ASSESSING THE IMPACT OF HUNGARY'S PUBLIC HEALTH PRODUCT TAX: AN INTERRUPTED TIME SERIES ANALYSIS

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SUMMARY

Objectives: Imposing taxes on unhealthy goods can generate income, raise people's health awareness, and eventually decrease the prevalence of chronic diseases. Our aim was to assess the impact of Hungary's public health product tax (PHPT) since its implementation in September 2011. Differences in purchasing habits between households with different income statuses were also compared.

Methods: A retrospective, descriptive analysis of tax bases and income was carried out, and an interrupted time series analysis using the generalised least squares method was performed to examine the changes in trends regarding the purchase of taxable products before and after the implementation of the tax. The amount of tax base (in kilograms or litres), income (in HUF and EUR), and annual purchased quantity of food and beverage groups per household were assessed. Data were derived from the National Tax and Customs Administration of Hungary and the Hungarian Household Budget and Living Conditions Surveys. The study sample was composed of households who participated in the surveys (mean = 8,359, SD = 1,146) between 2006 and 2018.

Results: The households' tax bases and incomes increased constantly (with a few exceptions). The total revenue was 19.49 billion HUF (67.37 million EUR) in 2012 and 59.19 billion HUF (168.55 million EUR) in 2020. However, the households' purchasing habits did not change as expected. A significant short-term decrease (between 2012 and 2013) in purchasing unhealthy goods was observed for three groups: soft drinks ($p = 0.009$), jams ($p = 0.047$), and fruit juices ($p = 0.038$). Only soft drinks showed a significant decreasing trend in the post-intervention period between 2012 and 2018 ($p < 0.001$).

Conclusions: We concluded that the PHPT did not decrease households' unhealthy food purchasing trend, although it has a positive effect as it can create revenue for health care and health-promoting programmes.

Key words: public health, food and beverages, taxation, Hungary

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INTRODUCTION

Resource scarcity has been a great issue for healthcare systems. The World Health Organization (WHO) has drawn attention to the need for innovative finance mechanisms for sustainability (1). Imposing a tax on goods related to unhealthy consumption (e.g., beverages with high sugar content, junk food, alcohol, and tobacco) could be even more effective since it could simultaneously generate resources, raise health awareness, and eventually decrease the number of chronic diseases (2–5).

It is known that an individual's behaviour and shopping habits can be altered by governmental actions (6). The essence of Pigouvian taxes on unhealthy food or nutrients is the internalisation of the costs raised by their harmful effects (7, 8). Several countries have already developed such a levy (9–11). Evidence shows that such political decisions could contribute to a decrease in the consumption of unhealthy products, thus improving the overall status of public health, the ability to work and reduce health expenditures (7). Nation-level action plans and programmes are used worldwide to fight non-communicable diseases (NCDs). Tax bases usually derive from risk factors of NCDs with a high prevalence (tobacco, alcohol, added sugar). Regarding a public health tax, evidence shows that they most likely apply to beverages with high sugar content; however, some countries extend the tax base to other products.

Raising health awareness with taxes can be achieved in other ways, for instance by helping to organise health-promoting programmes with the aid of tax benefits or reducing the burden placed on useful (healthy) services and products. Lowering the value-added tax (VAT) rates of healthy foods could be an efficient solution for people with lower income or education. According to the European Public Health Alliance, ten European countries have already reduced their VAT rates on fruits and vegetables to the minimum levels allowed by the European Union (12).

Several chronic diseases can be developed by poor dietary habits, and excessive body weight is a serious risk factor for type 2 diabetes, cardiovascular diseases, and several types of cancers. The average BMI of Hungarian adults rose (25.07–27.52), as did

the prevalence of obesity (24.87%–27.38%) between 2011–2016 (13). Therefore, Hungary introduced public health product tax (PHPT) in September 2011 (14, 15). Its main goal was to improve the population's health status by changing their dietary habits, finance health-promoting programmes through PHPT benefits, and create revenue – primarily to fund the long-awaited increase of health workers' wages (16–18). Despite other countries' tax systems, PHPT is levied on a uniquely broad spectrum of goods, which are taxable when their sugar, salt, methyl-xanthine, or alcohol content is above a certain level. The tax rate is determined in either kilogram/Hungarian forints (HUF) or litre/HUF. Table 1 shows an exact list of groups and the conditions of taxation.

