

Original Article

# Total Healthcare Expenditures from the 2017 Iran's National Households Income and Expenditure Survey: The Application of Two-Part Models

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Biosciences 2019:10(2)**Abstract**

**Introduction:** Although the precise estimates of healthcare expenditures are critical for health policy-makers, the right-skewed distribution and a substantial number of zero values of the measures of healthcare expenditure make such estimates challenging. The present study used conventional two-part (CTP) and marginalized two-part (MTP) models to handle the skewness and zero-inflation in expenditure distribution as two serious challenges.

**Materials and Methods:** Data was used from the 2017 Households Income and Expenditure Survey (HIES; 38,252 households), a national cross-sectional study in Iran. CTP and MTP models were utilized to estimate the medical supplies, outpatient, inpatient and total medical expenditures. The rural-urban difference in total medical expenditures and other health services were also examined. All data analyses were performed using SAS. For all tests, two-sided p-values <0.05 were interpreted as statistically significant.

**Results:** The mean (SD) out-of-pocket spending for total healthcare was \$143 (\$488) per capita, and \$182 (\$650) and \$105 (\$239) for urban and rural areas, respectively. The mean (SD) medical supplies cost per capita was \$48 (\$240), and the mean (SD) of outpatient cost per capita and inpatient cost per capita were \$61 (\$245) and \$34 (\$294), respectively. Both CTP and MTP models suggested that urban population spent more money on total expenditures than rural populations ( $p < 0.05$ ). Although both models gave the same set of parameter estimates, the AIC indicated that the MTP-GG model was a more appropriate fit.

**Conclusion:** The marginalized models provided better estimates in documenting inequalities/healthcare expenditures. Unlike the CTP model, the estimation of covariate effects on the marginal mean of the whole population via using the MTP model is straightforward. However, the MTP model may not outperform the CTP model in all cases. The applications of such models need to be considered in the future research to provide better estimates/documentations of healthcare expenditure and healthcare inequalities. In addition, these findings suggest a substantial inequality in healthcare expenditures between urban and rural areas. Considering the differences in urbanity and rurality can be of interest to health economists and policymakers.

**Keywords:** Healthcare expenditure, Conventional two-part model, Marginalized two-part model, Inequality, Iran

**1. Introduction**

Healthcare expenditure usually refers to both the medical expenditure and cost

associated with home healthcare and long-term care. Medical expenditure is defined as the expenses on investigations, outpatient

care, inpatient care, drugs, and medical supplies. Hospital care, professional services, and medical supplies/pharmacological treatments are the three categories of health expenditures with the highest per capita figures [1].

Healthcare expenditure as a proportion of Gross Domestic Product (GDP) varies considerably over time, across countries and the region (in terms of rurality and urbanity) [1-3]. In different countries, an increase observed in healthcare services demand leads to a rise in health spending. In the United States, for instance, the share of GDP devoted to health care increased from 9% to 16% during 1980-2008 [4]. The expenditure index in Iran has increased by a factor of 30 over the past two decades, while the growth in health expenditures index has experienced a 71-fold increase. According to reports of the Iranian Health Management and Economics Research Center, healthcare expenditures grew dramatically from \$145 per capita in 2004 to \$350 in 2014 [5].

Medical expenditure data is often right-skewed and includes an excess number of zero values. For modeling the mean of skewed data with additional zero values, several models and statistical techniques have been proposed [6]. In terms of medical expenditure, the excessive zero shows a population of 'non-users' who do not have health care or medication in a specific period of time and consequently, do not have any medical costs. Moreover, the continuous part of the expenditure data shows the level of spending among health services consumers. Previous studies indicated that mixture models performed better than one part models at reflecting the distributions of medical expenditure [6-11]. Fitting conventional two-part (CTP) and marginalized two-part (MTP) models are common approaches for modeling this type of data. CTP and MTP models were developed for flexible generalized gamma (GG) family of distributions by Voronca *et al.* [12]. The main limitation of these

conventional two-part models is the conditional (on non-zero values) interpretation of regression coefficients made from the second part. In addition, a generalization of the results is only applicable to user population (e.g. non-zero values). Furthermore, each part of the models has its own parameters estimates which may lead to conflicting conclusions from CTP model about the overall effect of the covariates on the overall population mean. The MTP models parameterize the marginal mean among all zero and non-zero values directly from the regression coefficients and give a direct explanation of covariate effects on the marginal mean (the entire population of users and non-users). In essence, if the goal is to determine the overall population mean of medical expenditure, without taking the mentioned characteristics into account, the estimates and statistical inferences would be inaccurate.

Healthcare expenditures' growth influences rural and urban populations differently due to the lower income of rural populations compared with their urban counterparts [1]. To assess urban-rural difference in total healthcare expenditures, few studies have been conducted on Households Income and Expenditure Survey (HIES). In all of these studies, however, only non-zero expenditures were considered in the analysis [13-16].

In many cases, investigators' main interest lies in knowing the effects of predictor variables on the whole population. Thus, this paper examines the rural-urban difference in total medical expenditures, as well as expenditures for different types of health services (i.e. medical supplies, outpatient, and inpatient care). This research focused on the urban-rural difference in medical expenditures for the three most costly categories. the CTP-GG and MTP-GG models were used to examine the relationship between some factors and medical expenditures.

