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Research Article

Investigating the desire to replace herbal medicines with chemical drugs

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Abstract

Background: In the most studies, differentiation of two issues: purchase quantity and willingness to purchase has not been considered. The purpose of this study was to eliminate the error caused by non-separation of these two issues.

Methods: Data were extracted from the raw data of the rural household expenditure and income survey plan of 2019. For removing sampling bias due to the low share of buyers of medicinal plants for treating in the society, the two-stage Heckman model was used countrywide.

Results: Based on the estimation results, for every ten million rials increase in drug cost and income, the willingness to pay for medicinal plants increases by 200 and 800 rials, respectively (P <0.01). Also, the presence of medicinal plants in the region and access to physicians increases the consumption of medicinal plants by 2.7 and 1.4%, respectively (P <0.01). But time and age of head of household had no significant effect at this level. The marginal effect indicated the location conditions of families (in terms of access to medicinal plants and treatment) are more effective than social and economic variables on behavior of people's willingness to buy medicinal plants. After estimating purchase function and calculate the elasticities, it turned out, medicinal plants are a normal commodity.

Conclusion: The results showed that the variables affecting the choice of medicinal plants are different from the factors affecting of consumption of these products in terms of type and amount of effect.

Keywords: Medicinal Plants, Rural Households, Heckman Two-Stage Model, Small Communities, Iran.

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Introduction

The oldest use of medicinal plants in the Middle East is from the Stone Age. In fact, by the 20th century, most medical scientific pharmacopoeias had been extracted from the same plant cultures of different nations (1-2). The utilization of medicinal and aromatics plants (MAPs) is common in countries with ancient civilizations, such as China, India, Egypt, and Iran. The results of Iranian historical studies have shown that the history of the use of medicinal herbs in Iran dates back to the time of Aryan civilization from about 6500 to 7000 BC when Zarathustra referred to the properties of medicinal plants in his writings (3-4). Many drugs, such as strychnine, aspirin, vincristine, taxol, artemisinin, and blind root, are plant. About a quarter of all drugs that are compounded in US pharmacies contain plant-derived active ingredient (5-6). Today total trade in MAPs is more than 10 billion US$ (2-3). Scientific studies have proven the efficacy and safety of some complementary therapies including medicinal plants in the treatment of some diseases (6-7). Although medicinal plants are generally less effective and accessible to people than medicinal plants, in contrast, fewer side effects and cheaper medicinal plants can offset the perception (8). According to the Islamic Republic of Iran's 20-year National Vision Document, it should be ranked among the top 12 countries in the field of industrial and medicinal plants for economic, social and health development (9-11).

Numerous factors have been mentioned in various studies on the factors that affect the consumption of plants as a medicine. People's attitudes and beliefs about the high healing and low risk of these products compared to chemical drugs are the most important factor (1-2, 6, 8, 10, 11-13). By Increasing people's knowledge of the properties of medicinal plants make increase their willing to consume these products (1, 8, 10-12,14). Other factor such as the advice of doctors is confirmed by some researches (1-2, 8, 12). Results of various of studies are showed that individual and social characteristics such as age (1-2, 14), gender (14), lifestyle (2, 6,14) region (1, 10, 15) Health status (2, 15, 16) has been effective. In addition, economic variables such as price (1, 8) and income of the household (1, 8, 16) were also shown to be effective in their acceptance of medicinal plants.

Despite numerous studies on the factors affecting the consumption of medicinal plants, in most of these studies the statistical population is limited to those who consume these products. Therefore, it ignores the information of other people, which will bias the results. In marketing, there are distinctive buying behaviors and buying rates. The purpose of this study was to identify and measure the factors affecting the purchase intention and purchase rate of medicinal plants using the information of all consumers and non-consumers.

Methods

Design, setting and sample

In many regression models used to discover the relationship between a behavior and its effecting factors in a particular group of people, there are two types of errors, the non-random sampling error and the same error assuming the behavioral factors (here cost of medicinal plants). The non-random error of the sample is due to the fact that people who do not use plants and who did not choose it at all, are removed from the sample and their information is lost (1, 11).