Our study aims to assess the effect of Hungary's public health product tax on the household-level purchasing of unhealthy food products. We believe our findings might help other countries to establish or reform their policy for a sustainable, profitable, and educational public health tax system.

MATERIALS AND METHODS

We assessed the impact of PHPT through two datasets. First, we analysed the amount of tax bases (in kilogram or litre) since PHPT implementation, as well as the amount of tax (in HUF and EUR). Data were derived from the National Tax and Customs Administration of Hungary and the National Institute of Health Insurance Fund Administration for the years 2011–2020.

Second, we measured Hungarian households' trends of purchases based on the Hungarian Household Budget and Living Conditions Surveys. They contain information on consumption and expenditure on goods grouped by the Classification of Individual Consumption by Purpose (COICOP). The selected households are divided into 24 subsamples, in which people are obliged to record the amount of money spent on every purchase for two weeks; in this way, representative, annual per capita data can be captured. The number of participating subjects was 8,359 (SD = 1,146), on average, between 2006–2018. We compared purchases of the first (lowest income) and fifth (highest income) quintiles as well. The first quintile represented 14.53% (SD = 0.63%), while the fifth represented 24.54% (SD = 2.31%), of the sample.

The effect of PHPT on dietary habits is presented through the annual amount of purchased products in kilograms or litres. It is important to highlight that the method of data collection did not allow for measuring every food group as seen in Table 1, as it differs from the COICOP groups.

The interrupted time series analysis (ITS) was conducted with the generalised least squares method. ITS is a widely used quasi-experimental analysis when randomised trials cannot be conducted, but the impact of an (most likely public health) intervention must be measured (19–22). In ITS, two separate regression lines are present pre- and post-intervention trends of the selected indicator. In this study, the equation of a linear trend goes as:

$$quantity_{jt} = \beta_0 + \beta_1 * time_t + \beta_2 * level_j + \beta_3 * trend_{jt} + \varepsilon_{jkt},$$

where j is status (0 = pre-tax, 1 = post-tax); t is the number of years (starting year = 1); β_0 is the intercept; β_1 is the slope for pre-intervention trend; β_2 shows the immediate level change after implementation; while β_3 adds trend change in the post-tax period.

When using a control group to rule out other factors influencing the change in the analysed indicator, the following equation is used:

$$quantity_{jkt} = \beta_0 + \beta_1 * time_t + \beta_2 * group_k + \beta_3 * group_k * time_t + \beta_4 * level_{jt} + \beta_5 * trend_{jt} + \beta_6 * level_{jt} * group_k + \beta_7 * trend_{jt} * group_k + \varepsilon_{jkt},$$

where, besides the above-mentioned variables, two additional values show the level and slope difference between the intervention and control group before (β_2, β_3) and after intervention (β_4, β_5), and the relative changes depending on the values of the control indicator (β_6, β_7).

Time series were tested with autocorrelation (ACF) and partial autocorrelation functions (PACF) and were corrected with the appropriate AR(p) model when it was necessary.

As stated by a recommendation of the Effective Practice and Organisation of Care (EPOC) Group, ITS can be conducted when there are at least three time points before and three after an intervention, to define two regression lines (23). As Hungary introduced the PHPT in September 2011 and we assessed annual data, also the number of taxed products was fewer until January 2012, this was considered as a pre-tax year; thus, 2006–2011 shows pre-tax trends, while 2012–2018 shows post-intervention trends (2006–2014 and 2015–2018 for alcoholic beverages).

We selected the analysed COICOP groups based on the following criteria. First, data on purchased quantity had to be available (direct consumption was not measured; therefore, the annual purchased quantity was used as a proxy for consumption). Second, the selected COICOP groups had to include taxed goods of a large proportion. The law has covered alcoholic drinks only since 2015, and only a few types of these drinks are subject to PHPT (beer and wine are exceptions); thus, we assessed the impact of the tax on alcoholic drinks using only data on spirits. Finally, we selected the following COICOP groups for analysis (codes appear as presented by the Hungarian Central Statistical Office): cocoa powder (01.2.1.3.0), jam (01.1.8.2.1), processed (chipped) potatoes (until 2015: 01.1.7.9.0; since 2015: 01.1.7.4.2. and 01.1.7.5.0 – chips), soft drinks (until 2015: 01.1.2.2.0; since 2015: 01.1.2.2.1), syrups and concentrates (01.2.2.3.2), fruit juices (01.2.2.3.1), and spirits and liquors (02.1.1.1.0).