## 2. Materials and Methods

### 2.1. Data

The cross-sectional data used in this study were retrieved from a sub-sample of the most recent Households Income and Expenditure Survey (HIES), administered by the Statistical Centre of Iran (SCI) in 2017. HIES's main purpose is to estimate the average expenditure and income among urban and rural households in Iran. The HIES self-reported questionnaire has different sections including demographic characteristics, monthly and yearly household outcome (food and non-food expenditure), and annual household income. The household health expenses (HHE) are recorded as a part of non-food expenditures of the questionnaire. In our study, we focused on the HHE data, which consists of monthly and annually medical supplies and outpatient and inpatient expenditures. We considered only out-of-pocket health expenses of HHE, so government fiscal supports and insurance premium were not taken into account. At the time of HIES data collection, one U.S. dollar was worth, on average, 29580 Rials (Iranian currency) [14, 17].

### 2.2. Outcome

In this study, the total medical expenditures were assessed which is the sum of three health service expenditures: (1) expenses for medical supplies, (2) expenses for outpatient care, and (3) expenses for inpatient care. This measure considered the entire household expenditures during 12 months before the interview.

### 2.3. Independent Variables

The most important explanatory variable in our study was the household's place of residence (0=rural/1=urban). Urban area was defined as an area with a population of at least 10,000, following the definition from the Ministry of Roads and Urban Development in 2017.

Other explanatory variables were gender, age, literacy of household head, health insurance coverage, family members' mean age, number of elderly members, number of pre-school children ( $0 < \text{age} \leq 5$ ), and household income.

### 2.4. Statistical Analysis

In this study, univariate statistics were used to evaluate the rural-urban differences. To evaluate the potential impact of place of residence on medical expenditures, the CTP- Generalized Gamma and MTP- Generalized Gamma models were fit. Place of residence and family members' mean age were included in the continuous part of the CTP-GG and MTP-GG models. Place of residence and number of elderly members were included in the binary part. Other covariates were removed from both final models because of their small effects according to the AIC index. Lower AIC index values indicate better fit between model and data

Two part models are common approaches for modeling semi-continuous data. Brief descriptions of the CTP and MTP models and Generalized Gama (GG) family are as follows. All data analyses were performed using PROC NL MIXED in SAS.

Let  $Y_i$  denote the medical expenditure of the  $i$ th household, as a positive continuous outcome with a point mass at zero and let  $f$  be the probability density function (p.d.f.) corresponding to a continuous distribution defined on a positive domain.

$X_i'$  represents the covariate vector corresponding to the  $i$ th household used for the binary part,  $Z_i'$  represents the covariate vector corresponding to the  $i$ th household used for the continuous part of the CTP-GG and MTP-GG models; the parameter vector  $\alpha$  corresponds to the model coefficients of binary part of the CTP-GG and MTP-GG models, while  $\delta$  and  $\beta$  are the vectors of conditional and marginal coefficients corresponding to the continuous part of a CTP-GG and MTP-GG models respectively.

**2.4.1. Generalized Gama (GG) Family**

The GG family can represent various types of distributions with non-negative support which can cover different shapes and has the ability to model various data sets with different degrees of asymmetries and skewness. The GG family includes special cases such as the Weibull ( $\kappa = 1$ ), lognormal ( $k = 0$ ), and gamma ( $\kappa = \sigma$ ) distributions [8, 12, 18]. The p.d.f of a continuous random variable Y following a GG distribution can be written as:

$$f(y, \lambda, \sigma, \mu) = \frac{\eta^\sigma}{\sigma \Gamma(\eta) \sqrt{\eta}} \exp\{u \sqrt{\eta} - \eta \exp(\lambda u)\} \quad (1)$$

where  $\sigma > 0$  is a scale parameter,  $\lambda$  and  $\mu > 0$  are shape and location parameters and  $\Gamma(\cdot)$  is the standard gamma function. In addition  $u = \text{sign}(\lambda) (\log y - \mu) / \sigma$  and  $\eta = |\lambda|^{-2} > 0$ .

**2.4.2. Conventional Two-Part Models (CTP)**

The general form of the p.d.f. for a CTP model [19] is given by

$$g_{CTP}(y_i) = \begin{cases} 1 - \pi_i, & \text{if } y_i = 0 \\ \pi_i f(y_i; X_i' \delta), & \text{if } y_i > 0 \end{cases} \quad (2)$$

where the probability of being non-zero,  $\pi_i$ , could be modeled using a logit link:

$$\text{logit}(\pi_i) = Z_i' \alpha$$

and the location parameter  $\mu_i$ , could be modeled in the second part of the CTP model assuming a log link:

$$\mu_i = E(Y_i | Y_i > 0) = X_i' \delta \quad (3)$$

The marginal mean and the variance of  $Y_i$  can be derived from a CTP model as follows:

$$E(Y_i) = \pi_i E(Y_i | Y_i > 0), \quad V(Y_i) = \pi_i [E(Y_i^2 | Y_i > 0) - \pi_i E(Y_i | Y_i > 0)^2] \quad (4)$$

