Households' food expenditures in urban areas of Iran: An application of small area estimation

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DOI: 10.2427/12704
Accepted on November 20, 2017

ABSTRACT

Objective: Food is a fundamental factor for human development, and inequalities in nutrition are related to inequalities in health .The purpose of this study was to estimate Household Food Expenditure (HFE) in urban areas of Iran at district-level using small area estimation (SAE) methods.
Design and Methods: We used the Fay-Herriot model, a well-known area-level model of SAE. The main data were the urban data of HFE collected by Statistical Centre of Iran (SCI) in 2013. The environment of our study was urban areas of Iran and the study unit was household.
Results: Findings showed that the average number of rooms in each household, migration rate, proportion of male headed households (PMH) and Proportion of the active population`s employed at the district level had a significant effect on HFE. Differences between aggregated province estimates and estimates reported by SCI were not significant (P=0.609). The lowest and the highest HFE was related to Pishva district with 27,067 thousand Rials (TRs) and Boyer-Ahmad district with 85,175 TRs, respectively.
Conclusions: Small-area estimation is advantageous for surveillance of HFE at the district level. This method allows documentation of geographic disparities and improves our understanding of the spatial distribution of HFE in urban areas of Iran.

Key words: Households' food expenditures, small area estimation, urban area, geographic disparities.

INTRODUCTION

Food is a fundamental factor for human development [1], and inequalities in nutrition are related to inequalities in health [2]. Rising food prices not only decrease the quality of nutrition but also reduce the expenditure on other fundamental needs such as health and education, leading to inequality in food expenditure in different socio-economic groups [3].

According to the Food and Agriculture Organization (FAO) report in 2011, the world's food supply is enough to feed the global population, but there are deep inequalities across countries, towns, and households in terms of accessibility to food [4].The household expenditure data suggest that high-income households pay for most food groups such as fruits and prepared foods more than poorer households [5]. Such studies have found significant relationship between the household food expenditure (HFE) and health status [6,7].

However, households' budgets have been significantly reduced due to the recent economic crisis or the 'Great Recession'. Concurrently, the price of goods, on average, have increased sharply and so has the price of food [8]. Assessment of disparities in the households' food expenditures can help politicians and management executives to distribute food products and other funds equitably [9].

Iran is located in the western Asia, with a climate ranging from arid or semiarid to subtropical along the Caspian coast and the northern forests. The vastness of Iran has caused disparities in the HFE [10]. The Statistical Center of Iran (SCI) carries out an annual household survey to estimate the Iranian rural and urban households' expenditure and income (the Iranian Rural and Urban Households' Expenditures and Income Survey (IRUHEIS)). Since the samples are not optimum for the district level, the SCI reports the results of the survey at province level [11,12]. The aim of this study was to estimate the HFE in the urban areas of Iran (at the district level). For this reason, we need to employ appropriate method such as small area estimation (SAE).

When we have areas with insufficient samples, SAE method can help us to take strength using variables of interest from other areas (related and/or time period's areas) [13].

MATERIALS

Study population and Data source

The annual Iranian Rural and Urban Households' Expenditures and Income Survey (IRUHEIS), is carried out in all provinces of Iran by the SCI. The aim of the survey is to have the estimates related to households' expenditures and income in the province level. In this study we analysed the urban data of IRUHEIS 2013 (between 21 April 2013 and 20 April 2014) [11,12].

Of 18,876 households that participated in the IRUHEIS 2013, we analysed the households with complete data. Thus, the final sample included 18,850 households. The HFE includes all payments made to receive the required nutritious and essential food items including meat, dairy products, cereal and bean, bread and flour, biscuit and cake, oil and butter, fruits and vegetables, nuts, sweets and sugar, additives and dressing, as well as cigarette and tobacco [12].

The data of district-level socio-demographic measures came from the 2011 census of Iran and "less-developed regions identification "project that was conducted by the Iranian Ministry of Interior [14]. District-level variables, including the average number of households, the average number of rooms in each household (ANRH), proportion of male-headed households (PMH), proportion of the active population employed (PAPE), sex ratio, proportion of the population in the age group older than 65 years, 25 to 64 years, 15 to 24 years and younger than 15 years, were obtained from the data of Iran 2011 National Population and Housing Census. We also considered gross domestic products (GDP), proportion of households supported by Imam Khomeini Relief Foundation, distance from province capital, per capita income of municipalities, and migration rate. These data were produced by the ministry of Interior in a project conducted for identification of less developed regions.