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However, non-consumption means that they have not reached the threshold of purchase preference. The second error is due to the assumption that the same factors determine the amount of medicinal plants purchased. They are exactly the ones that effect the selection of plants while they can be different (10-12). The Tobit pattern reduces the first error by using both medicinal plant users and other individuals. But to mitigate the second error, Heckman proposed a two-step algorithm that utilized information from both groups (2). The first equation is selection, which includes Probit regression. In this model, factors affecting the selection (or non-selection) of medicinal plants are examined (1, 2). The second model, which is a multivariate linear regression, identifies and quantifies the factors affecting the decision on the cost of medicinal plants.

People who do not exhibit buying behavior of medicinal plants have a willingness to buy (Y*) less than the price of the medicinal plants and therefore what is observed is non-buying behavior (2). Purchasing behavior is observed for people whose willingness to buy medicinal plants (Y*) is greater than its price and therefore Y = 1. Thus, the Probit pattern is defined as follows:

$$Y_i = Z_i\beta + \varepsilon_i \qquad Y_i = 0 \quad if \quad Y_i^* < \tau$$

$$Y_i = 1 \quad if \quad Y_i^* > \tau$$

In function (1) Z is the set of variables affecting the selection of medicinal plants and ε is the residual random variable. Y* hidden variable and Y behavioral variable visible. ß is a vector of pattern parameters (unknown) that should be estimated. After estimating the parameters of the selection model, the decision model is estimated based on the relationship between the variables affecting the amount of medicinal plants purchased (13). The following linear regression is used here:

$$Q_i = X_i\alpha + \sigma\lambda_i + \psi_i \qquad (2)$$

In function (2) Q, the cost of purchasing medicinal plants, X is the variable affecting purchasing behavior, λ is the inverse ratio of Mil's (IMR) that connects the first regression to the second, α and σ (unknown) parameters are estimated, and Ψ are random variables. IMR(λi) of relationship.

$$\lambda_i = \frac{\phi_i(Z_i\beta)}{\Phi_i(Z_i\beta)} \qquad (3)$$

Where ϕi (Zi β) is a density function and Φi (Zi β) is a cumulative distribution function of a random term. At this stage, after entering the inverse variance of likelihood, if the coefficient is statistically significant, omitting the zero observations (people who did not purchase medicinal plants in the year under study) would cause the model parameters to be skewed, in other words, using the two-step model Heckman seems necessary (10-12). Applying the two-step model in addition to eliminating the skew, eliminates the heterogeneity variance and increases the estimation efficiency.

The data were extracted from the raw data of the rural household expenditure and income survey plan of 2019. Cost data were obtained from Section 6 (Household Health Costs) of Section III and income data were collected from Section IV. The sample included 12184 households. Extracted variables included medicinal plants cost (to determine Y and Q), household head gender and age, income and medication cost for X functions, household head gender and age, literacy, medication income and expense, treatment share of household income for the function Z was chosen based on the information constraint.

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The expenditure and income plan of rural households in 2019 was done based on the information of 18251 rural households across the country by stastical center of Iran. The target population of this plan includes all households living in rural areas. These sample households were selected from 395 cities in the rural areas of the whole country. figure 1 shows a summary of the expenditures share of a rural households in 2019.

Results

Map 1 shows size of the annual rural market of herbal medicine in different provinces of the country according to the data of the Population and Housing Censuses (published by Statistical Center of Iran 2018) and research data. The annual rural market size of herbal medicine in the country is estimated to be about 80 million $US. Also, Iran's map in map 1 indicates that the market value of medicinal plants in different regions is not the same. On average, the consumption cost of these products in deprived and underdeveloped provinces is higher than other provinces.