For example, when GG is assumed for the continuous part, the marginal mean is

$$E(Y_i) = \pi_i \exp\{\mu_i + C(\sigma, k)\} = \frac{\exp(Z_i' \alpha)}{1 + \exp(Z_i' \alpha)} \exp(X_i' \delta + C(\sigma, k)) \quad (5)$$

**2.4.3. Marginalized Two-Part Models (MTP)**

For an MTP model, the general form of the p.d.f [18] can be written as

$$g_{MTP}(y_i) = \begin{cases} 1 - \pi_i, & \text{if } y_i = 0 \\ \pi_i f(y_i; X_i' \delta), & \text{if } y_i > 0 \end{cases} \quad (6)$$

which gives a marginal mean of the form

$$E(Y_i) = \exp(X_i' \beta) = \xi_i \quad (7)$$

Searching for the location parameter of the GG distribution in the expression of  $E(Y_i)$  equation in CTP model, we will obtain:

$$\mu_i = X_i' \beta - \log(\pi_i) - C(\sigma, k) \quad (8)$$

**2.4.4. Comparison of Treatment Effect Estimates**

According to the model defined in (3),  $\delta_j$  can be interpreted as the effect of one unit increase in the  $j$ th covariate,  $x_{ij}$ , on the conditional mean of  $Y_i$  given that  $Y_i$  is non-zero. Specifically, if  $x_i = z_i$ , the increase rate of the marginal mean can be calculated as:

$$\frac{E(Y_i | x_{ij} = j + 1, \tilde{x}_i)}{E(Y_i | x_{ij} = j, \tilde{x}_i)} = \frac{1 + \exp[\tilde{x}_i' \tilde{\alpha} + \alpha_j - j]}{1 + \exp[\tilde{x}_i' \tilde{\alpha} + \alpha_j - (j + 1)]} \exp(\alpha_j + \delta_j) \quad (9)$$

where  $\tilde{x}_i$  and  $\tilde{\alpha}$  are  $x_i$  and  $\alpha$  with the  $j$ -th element of  $x_i$  and  $\alpha$  removed, respectively.

Using the MTP model (7),  $\beta$  is estimated for the whole population while  $\delta$  is conditional on  $Y_i > 0$ . More precisely, the left part of (9) equals  $\exp(\beta_j)$ , based on the model (6), which could be seen as the per-unit effect on the unconditional marginal mean [12].

**3. Results**

The overall sample size was 38,252 households, with 49.3% from urban areas. The mean (SD) age of the sample was 36.6 (17.5), and 78.8% ( $n=30145$ ) of them were younger than 65 years old. The main outcomes under study (i.e. medical supplies, outpatient, inpatient, and total medical expenditures) had significant percentages of zeroes (40%, 50%, 80% and 30%, respectively). Descriptive statistics for the outcomes and covariates are shown in Table 1. The mean (SD) total medical expenditures per capita was \$143 (\$488), whereas the mean (SD) medical supplies cost per capita was \$48 (\$240), and the mean (SD) of outpatient cost per capita and inpatient cost per capita were \$61 (\$245) and \$34 (\$294), respectively. The mean (SD) total medical expenditures per capita in urban and rural areas were \$182 (\$650) and \$105 (\$239), respectively. The total medical expenditures

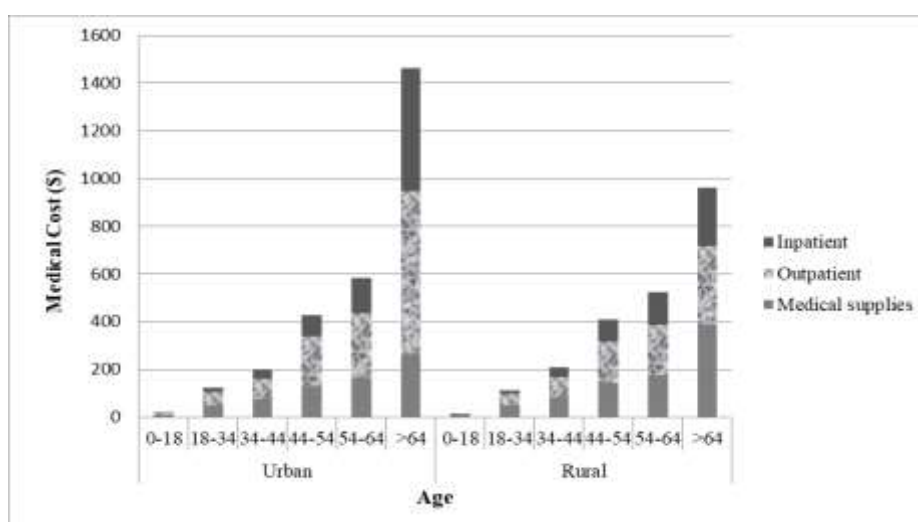
and its components (i.e. medical supplies, outpatient care, and inpatient care) are

presented in Figure 1 by age and place of residence.