We used proper transformation of independent variables to reach the highest correlation with the dependent variable (power for continuous variables and logarithm for proportion variables). We also utilized scatterplots and correlation coefficients to assess collinearity between independent variables.

Statistical analyses

We used small area analysis to estimate the HFE in each district of Iran. Suppose that we have M areas in the population and only m areas are sampled. The SAE by the Fay–Herriot model has the following linear form:

$$\hat{\theta}_i = z_i^T \beta + b_i v_i + e_i \qquad i = 1,\dots,m$$

In this model $\hat{\theta}_i = g(\hat{\bar{Y}}_i)$ where $\hat{\bar{Y}}_i$ is the direct estimator of the small area mean in area i, b_is are known positive constants (typically assumed to be $b_i = 1$), $\beta = (\beta_1, \dots, \beta_p)^T$ is the $p\times1$ vector of regression coefficients. Moreover, v_i's are area-specific random effects assumed to be independent and identically distributed (iid) as $N(0, \sigma_v^2)$ with

$$E_m(v_i) = 0 \quad , \quad V_m(v_i) = \sigma_v^2 (\geq 0)$$

Where E_m and V_m denote the model expectation and variance, respectively.

e_i's are independent sampling error with distribution of N$(0, \Psi_i)$, where sampling variances Ψ_i's are assumed to be known. Also, v_i's and e_i's are assumed to be independent [15]. In the non-sampled districts, we did not have the random effects (v_i's) and only covariates synthetic estimates were obtained.

All statistical analyses were performed using package SAE in R (version 3.0.1) [16]. The results are presented in 1,000 Rials (Iranian currency). According to the Central Bank of Iran, the average purchasing power parity (PPP) of one US dollar was equal to 24,715 Rials during the data collection period [17].

Evaluation of SAEs

Since there was no gold standard, we used province-level direct estimates reported by the SCI to evaluate the validity of the SAEs. We calculated the following absolute relative difference (ARD) at each district.

$$ARD_{ij}\% = \frac{|HFE_i - HFE_{ij}|}{HFE_i} \times 100$$

Where i shows province (i=1,..., 31) and j district ($j = 1, \dots, m_i$).We also compared the aggregated province estimates (average of district estimates in each province) with direct provincial estimates reported by the SCI.

Each prediction needs its variation to explain the precision. In small area estimations, the root mean square error (RMSE) is used to show the precision of each predict, generally. The smaller RMSE leads to higher precision of each predict. Another way to describe the variation of a test or prediction is to calculate the coefficient of variation, or CV. The CV expresses the variation as a percentage of the mean(18). We calculated the RMSE using

$$RMSE(\hat{\theta}_i) = \sqrt{E(\hat{\theta}_i - \theta_i)^2}$$

and the CV of each predict using

$$CV(\hat{\theta}_i) = \frac{RMSE(\hat{\theta}_i)}{\hat{\theta}_i} \quad i = 1, \dots, 429$$

P-values <0.05 were considered significant.

RESULTS

In this study, we analysed the HFE data collected in the IRUHEIS in 2013. In that project, the SCI randomly selected 387 out of 429 districts in order to estimate the province-level HFE. Twenty six households did not complete the questionnaire, so we analysed the data of 18,850 households. Forward selection on the FH model was used to find the final model. In the forward method, independent variables (ordered by their correlation with dependent variable) are inserted into the model serially where only significant variables remain.

Table 1 shows the final model of our study. Accordingly, only ANRH, migration rate, PMH, and PAPE had a significant effect on the HFE. ANRH and PMH had a positive effect and the rest had a negative effect on HFE. In addition, a 1% increase in PMH increased HFE by about 1.61 million Rials on average.

Figure 1 shows the zoning of the HFE in the urban areas. The lowest and the highest HFE was related to Pishva district (in Tehran province) with 27,067 thousand Rials (TRs) and Boyer-Ahmad district (in Kohgilouyeh and Boyer-Ahmad province) with 85,175 TRs, respectively. Table 2 presents five estimations by the model with the highest and lowest RMSE. Accordingly, Qom district (in Qom province) and Kavarr district (in Fars province) had the lowest and the highest RMSE, respectively. In addition, Miandoroud (in Mazandaran province) and Tehran (in Tehran province) had the highest and lowest CV, respectively.

