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Original Article

Impact of Targeted Subsidies Reform on Household Nutrition: Lessons Learned from Iran

Afsaneh Saeediankia [1], Sara Emamgholipour [2], *Hamed Pouraram [1], Abdoreza Mousavi [2], *Reza Majdzadeh [3,4]

1. *Department of Community Nutrition, School of Nutrition and Dietetics, Tehran University of Medical Sciences, Tehran, Iran*
2. *Department of Health Management & Economics, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran*
3. *School of Health and Social Care, University of Essex, Colchester, UK*
4. *Department of Epidemiology and Biostatistics, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran*

***Corresponding Authors:** Emails: h-pouraram@tums.ac.ir; reza.majdzadeh@essex.ac.uk

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Abstract

Background: In 2010, Iran became the first major oil-exporting country to reduce substantially implicit energy subsidies by increasing domestic energy and agricultural prices by up to 20 times. The current research aims to evaluate the profound impact of the countywide implementation of this targeted subsidy reform (TSR) on the consumption patterns of households in Iran, specifically in relation to the consumption of healthy food commodities.

Methods: This study employed a robust approach to examine the impact of the TSR on household food consumption, as a natural experiment, using pooled cross-section data from the Household Income and Expenditure Survey (HIES) spanning the years 1992 to 2019. The analysis was based on a comprehensive interpretation of survey data, which served as the primary source for analysis. The estimation procedure utilized an interrupted time series (ITS) model to capture the parameters associated with food consumption.

Results: The findings revealed a substantial increase in household expenditures on food immediately following the policy intervention, with an impressive rise of 823 thousand Rials (equivalent to approximately $6.36 based on the floating exchange rate in 2019). Furthermore, the results strongly indicate a significant annual upward trend in total monthly food expenditures per adult person, surpassing the pre-intervention trend by 441 thousand Rials (approximately $3.40) (P=0.044, CI=[12.86, 1016.81]). Moreover, the implementation of the policy led to an annual per capita increase in fruit consumption by 1.02 grams per day (P=0.225, CI=[-0.68; 2.72]).

Conclusion: This study shows that the initial positive effects of the TSR have gradually been eroded by inflation in subsequent years. This experience can serve as a lesson for all countries that TSR should be accompanied by other measures, such as poverty alleviation interventions, in order to achieve desired long-term results.

Keywords: Health policy; Food security; Universal health coverage; Interrupted time series analysis; Iran

Introduction

Nutrition has a determinant role in health, well-being, learning, workplace efficiency, and economic development (1, 2). Many developing countries employ food-price subsidies or controls

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to improve nutrition. However, subsidizing commodities accounting for a higher share of a household's budget can produce great wealth effects. Allocating subsidies in cash for different foods with little nutritional value might undermine initiatives aimed at reducing poor nutrition (3). Subsidy reform suggestions are typically accompanied by generic advice for targeted transfers to support poor and vulnerable groups (4) . Redistributive plans such as subsidies have recently attracted more attention from policy-makers for understandable reasons (5).

Targeted subsidies refer to a reduction or gradual elimination of subsidies for the well-off classes and increment of them for the poor and disadvantaged. Benefits offered by a redistributive program consist of reducing exclusion and inclusion errors as well as leading to fair consequences (6). Cash transfer programs attracted a great deal of attention in terms of alleviating poverty and raising living standards (7). Many governments implement cash transfers for the provision of welfare services, or even for relief purposes. Large multilateral food donors (notably the World Food Program) are piloting cash transfers, and advocates of cash transfers (e.g., the UK's Department for International Development) recognize that food aid continues to have an important role, especially in contexts of commodity market failure (8).