**Table 1.** Descriptive statistics for studying variables across place of residence (n=38252)

|                           | Place of residence        |               | p-value |
|---------------------------|---------------------------|---------------|---------|
|                           | Urban (18871)             | Rural (19381) |         |
| <b>Outcome</b>            |                           |               |         |
| Medical supplies cost     | 56 ± 323 <sup>†</sup>     | 39 ± 110      | <0.001  |
| Non-zero                  | 11832 (62.7) <sup>‡</sup> | 12288 (63.4)  | 0.080   |
| Outpatient cost           | 79 ± 320                  | 43 ± 135      | <0.001  |
| Non-zero                  | 9115 (48.3)               | 9109 (47.0)   | 0.012   |
| Inpatient cost            | 46 ± 398                  | 23 ± 123      | <0.001  |
| Non-zero                  | 4170 (22.1)               | 4477 (23.1)   | 0.027   |
| Total expenditures        | 182 ± 650                 | 105 ± 239     | <0.001  |
| Non-zero                  | 13172 (69.8)              | 13450 (69.4)  | 0.392   |
| <b>Covariate</b>          |                           |               |         |
| Family members' mean age  | 35.64 ± 16.28             | 37.62 ± 18.58 | <0.001  |
| Elderly members (age ≥65) |                           |               |         |
| none                      | 15493 (82.1)              | 14652 (75.6)  | <0.001  |
| more than one             | 3378 (17.9)               | 4729 (24.4)   |         |

<sup>†</sup>Data are presented as Mean ± SD and <sup>‡</sup>frequency (%)



**Figure 1.** Components of medical expenditures for urban and rural sample

To assess the relationship between the place of residence and medical expenditures, both CTP-GG and MTP-GG models were fit to

the data. Results are presented in Tables 2 and 3, separately for medical supplies, outpatient care, inpatient care, and total

expenditures. The shape (*Sigma*) and scale (*t*) parameters of the CTP-GG and MTP-GG models suggested that the CTP-GG and

MTP-GG models could be good choices for analyzing this data ( $p < 0.05$ ).

**Table 2.** MPT-GG model results for components of medical expenditures

| Coefficient        | Expenditure                |                            |                            |                           |
|--------------------|----------------------------|----------------------------|----------------------------|---------------------------|
|                    | Medical supplies           | Outpatient                 | Inpatient                  | Total                     |
| <i>Alphas</i>      |                            |                            |                            |                           |
| Intercept          | 0.418 (.015) <sup>†*</sup> | -0.271 (.015) <sup>*</sup> | -1.303 (.019) <sup>*</sup> | 0.623 (.016) <sup>*</sup> |
| Place of residence | 0.009 (.021)               | 0.103 (.021) <sup>*</sup>  | -0.015 (.024)              | 0.063 (.022) <sup>*</sup> |
| Elderly members    | 0.614 (.023) <sup>*</sup>  | 0.510 (.017) <sup>*</sup>  | 0.319 (.018) <sup>*</sup>  | 0.937 (.027) <sup>*</sup> |
| <i>Betas</i>       |                            |                            |                            |                           |
| Intercept          | 3.250 (.021) <sup>*</sup>  | 2.855 (.026) <sup>*</sup>  | 1.828 (.048) <sup>*</sup>  | 3.459 (.018) <sup>*</sup> |
| Place of residence | 0.068 (.014) <sup>*</sup>  | 0.208 (.018) <sup>*</sup>  | 0.204 (.032) <sup>*</sup>  | 0.116 (.012) <sup>*</sup> |
| Mean age           | 0.040 (.000) <sup>*</sup>  | 0.046 (.000) <sup>*</sup>  | 0.055 (.001) <sup>*</sup>  | 0.058 (.000) <sup>*</sup> |
| <i>Sigma</i>       | 0.894 (.004) <sup>*</sup>  | 0.973 (.005) <sup>*</sup>  | 1.212 (.010) <sup>*</sup>  | 0.833 (.004) <sup>*</sup> |
| <i>t</i>           | 4.012 (.261) <sup>*</sup>  | 2.850 (.146) <sup>*</sup>  | 2.749 (.217) <sup>*</sup>  | 2.099 (.067) <sup>*</sup> |
| -2 Log Likelihood  | 337267                     | 286829                     | 151111                     | 405712                    |
| AIC                | 337285                     | 286847                     | 151129                     | 405730                    |

<sup>†</sup> Coefficient estimate (standard error)