Figure 2 shows the zoning of ARD in each district of Iran. Accordingly, Freydoun-kenar in Mazandaran province had the lowest ARD (0.13%) and Moraveh-Tapeh in Golestan province had the highest ARD (49.56%). The differences

TABLE 1. Results of Fay-Herriot model on households Food Expenditures (1000 Rials).

Variables	Beta	SE	P-value
Intercept	-9.40×10^4	2.55×10^4	<0.001
ANRH	8.06×10^3	1.33×10^3	<0.001
Migration	-2.60×10^2	8.71×10^1	0.003
PMH	1.61×10^5	2.80×10^4	<0.001
PAPE	-2.58×10^4	7.23×10^3	<0.001
$\sigma_v^2 = 1.08\times10^8$		AIC=13732	

Abbreviation: ANRH, average number of room at each household; PMH, proportion of male headed households; PAPE, Proportion of the active population`s employed; SE, standard error.

FIGURE 1. Zoning of annual household food expenditures in district-level in Iran estimated using Fay-Herriot model (1000 Rials)

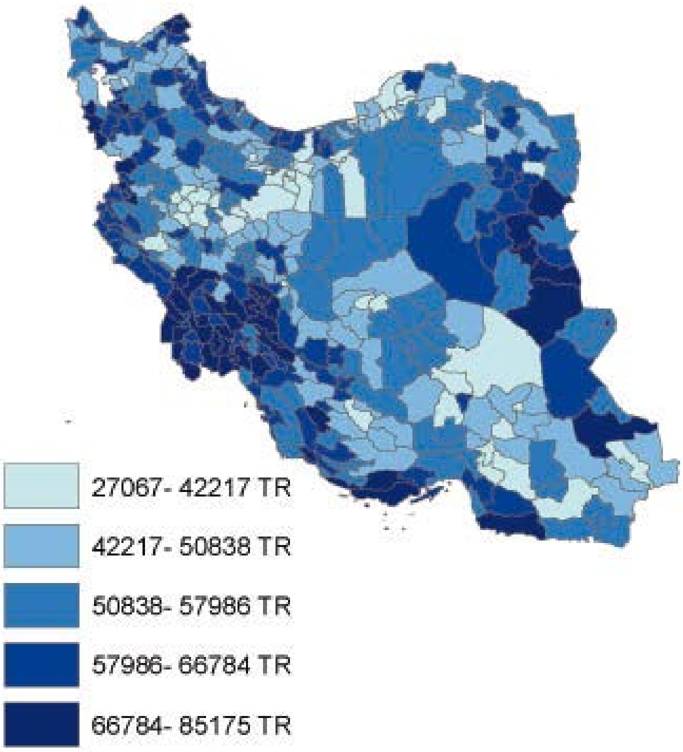

FIGURE 2. Zoning of absolute relative difference between province-level Household Food Expenditures direct estimates reported by the Statistical Center of Iran and district-level estimates by the Fay-Herriot model in Iran

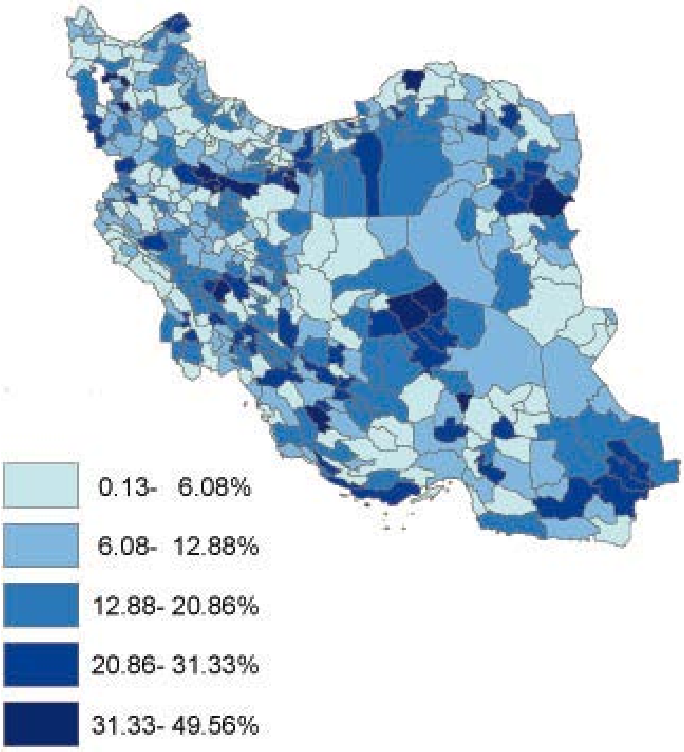

TABLE 2. Five districts with the highest and lowest mean square error estimated using Fay-Herriot model