In 2010, Iran initiated an unprecedented economic reform called the Targeted Subsidies Reform. The Targeted Subsidies Reform was widely regarded as the most comprehensive economic "surgery" in Iran's modern history at the time of its implementation. Its primary objective was to address the significant issue of indirect subsidies on energy products, which had been substantial in nature. A revised price structure was introduced for liquid fuels, natural gas, electricity, water, and public transportation. Notably, around 80 percent of Iran's population gained unrestricted access to compensatory payments deposited in dedicated bank accounts. By significantly reducing indirect subsidies and implementing direct energy dividend transfers to the population, Iran became the first major energy-producing and exporting nation to undertake such a transformative reform. This historic undertaking represents a significant milestone in Iran's economic landscape, signifying a paradigm shift in energy subsidy policies that may have implications for other countries (9). Reduced subsidy of fuel products and some commodities coinciding with a continuing increase in their prices was accompanied by a compensatory cash transfer program in which an amount of 455,000 rials (equivalent to about $3.51 in 2019) per month was paid for each citizen unconditionally (10). Composition of the diet could be affected by major economic transitions and changes in purchasing power (11). The welfare implications of pro-poor policy ought to be measured theoretically and empirically and the subsidy on nutrition in not an exception. By virtue of expanding households budget sets, in a revealed preference framework (people are rational and make well-informed decisions) the subsidies must improve welfare regardless of whether they improve nutrition (3). Clear interrelationships between TSR and consumption of food have been acknowledged in some domestic studies revealed that this plan has positive effect on red meat and fish demand (1).

We aimed to address the question of whether the magnitude of subsidy payment to households is sufficient to a substantial improvement in demanding food commodities. Otherwise, the government might only handle this public entitlement by confining the well off with no qualifications and targeting the program to the poor. This study is to examine the effect of TSR on food consumption using time series econometrics models. ITS analysis help attribute the changes in outcomes of interest to an intervention with enormous statistical power. As regards originality, this study, for the first time, introduced a new idea of how the public policy of cash transfer affected society's nutritional measures. In Addition, there was no natural experience to be assessed in this area. Hence, this is an attempt to provide evidence on the marginal effect of the subsidy on the cost of purchasing food items in Iran.

Materials and Methods

Sample description

We used data from Household Income and Expenditure Survey (HIES), including annual information regarding households' expenditures, to assess the nutritional effect of the cash transfer program in Iran over the period 1992 to 2019 (Table 1). The HIES is administered by the Statistical Center of Iran (SCI) and is representative at the national level. Our analysis contains expenditure data from 870,000 households on food and by different commodity groups. The unofficial (floated) exchange rate in 2019 was employed to convert IR Rial to US dollar (1USD = 129,393Rial) (12).

Table 1: Data table to estimate the effect of the implementing Targeted Subsidies Reform (TSR)

Year	*Time since start of implementing the TSR*	*Average food expenditures; Thousand Rials, per household, per month*	*Food consumption; Grams per person, per day*		
			Meat, Poultry, Fish, Eggs, Legumes, and Nuts	Fruits	Vegetables
1992	-17	911	141	177	216
1993	-16	1,114	141	201	244
1994	-15	1,378	140	199	220
1995	-14	1,994	135	190	235
1996	-13	3,042	147	172	227
1997	-12	3,331	121	166	233
1998	-11	3,931	133	168	238
1999	-10	5,149	133	187	245
2000	-9	6,150	133	166	274
2001	-8	6,702	141	168	250
2002	-7	7,265	152	171	270
2003	-6	9,036	177	181	296
2004	-5	10,710	186	182	290
2005	-4	40,939	199	211	321
2006	-3	13,793	199	226	312
2007	-2	14,768	193	191	274
2008	-1	17,465	199	201	286
2009	0	20,070	188	191	288
2010	1	21,214	187	194	291
2011	2	25,327	190	214	282
2012	3	32,237	195	212	276
2013	4	43,920	186	208	272
2014	5	54,519	186	199	261
2015	6	56,080	181	203	268
2016	7	57,396	179	193	256
2017	8	60,038	178	199	270
2018	9	67,731	177	212	267
2019	10	84,045	171	188	256

Study design

An interrupted time series analysis as a quasi-experimental, counterfactual design was applied to evaluate the policy effect on food expenditures. The advantage of ITS in observational data is that this approach controls the effect of time trends on the time series of outcome variables (13).

The study was based on country-level data and the sample included 28 observations (i.e., one per year). Segmented regression analysis of ITS is the most commonly-used model to explore the effect of interventions on an outcome of interest (14). The interruption period was defined in 2010, dividing the sample into two distinct subperiods; before and after the adoption of the intervention (Fig.1).