<sup>\*</sup> Significant at 0.05

**Table 3.** CTP-GG model results for components of medical expenditures

| Coefficient        | Expenditure                |                            |                            |                           |
|--------------------|----------------------------|----------------------------|----------------------------|---------------------------|
|                    | Medical supplies           | Outpatient                 | Inpatient                  | Total                     |
| <i>Alphas</i>      |                            |                            |                            |                           |
| Intercept          | 0.374 (.016) <sup>†*</sup> | -0.240 (.015) <sup>*</sup> | -1.312 (.018) <sup>*</sup> | 0.628 (.016) <sup>*</sup> |
| Place of residence | 0.015 (.021)               | 0.101 (.021) <sup>*</sup>  | -0.013 (.025)              | 0.072 (.023) <sup>*</sup> |
| Elderly members    | 0.755 (.025) <sup>*</sup>  | 0.408 (.020) <sup>*</sup>  | 0.345 (.0216) <sup>*</sup> | 0.895 (.029) <sup>*</sup> |
| <i>Deltas</i>      |                            |                            |                            |                           |
| Intercept          | 3.387 (.019) <sup>*</sup>  | 3.294 (.015) <sup>*</sup>  | 2.802 (.046) <sup>*</sup>  | 3.620 (.020) <sup>*</sup> |
| Place of residence | 0.083 (.012) <sup>*</sup>  | 0.182 (.015) <sup>*</sup>  | 0.248 (.026) <sup>*</sup>  | 0.119 (.010) <sup>*</sup> |
| Mean age           | 0.039 (.000) <sup>*</sup>  | 0.046 (.000) <sup>*</sup>  | 0.053 (.000) <sup>*</sup>  | 0.057 (.000) <sup>*</sup> |
| <i>Sigma</i>       | 0.894 (.004) <sup>*</sup>  | 0.991 (.005) <sup>*</sup>  | 1.221 (.010) <sup>*</sup>  | 0.846 (.004) <sup>*</sup> |
| <i>t</i>           | 4.633 (.035) <sup>*</sup>  | 3.110 (.176) <sup>*</sup>  | 2.967 (.253) <sup>*</sup>  | 2.270 (.077) <sup>*</sup> |



| Coefficient       | Expenditure      |            |           |        |
|-------------------|------------------|------------|-----------|--------|
|                   | Medical supplies | Outpatient | Inpatient | Total  |
| -2 Log Likelihood | 337434           | 287368     | 151171    | 406219 |
| AIC               | 337452           | 287386     | 151189    | 406237 |

† Coefficient estimate (standard error)

\* Significant at 0.05

Table 2 presents the obtained results from fitting MTP-GG models. Adjusting for other covariates included in the models, place of residence was positively associated with all outcomes in the continuous part, meaning that living in urban areas was associated with higher medical care expenditure. In addition, family members' mean-age was positively associated with all outcomes, which implies higher medical expenditures for the older population. Moreover, the place of residence was linked to the probability of incurring non-zero outcome for outpatient and total medical expenditures. The probability of having non-zero expenditures in urban areas was higher compared to rural areas. More specifically, the exponential of the alpha coefficient corresponding to the place of residence in the MTP-GG model for total medical expenditures (OR = 1.065) can be interpreted as: "living in urban areas increases the chance of having a non-zero outcome by 6.5%."

Similarly, the exponential of beta coefficients in Table 2 can be interpreted as the per-unit effect of the predictor variables on the marginal mean of total medical expenditures. After adjusting for other covariates, the marginal mean of the total medical expenditures was 1.123 times more

for people in urban areas compared to that of people in rural areas. Note that in all quantiles in Table 4, the estimated means for urban areas are 1.123 times of the means in rural areas, reflecting the homogeneous estimated treatment effect from the model across family members' mean age and the number of elderly members.

To compare the obtained results from MTP and CTP models, a CTP-GG model was fit. A logistic regression model was used to estimate the probability of incurring non-zero expenditures and a GG model on the subgroup of the population who had non-zero medical expenditures (Table 3). Although both the CTP-GG and the MTP-GG models gave a same set of parameter estimates, the AIC indicated that the MTP-GG model was a more appropriate fit.

Similar to MTP-GG model, the logistic regression revealed that urban areas were associated with 7.5% higher odds of incurring total medical expenditures compared to rural areas (Table 3). Note that at each quantile, the effect of place of residence on medical expenditures' estimated means was not the same, showing the heterogeneous model-estimated treatment effect across the distribution of family members' mean age and the number of elderly members (Table 4).

**Table 4.** The effect of place of residence on medical expenditures' estimated means

| Quantile                       | MTP estimated means |       |       | CTP estimated means |       |       |
|--------------------------------|---------------------|-------|-------|---------------------|-------|-------|
|                                | Urban               | Rural | ratio | Urban               | Rural | ratio |
| Mean age 32, Elderly members 0 | 118                 | 105   | 1.123 | 78                  | 68    | 1.147 |
| Mean age 65, Elderly members 1 | 863                 | 768   | 1.123 | 718                 | 629   | 1.141 |
| Mean age 79, Elderly members 2 | 2409                | 2144  | 1.123 | 2225                | 1964  | 1.133 |

#### 4. Discussion

In the present study, out-of-pocket spending for total healthcare was \$143 (\$488) per capita. The mean total medical expenditures per capita in urban and rural areas were \$182 (\$650) and \$105 (\$239), respectively. The mean medical supplies, outpatient and inpatient costs per capita were \$56 (\$323), \$79 (\$320), \$49 (\$398) in urban areas, while these costs were \$39 (\$110), \$43 (\$135), \$23 (\$123) in rural areas respectively. Khosravi *et al.* showed that more than 50% of healthcare expenditure is out-of-pocket in Iran, ranking the highest among all the World Health Organization (WHO) member countries [5]. As pointed out by a WHO report, health is considered to be extremely inequitable when more than 50% of total health spending is out-of-pocket, and equity is at least partially achieved for selective services only when this proportion stays between 30% and 50% [20]. The share of out-of-pocket payment in total health spending has increased in the last fifteen years. This increase has two reasons: 1) economic instabilities and macroeconomic mismanagement in the country and 2) impacts of changes to health insurance policies because of the significant increase in health services costs [16]. Compared to other high-spending countries, Iran had the lowest health expenditure per capita in 2014, while the USA had the highest health expenditures with \$9402 per capita [5, 21]. Levels of health expenditure depend on various socio-economic factors. For instance, higher expenditure levels may be a consequence of high inflation rate. The rate of inflation in Iran was 14.76% and 20.62%

in 2004 and 2011, respectively, while for WHO-member countries it was less than 5%. Also, higher health sector prices in the USA explains much of the difference between the USA and other countries [5, 21, 22].

