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Food Production Diversity and Diet Diversification in Rural and Urban area of Iran

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Abstract: The food security paradigm shifted from diet quantity to diet quality and consumption of a satisfactory amount of micronutrients around the world. Low dietary diversification and imbalance consumption of food groups are the main characteristics of Iranian households. Food production diversity can be a significant determinant of dietary diversity in developing countries such as Iran. Thus, this research tries to examine the impact of food production diversity alongside the socioeconomic and sociodemographic determinants on dietary diversity in rural and urban areas of the country. For this aim, a panel data set is constructed based on all the available data in rural and urban areas of 31 provinces of Iran from 2011 to 2016 and panel quantile regression applied to investigate the impact of the control variables. The main results indicate that food production diversity, household income, the share of food in household expenditure, literacy rate have a positive and significant impact on the dietary diversity in rural and urban regions of the country. Moreover, the food price index has a negative and significant effect on dietary diversity in both regions. Finally, the age of head of household and family size only has a negative impact on diet diversification in rural areas. According to these results, encouraging small farmers to change their production patterns to a more diverse pattern in a short time, and pursuing multidimensional approaches such as the promotion of agricultural value chain should be considered by policymakers to improve the dietary diversity in rural and urban areas. Furthermore, the establishment of rural retirement found and redistribution of current income subsidy can help the elderly and extended family in rural areas to enhance their diet quality. Finally, design a price monitoring approach alongside a flexible trade strategy to manage the food market prices can help households to consume the appropriate diet with enough micronutrients.

Keywords: Food and nutrition security, Shannon entropy Index, Quantile Regression, Panel data

Introduction

Malnutrition, including undernourishment, micronutrient deficiency, and overnutrition remains one of the biggest challenges to global development (Luckett *et al.* 2015). Between these issues, micronutrient deficiency in the household diet is the most troublesome challenge, because it creates inappropriate health outcomes, especially in

vulnerable (Drimie *et al.* 2013). In recent years it established that calorie intake reaches a satisfactory level in the world and many nutritional problems are not caused by the inadequacy of per capita energy intake, but a lack of diet quality (Carletto *et al.* 2013). Therefore, measurement of diet quality indexes gains considerable attention and dietary diversity considered as a proxy to measure nutritional quality (Ayenew *et al.* 2018; Mango *et al.* 2014).

In general, low diet quality characterized by a high proportion of starchy food and an insignificant amount of vegetables and animal sources and represents a low dietary diversity (O'Meara *et al.* 2019). Consequently, low dietary diversity could lead to increase the risk of nutrient deficiency in different vulnerable groups such as children, adolescent and elderly (Nachvak *et al.* 2017); moreover, it negatively affects adult work productivity, impaired physical and mental development and increase under five years mortality rate (Ochieng *et al.* 2017). On the other hand, a more diverse diet that includes all the food groups leads to a healthy population and helps to obtain optimal growth and development (Ciaian *et al.* 2018).

Dietary diversity defines a number of foods group consumption over a reference period. This index indicates that an increase in dietary diversity helps to ensure adequate intake of vital nutrients (Mukherjee *et al.*, 2018). Dietary diversity can represent nutrition adequacy and diet quality. Therefore, providing a healthy and diverse diet is the main pillars of sustainable strategies for overcoming global malnutrition (Powell *et al.*, 2017).

In most developing countries, household food consumption attached to agricultural production on the local scale (Koppmair *et al.*, 2017). Household diets in such regions mostly include the agricultural commodities produced in the same region. In recent decades, the transition from diversified cropping system toward cereal base system, on one hand, raise the availability of staple crops and per capita calories intake; on the other hand, the nutritional diversity of the global food system has remained largely stagnant (Remans *et al.* 2014). This issue becomes critical for developing countries because, for many years, the government navigates agricultural production through supportive policies to produce staple crops such as grain to provide the required energy consumption of households. Nevertheless, this agricultural production system cannot provide essential micronutrients (Koppmair *et al.*, 2017). Because of this monoculture system alongside the poorly developed market infrastructure and high transactions costs of smallholder integration into the fresh fruit, vegetable, and livestock value chain, the supply of fruit, vegetables, meat, and dairy has not kept up with growing demand for consumption of these products (Pingali, 2015; Snapp and Fisher, 2014). Therefore, the prevalence of micronutrient deficiency turns in to a widespread challenge in the developing world (Sharma, 2018).

