intake were to increase, the tax could yield even greater health and economic benefits than estimated.

We modelled reductions in disease incidence only, not case fatality (defined here as the probability of death from the disease among individuals with the disease), which might lead to underestimation of the total health effect. An analysis of the Salt Substitute and Stroke Study found that the sodium reduction intervention lowered both recurrent and fatal stroke among individuals with previous stroke, suggesting a potential survival benefit not captured in our model.[36] The economic analysis included only hospitalisation costs for type 2 diabetes, ischaemic heart disease, and stroke, excluding non-hospital costs, costs for other diseases, and indirect costs, such as productivity losses. These exclusions might underestimate the full economic benefit of the policy. Implementation costs were adapted from data on taxes on sugar-sweetened beverages in the USA and might not reflect the Philippine context. Our model did not include costs to industry associated with product reformulation, as the analysis was conducted from a government and extended health-care perspective. Moreover, relatively few taxed products exceeded nutrient thresholds by margins that would make reformulation feasible, and such costs would likely be modest and one-time.

Due to an absence of stratified data, we assumed equal disease incidence and mortality across wealth quintiles, which might underestimate benefits among poorer groups and overestimate them among wealthier groups. This assumption of equal distribution also limited our ability to compare Gini coefficients before and after the tax using absolute HALYs by quintile, as uniformly distributed baseline HALYs yield a Lorenz curve with a Gini coefficient of zero. Data from the PURE study[37] suggest cardiovascular mortality in middle-income countries was nearly twice as high in the poorest compared to the wealthiest populations. Future work should incorporate more granular socioeconomic data and explore open cohort-based models to capture changing risk and policy response.

Overall, these findings provide strong support for implementing nutrient-based food taxes as a tool to improve population health and reduce costs related to non-communicable diseases in LMICs. Moreover, they can enhance the cost savings of existing fiscal interventions, such as taxes on sugar-sweetened beverages. Our findings also strengthen the case for integrating NPMs into fiscal policy frameworks, ensuring that taxes are evidence-based, targeted, and aligned with other nutrition interventions. As more LMICs consider fiscal measures to address diet-related disease burdens, this study offers a practical, scalable, and equity-sensitive policy model.

In conclusion, a nutrient-based tax on packaged foods high in sodium or sugar could reduce the burden of diet-related diseases in the Philippines, generate substantial government revenue, and reduce health inequities. By integrating dietary changes, health outcomes, economic impacts, and equity considerations, our study offers a framework for evaluating similar policies globally. These findings support targeted nutrient-based food taxes as a cost-effective or even cost saving strategy for governments to reduce disease burden, promote equity, and raise revenue in LMICs.

Contributors

AS, ADK, CJC, LS, LKC, MEH, LJA, IA-A, and MM contributed to the conception and design of the study. AS, ADK, CJC, EAG, JPD, MEH, and MM contributed to data collection. MM and AS conducted the analysis. LJA and IA-A provided supervision. MM, AS, and ADK drafted the original manuscript. AS, ADK, CJC, EAG, JPD, AJDD, EBF, LS, LKC, MEH, LJA, IA-A, and MM reviewed and edited the manuscript. AS and MM directly accessed and verified the underlying data. All authors had access to all the data and were responsible for the final decision to submit the manuscript for publication.

Declaration of interests

ADK reports grant support from Resolve to Save Lives in support of the present work; and grant support from WHO–Alliance for Health Policy and Systems Research, WHO–NCD Platform, Oak Foundation, GHR Foundation, Opioid Industry Document Archive, and Bloomberg Philanthropies–Bloomberg Initiative for Global Road Safety; and honoraria from Johns Hopkins University, all outside of the present work. LJA reports grant support from the National Institutes of Health, Sheikh Khalifa Stroke Institute, and Cigarette Restitution Fund of Maryland; consulting fees from GiveWell; and payments or honoraria from Wolters Kluwer, Cardiometabolic Health Congress Symposium, and Controversies to Consensus in Diabetes, Obesity and Hypertension, all outside of the present work. MM reports grant support from WHO and consulting fees from GiveWell, both outside of the present work. All other authors declare no competing interests.

Data sharing

All data relevant to the study are included in the Article. Original data are available on request and approval. Requests for data should be directed to Matti Marklund at Johns Hopkins Bloomberg School of Public Health, and will be reviewed by the research team in accordance with the data sharing policies of Johns Hopkins Bloomberg School of Public Health.

Acknowledgments

This study was supported by Resolve to Save Lives funded by Bloomberg Philanthropies. We thank Neha Khandapur for assistance with food categorisation. During the preparation of this work the authors used ChatGPT-4o (OpenAI) to improve readability and clarity in limited parts of the manuscript. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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