Due to a decrease in the number of households participating in the surveys, the annual purchased quantity per household was calculated and used for our analysis. We calculated our results by R 3.5.3 software.

RESULTS

Analysis of Tax Bases and Income

The PHPT represents an ever-growing income source for the Hungarian healthcare system. The total revenue was 59.19 billion HUF (€168.55 million) in 2020, which is roughly equal to the annual dental or ambulatory care expenditures of the same year.

The ratio of products to each other did not change significantly in the assessed years; however, both the tax base and income increased every year since 2013 (Fig. 1).

Only sugared cocoa powder, condiments, jam, flavoured beers, and soft drinks showed a slight decrease in purchasing (Fig. 2). The amount of the PHPT income from food rose slightly over the years, but the ratio of one to another was roughly the same every year. Tax base of prepacked sweetened products (mean =

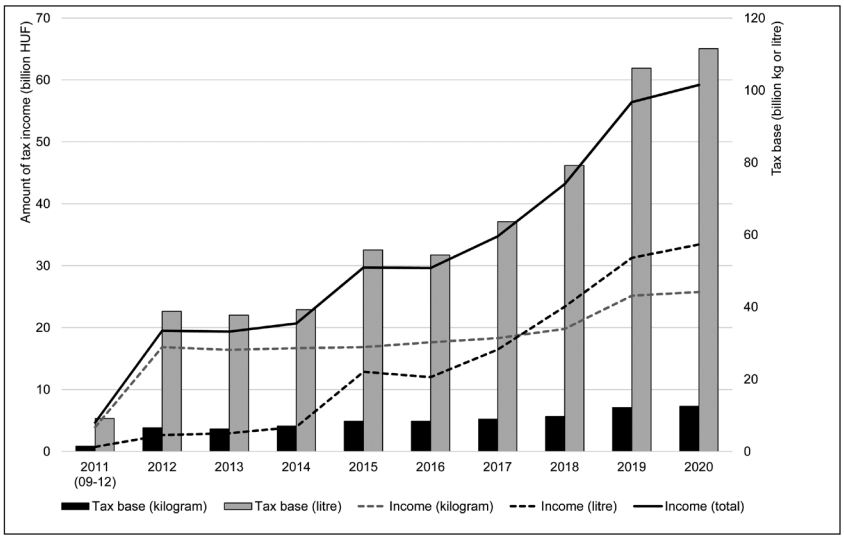

Fig. 1. *Tax base and amount of tax income between 2011–2020.*

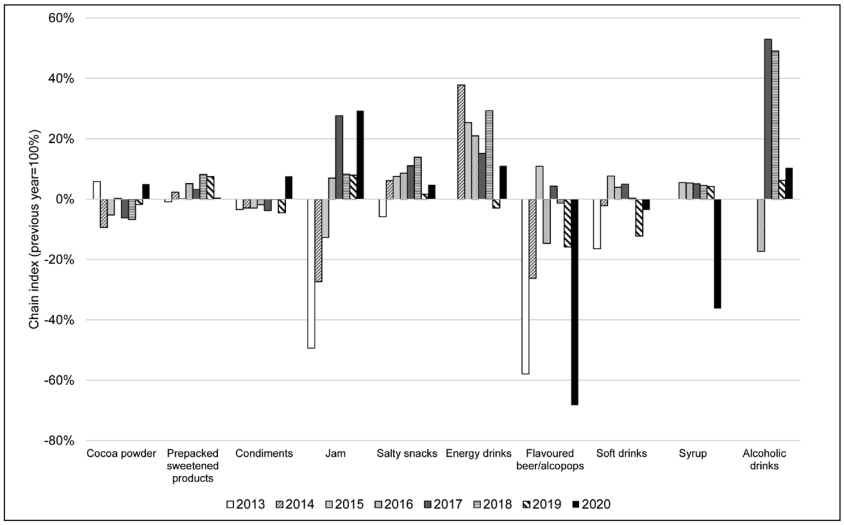

Fig. 2. *Chain indexes based on the quantity of taxable product bases between 2013–2020.*

Outliers (energy drink in 2013, syrup in 2013–2014) were not presented.