In Iran like many other developing countries because of income increase, urbanization, and change in people's attitude toward health, household diet shifts away from coarse grain and other vegetables toward a more diverse diet that includes consumption of more sugar, animal protein and, edible oils (Liu *et al.* 2014; Pingali 2015). Most studies in this area focused on a specific region or different population groups (Abdollahi *et al.*, 2014; Azadbakht *et al.*, 2015; Ghasemifard *et al.*, 2017). These Microscale studies conclude that low dietary diversity and imbalance consumption of food groups are the main characteristics of Iranian households at different income levels and between different subpopulation groups.

In the last decades, agricultural production policy support in Iran tends to increase the production of staple crops. In other words, agricultural policies are not in harmony with the diet transition. Therefore, there is a substantial gap between the consumer's demand and food production. This one-sided supportive policy approach can lead to low agricultural production diversity and, as a result, a significant gap between consumption and food production patterns might emerge (Koppmair *et al.*, 2017). Given the existing

gaps in the macro-scale studies, the present study contributes to the literature by using nationally representative data that contains information on household consumption, agricultural production, and geospatial variables to examine the link between agriculture production diversity and dietary diversification in rural and urban areas of Iran. Since household consumption pattern in rural and urban areas are different; therefore, in this study, impact of dietary diversity determinants have been investigated separately in rural and urban areas of Iran.

Background

In the last decades, dietary diversity gains considerable attention as a proxy of diet quality. Diet diversity is a quantitive measure of consumption that indicates the household access to different food groups and how evenly household food requirements provides from various food groups; therefore higher food production diversity index can be translated into higher demand for the variety of food groups (Kennedy *et al.*, 2010). Many studies indicate that diverse food production patterns, which define as the production of different food groups, have the potential to positively affect the dietary diversity via the production of food for own consumption and income effect (Pellegrini and Tasciotti, 2014; Ayenew *et al.*, 2018; Zanello *et al.* 2019). Firstly, the household grows its food and, more diverse production leads to a more diverse diet. In a second way, a more diverse food production pattern can boost household income, and additional income can be utilized for a more diverse diet (Demeke *et al.*, 2017).In a complex and developed food system, long value chains and large-scale food processing and retailing emerge as a vital pathway to improve dietary diversity (Ridoutt *et al.*, 2019). In such conditions, household consumption and production decisions are completely separable (Zanello *et al.*, 2019). However, in the least developed regions, with the simple food system due to the absence of a developed food supply chain and insufficient household income only, diverse food production pattern can improve the diet diversity and, household production and consumption decision are dependent on each other (Ridoutt *et al.*, 2019; Zanello *et al.*, 2019). Therefore, food production diversity is a vital factor in the transformation of dietary diversity in developing countries.

Many studies also revealed that demographic aspects and household Socioeconomics characteristics are the main effective components that shape household dietary diversity (Taruvinga *et al.*, 2013; Doan, 2014; Powell *et al.*, 2017; Ochieng *et al.*, 2017). Mayén *et al.* (2014) indicate it's more likely that household with higher Socioeconomics characteristics consumes more diverse basket of food products with the better quality; these households regularly consume a considerable amount of whole grains, meat, fish, fruit, and vegetables. On the other hand, a household with lower Socioeconomics statues relies on more staple food and fat to satisfy their energy requirements (Dillon *et al.*, 2015). Level of income, the share of food in household expenditure, and education generally considered Socioeconomics characteristics. While the increase in household income only leads to diet transition, improvement in the level of education can reverse, mitigate, and prevent the negative impact of nutrition transition and change the household food consumption toward a more diverse and healthy diet (Powell *et al.*, 2017). Household size and age of household head are other well-known Socioeconomics characteristics of the household that might have a significant impact on the dietary diversity of households (Taruvinga *et al.*, 2013).