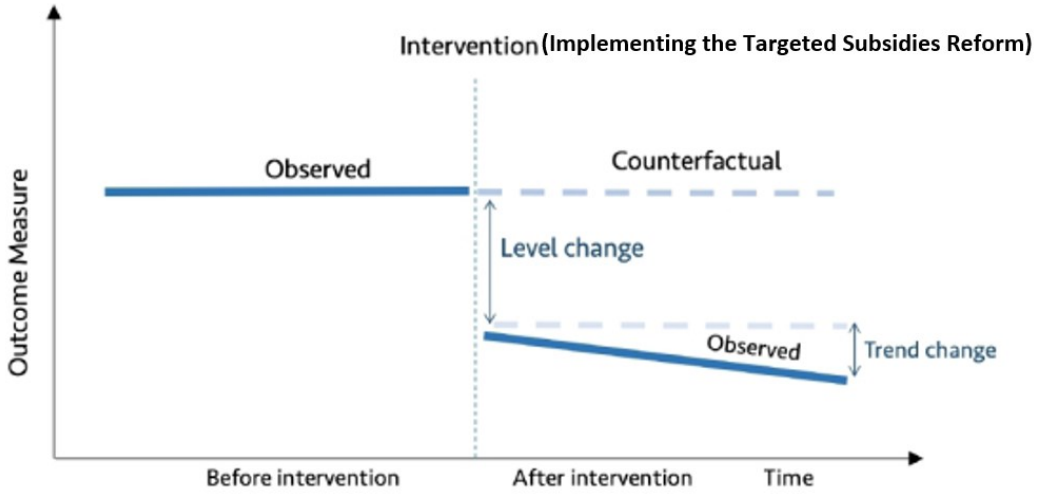

Fig. 1: Diagrammatic representation of single interrupted time series

Statistical Analysis and Diagnostic Assessment

When there is no control group to compare, the single-group ITS regression model assumes the following form:

$$Y\,t = \beta 0 + \beta 1\,timet + \beta 2\,interventiont + \beta 3\,time\,after\,interventiont + et$$

Alternatively;

$$Yt = \beta 0 + \beta 1Tt + \beta 2Xt + \beta 3XtTt + \varepsilon t$$

Where *Yt* stands for outcome variable at time point *t*, Tt for the time since the beginning of the observation period to the last time point, Xt for dummy variable (cash transfer) taking the values 0 occurring before intervention and 1 after the intervention, and *XtTt* for an interaction term (15). Several diagnostic assessments are needed prior to fitting statistical models. The presence of non-stationarity, autocorrelation, and seasonality in time series data can lead to biased estimation, and data should be adjusted for (14). Assessment of Augmented Dickey Fuller (ADF) test in our analysis exhibited stationarized residuals. To do so, we utilized differencing approach in which the series was yielded by subtracting from each time point t1 the value of the previous time point t-1, implying the change of Y. The normality of the residual was checked using the Jarque-Bera test. Findings from the test suggested the presence of normally distributed residuals. We did Newey -West regression to estimate the coefficients. This model which is based on ordinary least squares (OLS) regression allows for the correction of possible heteroskedasticity and autocorrelation in a series (15). We used Actest to test for serial correlation in the time series proposed by Cumby and Huizinga, finding autocorrelation of error terms at lags. Consistency and asymptotic normality of estimators are somewhat more difficult to establish in time-series settings be-

cause results that require independent observations, such as the central limit theorems, are no longer usable (16).

Variables

We obtained HIES data from the SCI. We controlled confounding effects by incorporating some variables in the model. Household income proxied by per capita gross domestic production (GDP) is among the variables having an effect on demand for commodities. The inflation rate as a macroeconomic indicator usually influences other economic variables. Iran has been experiencing higher rates of inflation over the past decade (17). Hence, GDP and 12-month average inflation rate over the study horizon and economic sanctions were included as control variables for the estimation.

Results

Segmented regression was used to estimate the changes in level (intercept) and slope (trend) in the postintervention period compared to the preintervention period. Level change shows the immediate change of outcome variable following the intervention. The term "segmented" implies a model having different intercept and slope coefficients for each interval before and after an intervention. The positive value of slope means that the outcome is increasing, and its negative value suggests it is decreasing.