73.22%, SD = 1.58%) has the highest proportion within foods, which is followed by salty snacks (mean = 13.69%, SD = 1.32%), condiments (mean = 9.86%, SD = 1.30%), sugared cocoa powder (mean = 3.54%, SD = 0.63%) and jam (mean = 0.09%, SD = 0.04%). When looking at beverages, soft drinks accounted for 84.50% (SD = 9.91%), on average, of all tax bases measured in litres; this number is 5.85% (SD = 1.96%) in alcoholic drinks, 1.02% (SD = 0.67%) in flavoured beers and alcopops, and 0.85% (SD = 0.51%) in syrups. The government substantially raised tax income of beverages in 2013, when the scope of the legislation was extended to energy drinks with 15 mg/100 ml methyl-xanthine content, and again in 2015 when alcoholic drinks became taxable. The tax base of energy drinks grew 36 times larger, and its income increased fivefold as a result of the extension. In 2015, the PHPT on alcoholic beverages was implemented; since then, it has provided 4–8% of the annual tax base, on average. Here we can see the biggest difference between the ratio of the tax base and income: despite its relatively low proportion, the alcoholic beverages group is the second most gainful product after soft drinks, bringing in as much as 8.35 billion HUF (€26.95 million) in 2015. There was a slight decrease in 2016: purchasing taxable items seemed to decrease by 17%. However, this would not become a trend; since then, income reached over 22 billion HUF (€69.00 million) – this meant 73.89% of beverages and 41.72% of total income in 2020.

Taxpayers have had a chance to reduce their tax liability by no more than 10%, which benefit is applied to organising health prevention and health promotion programmes. Since 2018, benefits can only be offered to finance programmes set up by the National Institute of Pharmacy and Nutrition of Hungary. As a result, it provided more than 2.5 billion HUF (€7.99 million) to help create such events so far.

Consumption Trends – Time Series Analysis

The β values shown in Table 2 are based on quantities (kilograms or litres). The first column shows the base levels (calculated), followed by the base trends (annual average changes in the

Table 1. *Rates of taxable products in Hungary in HUF and EUR*

Groups	Unit	Tax rate per unit							
		2011 (09–12)		2012–2018		2019 –		2022 (07) –	
		HUF	EUR	HUF	EUR	HUF	EUR	HUF	EUR
Sugared cocoa powder (sugar: > 40 g/dkg)	kg	100	0.31	70	0.22	85	0.26	–	–
Prepacked sweetened products (sugar: > 25 g/dkg or > 40 g/dkg and cocoa: < 40 g/dkg and milk: < 50%)	kg	100	0.31	130	0.40	160	0.49	210	0.52
Prepacked sweetened products (sugar: < 25 g/dkg or < 40 g/dkg cocoa and milk: > 50%)	kg	–	–	–	–	–	–	65	0.16
Prepacked sweetened products (sugar: > 40 g/dkg and < 40 g/dkg cocoa)	kg	–	–	–	–	–	–	110	0.27
Prepacked sweetened products (sugar: < 40 g/dkg and cocoa: < 40 g/dkg)	kg	–	–	–	–	–	–	40	0.10
Prepacked sweet or salty pasta (sugar: > 25 g/dkg or salt: > 1 g/dkg)	kg	–	–	–	–	–	–	210	0.52
Prepacked sweet or salty pasta (sugar: < 25 g/dkg)	kg	–	–	–	–	–	–	65	0.16
Nuts (sugar: > 15 g/dkg, unless contains > 8 g/dkg fibre)	kg	–	–	–	–	–	–	210	0.52
Nuts (sugar: < 15 g/dkg, unless contains > 8 g/dkg fibre)	kg	–	–	–	–	–	–	65	0.16
Condiments (salt: > 5 g/dkg)	kg	200	0.62	250	0.77	300	0.93	390	0.96
Jam (sugar: > 35 g/dkg)	kg	–	–	500	1.55	600	1.86	780	1.93
Jam (sugar: < 35 g/dkg)	kg	–	–	–	–	–	–	260	0.64
Salty snacks (salt: > 1 g/dkg)	kg	200	0.62	250	0.77	300	0.93	390	0.96
Energy drinks (methylxanthine: 1 mg/100 ml or taurine: 100 mg/100 ml)[a]	kg	250	0.77	250	0.77	300	0.93	390	0.96
Energy drinks (methylxanthine: > 15 mg/dl)	l	–	–	40	0.12	50	0.16	65	0.16
Flavoured beer and alcopops (sugar: > 5 g/dl)	l	–	–	20	0.06	25	0.08	33	0.08
Flavoured beer and alcopops (sugar: < 5 g/dl)	l	–	–	–	–	–	–	10	0.02
Syrup (sugar: > 8 g/100 ml, fruit: < 25%)[b]	l	–	–	200	0.62	240	0.74	310	0.77
Syrup (sugar: < 8 g/100 ml, fruit: < 50%)	l	–	–	–	–	–	–	105	0.26
Soft drinks (sugar: > 8 g/100 ml, fruit: < 25%)[b]	l	5	0.02	7	0.02	15	0.05	23	0.06
Soft drinks (sugar: < 8 g/100 ml, fruit: < 50%)	l	–	–	–	–	–	–	8	0.02
Alcoholic drinks (v/v: 1.2–5%)[c]	l	–	–	20	0.06	25	0.08	–	–
Alcoholic drinks (v/v: 5–15%)[c]	l	–	–	100	0.31	120	0.37	–	–
Alcoholic drinks (v/v: 15–25%)[c]	l	–	–	300	0.93	360	1.12	–	–
Alcoholic drinks (v/v: 25–35%)[c]	l	–	–	500	1.55	600	1.86	–	–
Alcoholic drinks (v/v: 35–45%)[c]	l	–	–	700	2.17	850	2.64	–	–
Alcoholic drinks (v/v: > 45%)[c]	l	–	–	900	2.79	1,100	3.41	–	–