The results of this study indicated that the proportion of zero total health expenditures in rural areas was higher than in urban areas. This difference could be explained by the fact that rural population's expenditure is usually spent on interventions and treatments rather than prevention and as a result, non-zero expenditures in rural areas are related to those in need of treatment, who constitute a smaller portion of the population.

The results of both CTP-GG and MTP-GG models suggested that urban populations spent more money on total expenditures than rural populations. There are several possible explanations for this result. The poverty rate is higher in the rural communities. Poorer households allocate relatively lower expenditure and subsequently lower healthcare expenditure than their richer counterparts in terms of absolute monetary value [3, 23]. With higher ability and willingness-to-pay for healthcare, urban residents are likely to use a higher level, more expensive and a greater amount of healthcare service. On the other hand, faced with income limitations, rural populations tend to reduce their utilization of healthcare services [24]. This difference could also be due to the social inequities between rural and urban areas (e.g., health insurance coverage, access to essential healthcare services or physician-to-population ratio) or due to differences in



their socioeconomic characteristics (e.g., differences in lifestyle behaviors, education level or tendency towards promoting good health practices and ascending use of private healthcare in urban populations) or due to any others rural-urban pattern differences in health risk factors [23, 25-28]. Although, these results differ from a few published studies [1, 23, 29, 30], they are consistent with the findings of many previous studies reporting higher expenditures on healthcare for the urban households [11, 14, 16, 31-35].

The contradictions in findings may be attributable to differences in various population characteristics such as ecosystem and geography, development, contribution and effectiveness of health centers, health programs and policies, healthcare utilization pattern and urban-rural population ratio. A significant socioeconomic discrepancy between rural and urban populations may cause the difference between the distribution of healthcare expenditure and OOP spending in several countries. It is possible that the OOP of urban residents is greater in absolute money but lower as a proportion of healthcare expenditure, compared with that of rural residents. Another reason for contradicting results could be the methodological differences of the studies, e.g. differences in assessment of the absolute money or healthcare expenditure, statistical and economic models, data collection strategies and approaches for calculating the healthcare expenditures. As mentioned earlier, considering the non-zero values or all values is another potential cause of controversies. Particularly, if the percentage of zeros is high, the estimated healthcare expenditures will change.

In this study, the family members' mean age was 36 years and the rural communities were almost 2 years older. For both urban and rural communities, the total medical expenditures were positively related to family members' mean age. In addition, urban families spent more on healthcare

than rural ones in all age groups. The proportion of expenditures associated with medical supplies and outpatient and inpatient care increased with family members' mean age in both communities. The percentage of having non-zero expenditure in households with elderly members was higher than households with no elderly members. A possible reason for this is the greater risk of chronic disease and hospitalization among elderly people [23, 36, 37]. Literature reviews confirm this finding [14, 37-46]. Although healthcare expenditure increases with higher age, but age itself does not explain why older people spend more on healthcare than younger people. Some mediating factors could influence the positive association between age and healthcare expenditure; for example, as the population ages the likelihood of disease-related complications and also the need for home-care services increases [37, 47].

The most interesting finding was that the MTP-GG model showed a better fit. This corroborates the findings of a number of previous works in similar fields. Voronca *et al.* showed that MTP-GG is very suitable when the true distribution of the data is unknown and the sample size is large [12]. Unlike the CTP model, the estimation of covariate effects on the marginal mean of the whole population via using the MTP model is straightforward. However, the MTP model may not outperform the CTP model in all cases. Indeed, if the main objective of the analysis is  $E(Y_i | Y_i > 0)$ , the MTP model engenders arbitrary heterogeneity and provides less interpretable estimates on the conditional mean of  $Y$  among the non-zero values.

Finally, the choice between models should be guided by the aims of the study. If the aim is to model treatment effects on  $E(Y_i)$  in the presence of confounders, one should use the MTP model. On the other hand, if the target of inference is  $E(Y_i | Y_i > 0)$ , the CTP model would be a better choice. In our work, family members' mean-age was only

included in the continuous part of the models, so it does not evaluate the impact of this variable in the overall population based on the CTP model unless the interpretation is restricted to non-zero expenditures.