Of the 12,184 households participating in the survey, 10,377 (85%) were male household heads. The gender of the household head was effective in purchasing medicinal plants so that male-headed households spent about 64% more than female-headed households. This may be due to the difference in income. On the other hand, the level of head-of-household literacy, either through traditionalism or through medical knowledge, may have different effects on herbal medicine consumption. Of the total households, 7771 were literate (about 64%) and the rest were very poor and illiterate. Research data show that households with a literate household head paid about 60% more than others in the month under study (Fig 2).

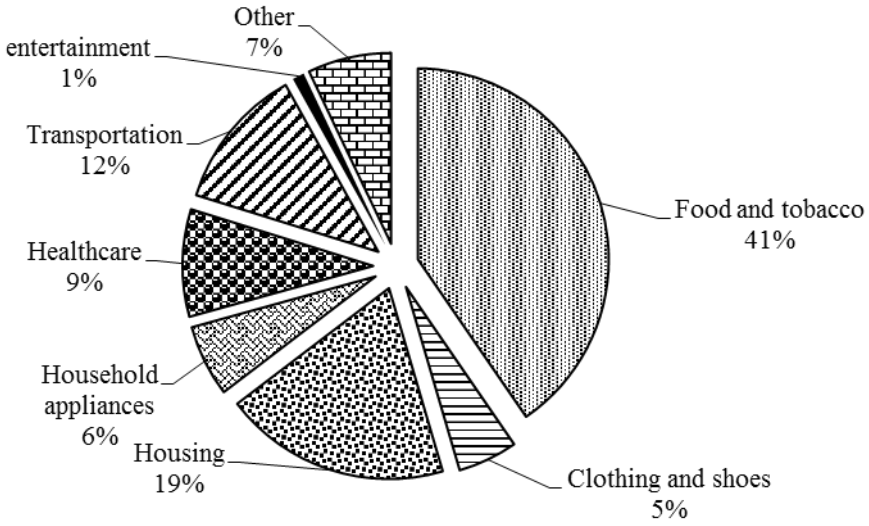

Fig1. Composition of expenses of a rural household in 2019

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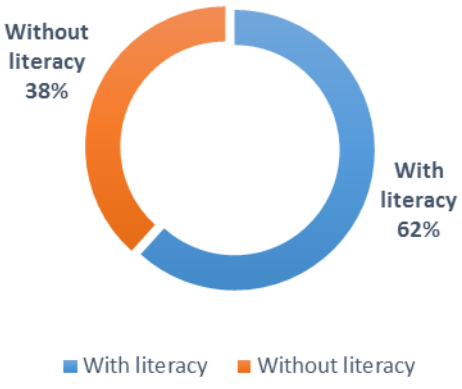
map1. Herbal medicine purchase per capita in rural regions, IRR per month Source: Research results, data taken from Statistical Center of Iran (2019)



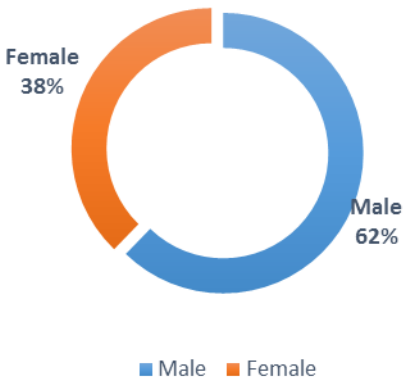


Fig2. Average monthly cost of medicinal plants per household in 2019 by gender and literacy

According to Figure 3, based on the extracted data, a large part of the rural community still does not buy medicinal plants. Studies examining people's purchasing behavior from medicinal plants, with the

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elimination of much of the community's information, are likely to get bias results.