District(Province)	Households Food Expenditures estimated (1000 Rials)	RMSE	CV (%)
Highest RMSE			
Kavar(Fars)	63628	9909	15.57
Miandoroud(Mazandaran)	56369	9894	17.55
Kalat(Khorasan Razavi)	56245	9675	17.20
Semirom(Esfahan)	64651	9546	14.77
Bavanat(Fars)	56507	9380	16.60
Lowest RMSE			
Karaj(Alborz)	53132	1527	2.87
Malayer(Hamadan)	32950	1357	4.12
Mashhad(Khorasan Razavi)	47361	1337	2.82
Tehran(Tehran)	54303	1163	2.14
Qom(Qom)	27313	1027	3.76

Abbreviation: RMSE, root mean square error; CV, coefficient of variation.

between aggregated province estimates (average of district estimates in each province) and the estimates reported by the SCI were not significant (P=0.609).

DISCUSSION

We demonstrated the value of small area analysis in producing district-level estimates of HFE in urban areas in Iran. In our study, Qom was not a small area because Qom province only had one district at that time. Furthermore, because Qom had the smallest RMSE, validation of our model is admissible. Our model showed that four out of 14 variables had a significant effect on the HFE. Similar to many studies and reports, PMH had a positive effect on the HFE, indicating the higher income of men than women [19-21].

In addition, our model showed that increased PAPE was associated with a decreased HFE. Chang reported similar results [22].

In 2002 Mafuru and Marsh showed the differences in food demands and expenditures and subsistence consumption between urban and rural regions of Tanzania [23]. A similar study conducted by Nkegbe et al. in 2009 showed the differences between households in terms of a number of factors such as female-headed, age-headed, uneducated, small aged rural households, and living farther from the capital based on the percentage of their income spent on food in Ghana [24]. In 1986 Majumdar reported the impact of the household size and composition (six age-sex categories) on the food expenditure in Haiti [25]. However, in our study, the household size did not have any significant effects on the HFE. A possible reason may be the higher number of predictors that we used in our research, such as ANRH. We expect to increase the ANRH with increasing the household size. Also, the increase of household size leads to higher HFE.

Similar to some studies, our results showed that the migration rate significantly decreased the HFE [26,27]. Moreover, a study carried out in Vietnam showed that only short term migration had a positive effect on the overall food expenditure [28].

Zoning of HFE showed that border districts, especially those on the Western border had a higher HFE, while zoning of ARD showed greater differences in small districts farther from the capital of the province. Similar patterns were seen in the RMSE of our predictions. On the contrary, larger provinces had higher disparities in terms of ARD.

To the best of our knowledge, HFE mapping has not been done for Iranian districts,so far. Contrary to our expectations, the results showed a lower HEF in some capital cities than other cities of the province.

The benchmarking methods showed the aggregated province estimates had no significant difference with the estimates reported by the SCI. This is another reason for the validity of our model.

The most important difference between our study and similar studies was the insufficiency of sample size in each district. This weakness was compensated by using SAE method to find acceptable predicts of HFE in urban areas of Iran.

One of the basic limitations of the SAE method is the use of variables that have a high correlation with the dependent variable. In this study, we tried to find these variables.

Acknowledgment

The authors are thankful to SCI and Statistical Research and Training Center for providing data for this project. The paper is taken from Biostatistics PhD Thesis of International Branch Shahid Beheshti University of Medical Sciences, Tehran-Iran.

Funding

The Authors have been no relevant financial to disclose.

Conflict of interest

The Authors declare that there is no conflict of interest.

Authors' Contribution

Study concept and design: Dr. Mehrabi and Soltani-Kermanshahi, Acquisition of data: Dr. Aliakbari-Saba, Analysis and interpretation of data: Dr. Mehrabi and Soltani-Kermanshahi, Drafting of the manuscript: Soltani-Kermanshahi, Critical revision of the manuscript for important intellectual content: Dr. Mehrabi, Dr. Kavousi, Dr. Baghestani and Dr. Mohammadi-Nasrabadi, Statistical analysis: Dr. Mehrabi, Dr. Kavousi, Dr. Baghestani, Dr. Aliakbari-Saba and Soltani-Kermanshahi, Study supervision: Dr Mehrabi.

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