[a]As of July 2022: contains either methylxanthine, taurine, ginseng or L-arginine; [b]as of July 2022: 50%; [c]alcoholic drinks have been taxed since 2015

product group's quantity bought by a household between 2006 and 2011). The third column contains the level changes, which state the immediate effect of the tax on shopping habits between 2012 and 2013. Finally, the trend changes of the post-intervention period (2012–2018) are in the fourth column.

For instance, soft drinks showed a small but continuous decreasing trend among the total household sample, and both assessed income quintiles before 2012, after which a significant drop followed it after the first year of the PHPT implementation. From then on, we observed a somewhat larger decreasing trend for the following years. Of the seven analysed groups, the levels of four reduced immediately after taxation, three of which were significant: soft drinks ($p = 0.009$), jams ($p = 0.047$), and fruit juices ($p = 0.038$). Only soft drinks showed a significant decreasing trend in the post-intervention period ($p < 0.001$). Based on the purchasing habits of different income groups, these groups tended to react differently to the PHPT, although the annual average changes of these goods were roughly the same during the pre-intervention period.

DISCUSSION

Taxes on unhealthy food and beverages have become a part of many countries' fiscal policies. Countries tax sugary drinks the most often, while extension of taxes to harmful food is less

Table 2. *Results of interrupted time series analysis*

COICOP groups	Unit	β (SE)			
		Base level	Base trend	Level change	Trend change
Processed potato	kg	2.32 (0.23)	−0.02 (0.06)	−0.51 (0.27)	0.26 (0.07)**
First quintile	kg	2.39 (0.45)	−0.05 (0.12)	−0.29 (0.53)	0.42 (0.14)*
Fifth quintile	kg	2.32 (0.23)	0.05 (0.06)	−0.96 (0.28)**	0.19 (0.07)*
Cocoa powder	kg	1.28 (0.12)	−0.03 (0.03)	0.14 (0.15)	0.02 (0.04)
First quintile	kg	1.51 (0.19)	−0.03 (0.05)	−0.09 (0.23)	−0.02 (0.06)
Fifth quintile	kg	0.88 (0.05)	0.01 (0.01)	−0.21 (0.06)*	0.00 (0.02)
Jam	kg	3.25 (0.20)	−0.19 (0.05)**	−0.54 (0.23)*	0.10 (0.06)
First quintile	kg	2.88 (0.22)	−0.11 (0.06)	−0.65 (0.26)*	0.03 (0.07)
Fifth quintile	kg	3.57 (0.07)	−0.23 (0.02)***	−0.20 (0.09)	−0.08 (0.02)**
Soft drinks (carbonated)	l	93.46 (2.55)	−4.46 (0.66)***	−10.11 (3.07)**	−4.98 (0.73)***
First quintile	l	133.58 (7.42)	−8.22 (1.90)**	1.58 (8.86)	4.92 (2.43)
Fifth quintile	l	65.39 (1.63)	−1.17 (0.42)*	−18.13 (1.96)***	2.75 (0.46)***
Syrup	l	3.74 (0.19)	0.01 (0.05)	0.03 (0.24)	0.03 (0.06)
First quintile	l	5.53 (0.98)	0.00 (0.25)	2.34 (1.17)	−0.48 (0.32)
Fifth quintile	l	2.45 (0.37)	0.07 (0.10)	−0.43 (0.45)	0.09 (0.12)
Fruit juice	l	44.78 (1.93)	−2.45 (0.50)***	−5.60 (2.30)*	2.55 (0.63)**
First quintile	l	37.49 (3.69)	−2.55 (0.95)*	−4.14 (4.40)	3.42 (1.21)*
Fifth quintile	l	50.69 (2.70)	−2.15 (0.69)*	−8.55 (3.22)*	−2.24 (0.88)*
Spirits	l	2.12 (0.10)	−0.11 (0.02)***	0.22 (0.19)	0.15 (0.07)*
First quintile	l	1.28 (0.11)	−0.07 (0.02)**	0.56 (0.20)*	−0.02 (0.06)
Fifth quintile	l	3.02 (0.24)	-0.13 (0.04)*	0.15 (0.45)	0.17 (0.15)