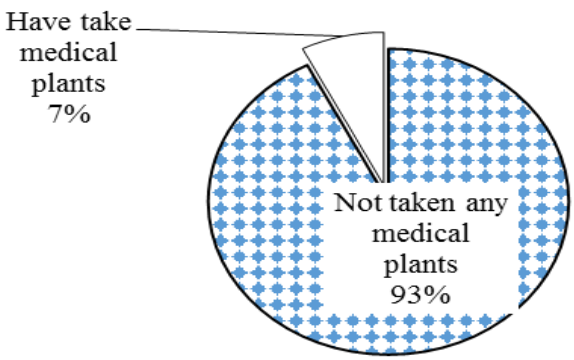

Fig 3. Share of households that purchased and consumed medicinal plants at least once

Household income is one of the important variables in deciding to buy. Table 1 shows the share of the costs of medicinal plant and chemical drags per decile, using the ten households by income levels. According to Table 1, there is no particular order of income deciles. For example, in the three deciles of the lowest-income households, the lowest decile pays the most for medicinal plants, but from the fourth to tenth decks there is no particular trend. According to past studies, economic variables such as income levels, medicine prices and family health levels are expected to be effective on the above changes. What can be conclusively concluded is that the share of medicine in household income is higher in the poor than in the wealthy. The lowest-income families, according to the table 1, spend 18.23% of their income on a variety of chemical and plants medicines. This share is the highest in all income deciles. The high ratio can be a sign of physical weakness in this deck (the face of the deficit), which is not out of mind due to malnutrition and poor quality of life, but is predicted mostly because of their low income (the denominator of the deficit). Given the large income gap in the community, it may be misleading to compare purchases and even the share of medications to show the effect of earnings (purchasing power) on medication preferences. For this reason, part of table 1, presents the proportion of households spending on the purchase of a medicinal plant over a chemical drug that indicates the importance of the plants medicine in the household basket. This share has an irregular trend from low to high income deciles. However, the proportion was no more than 5% in any decay.

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Table 1. Average cost of chemical drugs and plant medicines and their importance by income deciles

Income deciles	Average annual income ($US)*	Monthly average medication plants (($US)	Share of medication from Income (%)	Share of medicinal plants (%)	Share of chemical drugs (%)
1th decile	6190	0.28	18.23	0.53	3
2nd decile	11904	0.23	9.64	0.24	2.5
3rd decile	16904	0.16	7.91	0.12	1.5
4th decile	22380	0.24	5.49	0.13	2.4
5th decile	28095	0.23	4.16	0.1	2.5
6th decile	33333	0.34	3.85	0.12	3.3
7th decile	39285	0.30	3.63	0.09	2.6
8th decile	47142	0.39	3.13	0.1	3.3
9th decile	59761	0.61	2.68	0.12	4.7
10th decile	97142	0.31	1.96	0.04	2

The official exchange rate in 2019 equaled 1 $US=42,000 Rials

After adjusting the required data and the available two-stage Heckman function with maximum likelihood, the estimation and its results are summarized in table 2. According to the method described above, the selection function (whether or not to buy herbal medicine) was first estimated using a Probit function.

The results show that among the entered variables, medication cost, income, dummy variable of medicinal plants production poverty in the region, dummy variable of physician poverty in the region and family size have significant effects (P <0.01) but month (Questioning time) and age of head of household had no significant effect at this level. Concerning the effective variables, their marginal effect is presented in the last column (Table 2). According to the results, a one million Rials increase in the monthly medication cost reduces the probability of purchasing medicinal plants by about 2.67%. In other words, medicinal plants are less important for households with high chemical drug use, and these two do not replace each other. The positive sign of this coefficient indicate that people use herb for protecting their health, not to cure the disease. Similarly, increasing one person to household size reduces the likelihood of purchasing medicinal plants by about 0.078%, so they are more likely to be used in smaller families. On average, with one thousand Rials growth in household income, the probability of buying herb will increase by about 0.8%. For families who was living in unfavorable areas for growing herb its buy likelihood about 2.78 percent less than others. Also, areas where it is more difficult to access doctors are 1.4 percent more likely to buy medicinal plants. This result and the negative effect of chemical drugs can show that physicians do not believe much in herbal as disease healer. In this way, the location

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Conditions of families (in terms of access to medicinal plants and treatment) are more effective than social and economic variables.

show that consumer behavior does not depend on time, neither in the decision to choose them nor in the decision for the amount of the relevant cost. In both stages, the effect of the month (time) is not significant. Be statistically significant of Mills' reverse coefficient indicates that not using Heckman's two-step model causes a bias in estimates.