1. Slope for Food expenditure over the preintervention period had been increasing, but it is not statistically significant ($P \geq 0.05$). In other words, household expenditures on food including different types of meat experienced annual increments. By controlling for confounding in the model, our estimation revealed that household expenditures on food have increased by 823 thousand Rials (about $6.36) right after the intervention. Moreover, these results confirm an increase in the annual trend of total monthly food expenditures after the intervention (compared to the preintervention trend) of 441 thousand rials (approximately $3.40) per adult person ($P=0.044$, CI=[12.86, 1016.81]). In summary, the segmented regression analysis revealed that the TSR did not have any statistically significant effect on the level or trend of the food expenditures in either of the models (Table 2).

2. As the series on the values of Meat, Poultry, Fish, Eggs, Legumes, and Nuts consumption was non-stationary, we transformed the variable under consideration through first differencing to satisfy the stationarity assumption as a crucial element of a time series. However, differencing appears to remove the individual effect. The pattern of their consumption per adult per day showed a reduction following the implementation of allocating cash subsidies.

3. The starting level of fruit consumption was estimated to be 181 gr per adult per day, and it appeared to decrease every year prior to 2010 by about 0.99 gr. In the first year of the intervention (2010), there appeared to be a reduction in per capita fruit consumption of 6.17 gr, followed by a marked increase in the annual trend of per capita consumption (the preintervention trend) of 2.01 gr per year. We also observed that after the adoption of the policy, per capita fruit consumption increased annually at a rate of 1.02 gr per day ($P=0.225$, CI = [-0.68; 2.72]). Furthermore, inflation and sanctions have negative effects on fruit consumption while the per capita GDP led to an increase in it.

4. Consumed vegetables have increased on average by 6.14 gr per year from 1992 to 2010. In contrast, we observed a fall in their intake subsequent to the policy by 9.37 gr. A significant reduction in the annual trend of vegetable consumption was found in the post-policy period. Overall, following the policy, per capita vegetable consumption decreased yearly at a rate of 2.97 gr per day ($P=0.000$, CI = [-4.33; -1.61]). Sanctions and inflation were inversely associated with the outcome variable of interest. Figure 2 examines the effect of the plan enforcement on food intake using the HIES data after controlling for potential confounding variables.

Table 2: Parameter estimates, standard errors and P-values from ITS regression model, (1992-2019)

Expenditure measures	***Intercept(β0)***		***Time(β1)***		***Intervention (β2) (Change in level)***		***Tim_Aft_Int (β3) (Change in slope)***		***Dickey-Fuller (Stationary)***		***Jarque-Bera (Normality)***		***Cumby-Huizinga (Autocorrelation)***	
	Value	*P*	Value	*P*	Value	*P*	Value	*P*	*P*	Result	*P*	Result	*P*	Result
Food	-2060	0.019	73	0.450	823	0.610	441	0.177	0.000	-8.03	0.071	95.55	0.016	Lag 1
Meat	-1.75	0.72	+ 0.8	0.24	5.69	0.51	-1.85	0.13	0.000	-6.240	0.78	0.49	0.15	Lag 1
Vegetables	221.27	0.000	6.14	0.000	-9.37	0.25	-9.59	0.000	0.000	-5.06	0.82	0.39	0.93	Lag 1
Fruits	181.086	0.000	-0.995	0.405	-6.174	0.483	2.016	0.257	0.008	-3.466	0.273	2.593	0.042	Lag 1

P: *P*-Value

Food expenditure t = -30 + 126 $time_t$ + 2210 $intervention_t$ + 269 time after intervention

Food expenditure t = -2060 + 73 $time_t$ + 823 $intervention_t$ + 441 time after intervention + 56 $inflation_t$ -1102 $sanctions_t$ + 0.64 GDP_t

Meat$t$ = 0.74 + 0.25 $time_t$ - 4.36 $intervention_t$ - 0.77 time after intervention

$Meat_t$ = -1.75 + 0.8 $time_t$ + 5.69 $intervention_t$ - 1.85 time after intervention + 0.36 $inflation_t$ -14.81 $sanctions_t$ + 0.01 GDP_t

Vegetables t = 218.40 +5.14 $time_t$ -27.87$intervention_t$ -8.12 time after $intervention_t$