COICOP – classification of individual consumption by purpose; *p < 0.05; **p < 0.01; ***p < 0.001; β values are based on annual amount of quantity purchased (in kilograms or litres); SE – standard error

common. Hungary's 2011 introduction of the PHPT is a good example of a uniquely broad set of products that generate income every year that almost always exceeds budget drafts. Most tax bases and income show a positively growing trend since 2011 (with a few exceptions).

Choosing the optimal tax rate is the key to maintaining this form of public health policy (24). A high rate leads to dissatisfaction and eventually encourages people from buying taxable products abroad, and it can lose both its educational and economical purposes. A low rate cannot change consumer habits, although, if administrative costs are not too high, it can be perpetuated as a revenue source.

The direction of income use can also be a part of a tax's success. If the generated revenue is spent specifically on dealing with health issues, consumers accept an even higher tax rate (25–27).

The authors should acknowledge some limitations of this study. First, we were unable to analyse only the taxable food groups due to the available data set, as it differs from the COICOP food groups. Second, we could not assess some products that included many taxable victuals due to the COICOP nomenclature structure; for instance, data on other alcoholic beverages, such as alcopops, have been gathered separately only since 2015. Also, it is worth mentioning that other factors that might have had an impact on the results, such as some possible changes in the demographic or socioeconomic conditions of the samples.

An impact assessment of WHO summarised four key points for improving PHPT effectiveness: help the tax to achieve its goal by organising health programmes, especially among vulnerable groups; reducing the price of healthy foods; further increase PHPT rates; and continuous monitoring of the effect of the tax (28–29). First, health-promoting events financed from PHPT benefits have been organised since 2016 in Hungary. As of 2019, all programmes are coordinated by one national body. Second, the VAT of several food types decreased in the previous years – poultry, meat, fish, eggs (27%), and fresh milk (18%) fell to 5% evenly. Third, PHPT rate grew by 20% on average in 2019, while tax base was widened with other, previously tax-free spirits. The rate imposed on soft drinks, which accounts for the largest proportion of tax bases, was increased even more. As of July 2022, other products (e.g., pasta, nuts) have become taxed, and for certain food and drink groups, banded taxation has been introduced according to the sugar, fruit or cocoa content, with alcoholic beverages being excluded from the scope of taxed products.

CONCLUSIONS

Analysing the effects of public health interventions – such as the excising of taxes on unhealthy food and beverages – is extremely important. We concluded that taxes such as the PHPT can be an effective tool for revenue generation (30). A relatively low tax rate for a wide range of goods can create stable resources for health care. Nevertheless, the PHPT did not dramatically

reduce the households' shopping habits of unhealthy foods and beverages. Acceptance from the population and sustainability of such levies depends on multiple factors, such as the tax rate or the direction of income use.

Optimising taxes and improving the public health status is always a part of the stakeholders' agenda. It is harder to draw conclusions on the health impact of the PHPT as of now, but it has surely become a steady and ever-growing source for Hungary's healthcare system.

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Conflict of Interests

None declared

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Ethics Approval and Consent to Participate

Neither human participants nor clinical data of participants are involved in the study. De-identified and publicly available secondary statistical data were used on the annual turnover of taxable products coming from the National Tax and Customs Administration of Hungary and the Hungarian Central Statistical Office.

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