Table 2. Results of Heckman Two-Stage Model Estimation to Identify Factors Affecting Medicinal Plants Consumption in Iran

Model	Variable	Coefficient	Std. Err	P>|Z|	Elasticity
Decision equation: The cost of plants medicine	Medicine cost **	-6.04×10-8	1.44×10-8	0.00	-0.161
	Income**	0.0002	0.00007	0.00	0.22
	Month	- 0.002	0.0024	0.41	
	constant**	-0.71	0.0298	0.00	-
	Mills revers ratio**	0.496	0.0135	0.00	-
Model	Variable	Coefficient	Std. Err	P>|Z|	Marginal effect
Equation of choice: Herbal medicine selection model	Medicine cost **	-1.2×10-7	2.8×10-8	0.00	-2.67×10-8
	Income**	0.0005	0.0001	0.00	0.00008
	Month	-0.0025	0.0048	0.61	
	Product1**	-0.0177	0.0068	0.01	- 0.0278
	Doctor1	0.011	0.0068	0.1	0.0142
	age	-0.00032	0.00021	0.13	
	Size**	-0.0074	0.0021	0.00	-0.00078
	constant**	-1.45	0.0455	0.00	-

** and * were significant at 1 and 5%

After estimating the selection model, and censoring people who do not buy any medicinal plants, in stage two with a linear regression, the factors affecting the monthly purchase of these products were measured. As expected, family income has been a positive and significant (P<0.01) effect on the monthly cost of these products. Due to the income elasticity (shown in Table 3), medicinal plants are a normal commodity. On average, one percent increase in family income cause increases a 0.22 percent increase in its expenditure. In return, increasing the monthly cost for buying chemical drugs causes a significant reduction in the purchase of herb. On average, one percent increase in the cost of buying chemical drugs will result in a 0.16 percent decrease in the purchase of medicinal plants. Although the production of medicinal plants is seasonal, the estimation results

To show the amount of deviation if the censored data is not used, the linear regression model was estimated using all the data once. The results are presented in Table 3. Comparing these results with the results of the second stage of the Hackman model shows that the size and sign of the coefficients have very changed. Figure 4 shows the amount of bias. Because the high volume of data and the small share of people who consume medicinal plants, the difference in slopes is very huge.

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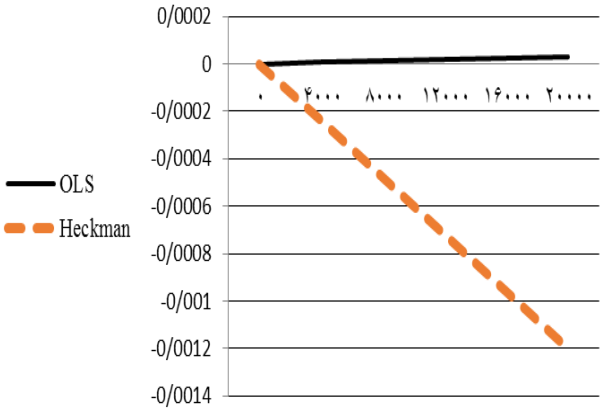
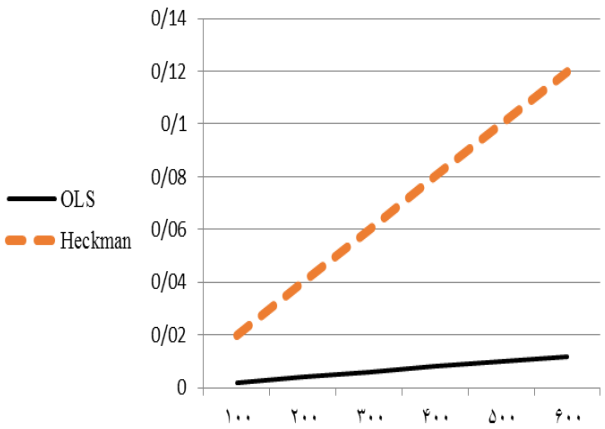
Table 3. Results of OLS Model Estimation to Identify Factors Affecting Medicinal Plants Consumption in Iran