The results of this study indicated that, in Iran, health spending is a function of the household's place of residence. Urban people can afford higher prices and higher levels of healthcare services because of their greater ability-to-pay, while for rural residents even small healthcare expenditures can be a catastrophic shock to the household economy. Therefore, differences in the influence of urbanity and rurality may provide important guidance for health economists and policymakers to address inequality in healthcare. Moreover, the government, health-care providers, and caretakers need to pay more attention to vulnerable groups such as rural people and the elderly to improve their access to essential healthcare services. Iran's rural development policies should be flexible enough to integrate health concerns into other policy elements. This suggests that more policy interventions are needed to ensure the equitable distribution of resources, regardless of geographic location.

In this study, the data regarding the expenditures of health services might not be very accurate; considering the obligations of insurance organizations, participants may not have about a clear understanding of the total amount of expenditures. Recall bias is also quite probable in this self-reported questionnaire as a database of the ISC was not connected to key institutions such as the Ministry of Health (MoH) and insurance organizations.

## 5. Conclusion

Our findings suggest a substantial inequality in healthcare expenditures between urban and rural areas. Considering the differences in urbanity and rurality can be of interest to health economists and policymakers.

## Conflict of Interest

The authors declare no conflict of interest.

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## Conflict of interest

The authors declare no conflict of interest.

## References

1. Lee W-C, Jiang L, Phillips CD, Ohsfeldt RL. Rural-Urban differences in health care expenditures: Empirical data from US households. *Advances in Public Health*. 2014;2014:1-8
2. Baltagi BH, Moscone F. Health care expenditure and income in the OECD reconsidered: Evidence from panel data. *Economic modelling*. 2010;27:804-811.
3. Wang L, Wang A, Zhou D, FitzGerald G, Ye D, Jiang Q. An empirical analysis of rural-urban differences in out-of-pocket health expenditures in a low-income society of China. *PloS one*. 2016;11:54-63.
4. Hartman M, Martin A, Nuccio O, Catlin A, Team NHEA. Health spending growth at a historic low in 2008. *Health Affairs*. 2010;29:147-155.
5. Khosravi B, Soltani S, Javan-Noughabi J, Faramarzi A. Health care expenditure in the Islamic Republic of Iran versus other high spending countries. *Medical journal of the Islamic Republic of Iran*. 2017;31:71-75.
6. Duan N, Manning WG, Morris CN, Newhouse JP. A comparison of alternative models for the demand for medical care. *Journal of business & economic statistics*. 1983;1:115-126.
7. Zhou X-H, Liang H. Semi-parametric single-index two-part regression models. *Computational statistics & data analysis*. 2006;50:1378-1390.

8. Olsen MK, Schafer JL. A two-part random-effects model for semicontinuous longitudinal data. *Journal of the American Statistical Association*. 2001;96:730-745.
9. Liu L, Strawderman RL, Cowen ME, Shih Y-CT. A flexible two-part random effects model for correlated medical costs. *Journal of Health Economics*. 2010;29:110-123.
10. Shojaei M, Kazemnejad A, Zayeri F, Vahedi M. Estimating the economic costs of functional gastrointestinal tract disease using regression two-part parameters model. *Razi Journal of Medical Sciences*. 2013;20:76-85.
11. Zare H, Trujillo AJ, Driessen J, Ghasemi M, Gallego G. Health inequalities and development plans in Iran; an analysis of the past three decades (1984–2010). *International journal for equity in health*. 2014;13:42-54.
12. Voronca DC, Gebregziabher M, Durkalski VL, Liu L, Egede LE. Marginalized Two Part Models for Generalized Gamma Family of Distributions. *arXiv preprint arXiv:1511.05629* 2015.
13. Soofi M, Rashidian A, Aabolhasani F, Sari AA, Bazyar M. Measuring the Exposure of Households to Catastrophic Healthcare Expenditures in Iran in 2001: the World Health Organization and the World Bank's Approach. *Hospital Journal*. 2013;12:39-50.
14. Mehrabi Y, Payandeh A, Ghahroodi ZR, Zayeri F. Determinants of Households Health Expenditure: A Population-Based Study. *Journal of Paramedical Sciences*. 2018;9:27-32.
15. Kavosi Z, Keshtkaran A, Hayati R, Ravangard R, Khammarnia M. Household financial contribution to the health System in Shiraz, Iran in 2012. *International journal of health policy and management*. 2014;3:243-249.
16. Ghasivand H, Gorji HA, Maleki M, Hadian M. Catastrophic health expenditure among Iranian rural and urban households, 2013-2014. *Iranian Red Crescent Medical Journal*. 2015;17:1-11.
17. Bell ML, Dominici F, Samet JM. A meta-analysis of time-series studies of ozone and mortality with comparison to the national morbidity, mortality, and air pollution study. *Epidemiology (Cambridge, Mass.)*. 2005;16:436-445.
18. Smith VA, Preisser JS, Neelon B, Maciejewski ML. A marginalized two part model for semicontinuous data. *Statistics in medicine*. 2014;33:4891-4903.
19. Cragg JG. Some statistical models for limited dependent variables with application to the demand for durable goods. *Econometrica: Journal of the Econometric Society*. 1971;39:829-844.
20. Organization WH. Strategy on health care financing for countries of the Western Pacific and South-East Asia Regions (2006-2010). Manila: WHO Regional Office for the Western Pacific; 2005, P.16-28.
21. Lorenzoni L, Belloni A, Sassi F. Health-care expenditure and health policy in the USA versus other high-spending OECD countries. *The Lancet*. 2014;384:83-92.
22. Weerasinghe M, Fernando D. Access to care in a plural health system: concerns for policy reforms. *Journal of the College of Community Physicians of Sri Lanka*. 2009;14:39-45.
23. Kumara AS, Samarasinghe R. Patterns and determinants of out-of-pocket health care expenditure in Sri Lanka: evidence from household surveys. *Health policy and planning*. 2016;31:970-983.
24. Reschovsky JD, Staiti AB. Access and quality: does rural America lag behind? *Health Affairs*. 2005;24:1128-1139.
25. Frenzen PD. Health insurance coverage in US urban and rural areas. *The Journal of Rural Health*. 1993;9:204-214.
26. Hare TS, Barcus HR. Geographical accessibility and Kentucky's heart-related hospital services. *Applied Geography*. 2007;27:181-205.
27. Matthews Z, Channon A, Neal S, Osrin D, Madise N, Stones W. Examining the "urban advantage" in maternal health care in developing countries. *PLoS medicine*. 2010;7:1-7.
28. Daneshkohan A, Karami M, Najafi F, Matin BK. Household catastrophic health expenditure. *Iranian journal of public health*. 2011;40:94-99.
29. Ziller EC, Coburn AF, Yousefian AE. Out-of-pocket health spending and the rural underinsured. *Health Affairs*. 2006;25:1688-1699.
30. Chevarley FM, Owens PL, Zodet MW, Simpson LA, McCormick MC, Dougherty D. Health care for children and youth in the United States: annual report on patterns of coverage, utilization, quality, and expenditures by a county level of urban influence. *Ambulatory Pediatrics*. 2006;6:241-264.
31. West AN, Weeks WB. Health care expenditures for urban and rural veterans in