Vegetables t = 221.27 + 6.14 $time_t$ - 9.37 $intervention_t$ - 9.59 time after intervention - 0.17 $inflation_t$ -18. 72 $sanctions_t$ + 0.02 GDP_t

$Fruits_t$ = 177.1228+1.044376 $time_t$ +11.02389$intervention_t$ -2.098921time after $intervention_t$

$Fruits_t$ = 181.068 - 0.995 $time_t$ - 6.174 $intervention_t$ + 2.016 time after intervention - 0.393 $inflation_t$-12. 172 $sanctions_t$ + 0.009 GDP_t

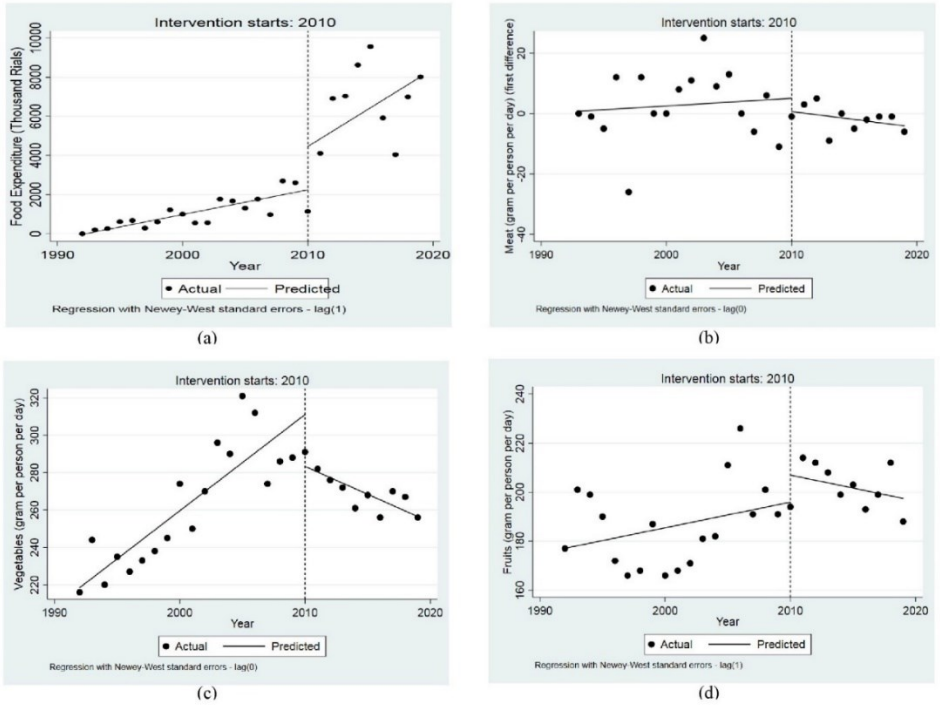

Fig. 2: Effect of implementing Targeted Subsidy Reform (TSR) on food consumption and expenditures before and after the TSR between 1992 and 2019

Discussion

Subsidies are defined as aid a government provides to a private undertaking. This aid includes direct or indirect. Direct aid is in the form of explicit funding (18). Direct cash transfers represent an alternative to target vulnerable populations and poor households to satisfy basic consumption needs. Many developed and developing countries have devised cash transfer plans to improve social protection including food security and consumption and reduce the poverty gap (19). Through TSR, targeted subsidies on sixteen items and services subject to international prices in Iran officially started by eliminating other subsidies. According to this reform, subsidies are supposed to be switched from products to cash payments where households would receive at least 50% of revenues resulting from the reform. This reform became one of the large-scale unconditional cash transfer programs in the world, covering 90% of the population and costing 10 percent of GDP in 2010. The second phase of the plan was to use additional revenues to support higher social benefits and public goods (9).