Model	Variable	Coefficient	Std. Err	P>|t|
Decision equation: The cost of plants medicine	Medicine cost	1.36×10^{-9}	1.3×10^{9}	0.296
	Income*	0.00002	7.9×10^{6}	0.004
	Month	- 0.0003	0.00026	0.21
	constant**	0.112	0.0023	0.00

*** and * were significant at 1 and 5%*



A: Medicine cost as health statue of household



B: total Income of household

Fig 4. Sampling bias of Decision equation: The cost of medicinal plants

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Discussion

In most related studies, the two issues of purchase behavior and willingness to buy (as a primary requirement for purchasing) have not been distinguished. This study aimed to eliminate the bias caused by non-separation of the two. Data were extracted from the rural household income expenditure data published by Statistical Center of Iran (SCI). Sample includes 12,184 households across the country. Descriptive results showed that the purchase of medicinal plants was higher in male-headed households than female-headed ones. Educated household heads pay more for the purchase of medicinal plants than others. More than 90% of households did not pay for the survey in the month leading up to the survey. Consumption of medicinal plants in middle income deciles is relatively more important.

The Hackman two-step model was used for quantitative analysis. After estimating the selection model, results indicate that drugs cost, family income, difficult access to herb and physician in the place of residence and family size have significant effects but time and age of head of household had no significant effect at this level. Therefore, location conditions variables than social and economic variables on selecting the medicinal plants are more effectiveness (2).

In second stage, after censoring data which did not buy any herb; we measured the factors affecting the monthly purchase of these products with a linear regression (1, 11). Family income has been positive effect and chemical drugs cost has been negative effect. According to the calculation of elasticity, herbs are normal commodity because one percent increase in family income cause increases (decrease) 0.22% (less than 1%) increase (decrease) in its expenditure. Also one percent increase (decrease) in the cost of buying chemical drugs will result in a 0.16% decrease (increase) in the purchase of medicinal plants. Statistically significant of the Mills' reverse ratio indicates that Heckman's two-step model utilization is correct. Fallow estimating the model, without censoring the data, it was proved that this estimate has a large bias and gives different (and wrong) results. if higher censored data, then higher the bias.

Limitations

Due to the limitation of information in this research (in terms of accessible variables), it is suggested that in future studies,

1- The study should be done in the field and via questioning,

2-The level of people's knowledge of the medicinal properties of plants should be measured and as an effective variable in the consumption behaviour,

3- Medicinal plants should be classified and investigated according to the type of effect

Conclusion

The use of plants as a medicine has a long history in human date and is far more than chemical drugs. In recent decades, due to the effects of chemical abuse, the willingness to medicinal plants has increased again (13). Given its knowledge in countries with a long civilization such as Iran, investment and development of the industry has a comparative advantage for the country. Accordingly, special attention has been paid to it in the national 20-year vision document of Iran. Pay attention to the status and promotion of each industry is important for the development of any industry.

The purpose of this article is to measure the impact of individual, social, economic and health variables on the willingness of people to replace medicinal plants with chemical drugs. Due to the small share of medicinal herb users to the total number of medicinal users, Heckman's two-stage model was used to delete sampling bias. The results showed that the willingness to pay for medicinal plants increases by increasing of health cost, household income, presence of medicinal plants in the region, unaccess or limitation of access to physicians.

The author of this article did not find any similar study that has the same purpose and method as the present research. But many studies of other

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methods and for other purposes were conducted on medicinal plants, which were mentioned in this article.

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Conflict of interests

The authors declared no conflicts of interests

Author's contribution: : All the necessary activities for doing this research, including variable selection, data collection, model selection, model estimation, interpretation of results and writing have been done by me.

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