- Veterans Health Administration care. Health services research. 2009;44:1718-1734.
32. Van Minh H, Phuong NTK, Saksena P, James CD, Xu K. Financial burden of household out-of-pocket health expenditure in Viet Nam: findings from the National Living Standard Survey 2002–2010. *Social science & medicine*. 2013;96:258-263.
33. Mohanty SK, Chauhan RK, Mazumdar S, Srivastava A. Out-of-pocket expenditure on health care among elderly and non-elderly households in India. *Social indicators research*. 2014;115:1137-1157.
34. Malik AM, Syed SIA. Socio-economic determinants of household out-of-pocket payments on healthcare in Pakistan. *International journal for equity in health*. 2012;11:51-58.
35. Samadi A, Rad EH. Determinants of healthcare expenditure in Economic Cooperation Organization (ECO) countries: Evidence from panel cointegration tests. *International journal of health policy and management*. 2013;1:63-68.
36. Andersson FL, Svensson K, de Verdier MG. Hospital use for COPD patients during the last few years of their life. *Respiratory medicine*. 2006;100:1436-1441.
37. Zhang P, Imai K. The relationship between age and healthcare expenditure among persons with diabetes mellitus. *Expert opinion on pharmacotherapy*. 2007;8:49-57.
38. Felder S, Meier M, Schmitt H. Health care expenditure in the last months of life. *Journal of Health Economics*. 2000;19:679-695.
39. Payandeh A, Mehrabi Y, Zayeri F, Ghahroodi ZR. Health Expenditure Modelling in Southeast of Iran: A Population-Based Setting Using Quantile Regression Perspective. *Health Scope*. 2017;6:1-6.
40. Spillman BC, Lubitz J. The effect of longevity on spending for acute and long-term care. *New England Journal of Medicine*. 2000;342:1409-1415.
41. Meerding WJ, Bonneux L, Polder JJ, Koopmanschap MA, van der Maas PJ. Demographic and epidemiological determinants of healthcare costs in Netherlands: cost of illness study. *Bmj*. 1998;317:111-115.
42. de Meijer C, Wouterse B, Polder J, Koopmanschap M. The effect of population aging on health expenditure growth: a critical review. *European Journal of Ageing*. 2013;10:353-361.
43. Gregersen FA, Godager G. The association between age and mortality related hospital expenditures: Evidence from a complete national registry. *Nordic Journal of Health Economics*. 2014;2:203-218.
44. Tchoe B, Nam S-H. Aging risk and health care expenditure in Korea. *International journal of environmental research and public health*. 2010;7:3235-3254.
45. Cutler DM, Meara E. The medical costs of the young and old: A forty-year perspective. *Frontiers in the Economics of Aging: University of Chicago Press*; 1998, p. 215-246.
46. Yazdi-Feyzabadi V, Bahrapour M, Rashidian A, Haghdoost A-A, Javar MA, Mehroolhassani MH. Prevalence and intensity of catastrophic health care expenditures in Iran from 2008 to 2015: a study on Iranian household income and expenditure survey. *International journal for equity in health*. 2018;17:44-57.
47. Eckardt M, Brettschneider C, van den Bussche H, König HH, Group MS. Analysis of health care costs in elderly patients with multiple chronic conditions using a finite mixture of generalized linear models. *Health economics*. 2017;26:582-599.