This study was designed to determine the effects of this cash transfer on household expenditures. We employed a single group interrupted time series analysis. This approach is commonly used to examine how a population-level intervention may affect the changes in slope and level of outcomes over time (20). The segmented regression analysis was estimated at different models with and without confounding variables. The current study found that food expenditures increased after the plan was implemented. To determine the effect of the TSR, Hosseini et al. reported that this plan not only has not been successful in improving urban household food security but also was associated with a marked increase in food insecurity. In addition, they noticed that the plan is linked to an increase in fruit consumption (1), which is consistent with our findings. A possible explanation for this might be the more expensive price of dried fruits as a substitute for fruits, which has made households to purchase more fruits. In accordance with the present results, a study of the effect of a targeted subsidy on the intake of fruits and vegetables in the United States demonstrated that fruit and vegetable intake has increased after the intervention (21).

Inflation has been identified as a major contributing factor to the increase in food expenditure and decreased fruit intake. The subsidy policy itself caused to a higher inflation rate in rural areas as compared to urban ones during some years (22). Data from a survey on the effect of subsidy removal before the implementation of the plan in Iran predicted 25% of inflation in construction and mining, 45% in chemical and 50% of costs in transportations (23). In general, the monthly payment of 455000 rials per person is not sufficient to cover the extra costs of living from removing the subsidies for households. A study investigating the effect of cash transfer programs in some African countries has found that regular and predictable transfer payment may raise the quality and quantity of food, and lower the prevalence of food insecurity, while smaller and irregular payments do not change food expenditure (24). The most obvious finding to emerge from this study is that there was a negative correlation between sanctions and food expenditure, fruit and vegetable consumption (healthy diet). Our model, for instance, predicted that sanctions account for a decline of about 15 gr in daily meat consumption for an adult person. Sanctions was linked to an increase in undernourished populations by 2.915% points (25).

There is some evidence to suggest that US sanctions against Iran have increased severe food insecurity by more than 50% in urban areas. Although the mechanisms through which they exert their effects are complex, higher inflation rates following economic sanctions are a likely explanation for food insecurity (26).

Subsidies payment in the Iranian economy in the current way is a major source of economic problems and reforming it can lead to improvement in living conditions and thereby raises social welfare (27). The data reported here appear to support

the assumption that early gains from TSR have gradually been eroded by inflation over the next years and the plan requires to be supplemented with other supportive social policy measures that are consistent with broader anti-poverty goals. In the same vein, agricultural policies can have an effect on supply and demand factors influencing the price of food and non-food markets; this price, in turn, affects the purchasing power of net buyer households and income of net sellers, and the budget choices of both (28). When reallocating resources, the best use of money in resource-constrained settings is an ongoing and highly disputed debate. In a context of high food price inflation and a fixed money payment, cash recipients would be expected to derive small welfare gains (8). The results obtained from the correlation analysis showed that price subsidies for the poor families in China is not associated with improved nutrition (3). The cash transfer program can be costly; its cost-effectiveness should be evaluated carefully by taking into account the balance between social costs and social benefits over time.

This research has several practical applications. Interrupted time-series is a powerful approach to assessing a policy impact when an experimental analysis is virtually impossible or unethical. In addition, this quasi-experimental design enables the researchers to control for the effect of secular trends in a time series of outcome measures (29). While based on a pre-post design, the outcome changes may incorrectly be attributed to the intervention in the presence of other forces (30). Moreover, there was no evidence of non-stationarity and we corrected for autocorrelation in our models.

A number of important limitations need to be considered in the current study. It was not possible to investigate statistical significance in the association between TSR and food consumption because the sample size was small. Further data collection is required to determine exactly how the plan affects calorie intake. The most important limitation lies in the fact that we do not distinguish between different socio-economic groups to see the impact of the TSR on the most vulnerable social constituencies.

Conclusion

The programs targeted at improving anti-poverty support do not necessarily result in pro-poor growth. The key issue regarding targeted subsidy enforcement is to ensure that it reaches the intended beneficiaries and to preempt shifting resources into other needs or other groups. If it is to target food insecurity, subsidy effects must be viewed in the light of other factors to grant access to healthy diets. Healthy food consumption has decreased over time after the plan, requiring it to be supplemented with other supportive social policy measures consistent with broader anti-poverty goals. The value of cash transfer is not enough to generate a significant improvement in food consumption. Governments could increase the magnitude of cash through restricting eligibility and targeting the program to the poor. However, further study should be done to investigate the effect of such policy on daily calories essential for a healthy life.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

Conflict of interest

The authors declare that there is no conflict of interests.

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