Alongside these variables, some studies provide enough evidence that variables such as food price index is the other effective determinant of dietary diversity (Dillon *et al.* 2015; Koppmair *et al.*, 2017; Krishna Bahadur *et al.*, 2018; Zanello *et al.*, 2019). In general, an increase in food price have a direct impact on their affordability and both

quality and quantity of diet. Evidence showed an increase in food price not only reduce the consumption of micronutrient-rich food but also reduces the consumption of staple food such as cereal (Green *et al.*, 2013; Herforth and Ahmed, 2015). in the region especially in the rural area of developing countries where access to the market is difficult and expensive.

Materials and Methods

Study Site, Sampling and data collection

This study conducted base on the Households Income and Expenditure Survey data, which gathered by the Statistical Center of Iran. The HIES provides the average income and expenditure for urban and rural households at provincial and country levels. It makes it possible to come to the household's income and expenditure composition and distribution patterns, the household consumption pattern, the weight for each commodity in the household consumption basket. The HIES target population includes all private and collective settled households in urban and rural areas. A three-stage cluster sampling method with strata used in the Survey. In the first stage, the census areas are classified and selected. In the second stage, the urban and rural blocks are selected and the selection of sample households is done at the third stage. In order to obtain estimations more representative of the whole year, the samples evenly distributed between the months of the year. In this study, most of the variables are extracted from this data set. Base on the literature review, in this study socioeconomic and sociodemographic determinants such as level of income, the share of food in household expenditure, age of head of household and, household size alongside the food price index and food production diversity considered as the main control variables. Stata software is used to estimate the relevant coefficients. Based on the data availability, the study was conducted at the provincial level and can be categorized as a macro-scale study; therefore, and all the variables are included in the analysis as a provincial average. Considering the advantage of both cross-sectional and time-series a panel data set is constructed based on all the available data in rural and urban areas of 31 provinces of Iran from 2011 to 2016. Description of these variables along with the sample mean values are presented in table 1.

Table 1 - Study variables used in the estimation

VARIABLES	SOURCE (UNIT)	RURAL AREA				URBAN AREA			
		Average	St. dev.	Min	Max	Average	St. dev.	Min	Max
Shannon Dietary Diversity	Study calculation (-)	1.8	0.11	1.53	2.08	1.9	0.09	1.6	2.1
Food Production Diversity	Study calculation (-)	1.59	0.16	1.20	1.88	1.59	0.16	1.20	1.88
Household Income	Iran Statistical Center (Million Real)	386831	112384	169923	752382	564168	150373	315779	1140184
Share of Food in Household Expenditure	Iran Statistical Center (Percent)	43.9	11.5	21	96.2	30	7.3	11.1	50.1
Age of the Household Head ()	Iran Statistical Center (Years)	51.2	2.7	44.2	57.6	49.3	2	42.5	54.3
Household Size ()	Iran Statistical Center (Number)	3.70	0.46	2.82	4.99	3.6	0.36	2.9	4.8
Literacy Rate (%)	Iran Statistical Center (Percent)	77.3	4.2	63.1	85.3	89	2.47	81.9	93.4

Food Price Index (%)	Iran Statistical Center (Percent)	216.8	41.7	142.8	264.7	221.543	0.72	143.4	272.6

Source: Research Findings

Dependent Variable

Dietary diversity can measure by several approaches; Between these approaches count measures are the most popular method and frequently used in literature (Ajani 2010; Snapp and Fisher 2014; Vellema *et al.* 2016). However, count base methods have two significant disadvantages. First of all, the consumption of a minor food item counts as same as the consumption of the important diet component. In other words, such indexes cannot capture the food items distribution in the household diet. Furthermore, count base indexes are sensitive to the recall period. For example, dietary diversity in a 24-hour recall period might be smaller than dietary diversity in 7 days recall period (Carletto *et al.* 2013; Vellema *et al.* 2016). Consequently, in this study Shannon entropy diversity metrics measured as an index of dietary diversity. Shannon entropy index not only captures the richness of the diet but also shows the evenness of different food group's distribution (Krivonos and Kuhn 2019; Remans *et al.* 2014). Shannon entropy index calculates as follow:

$$SE = \sum_{i=1}^{s} -(P_i \times \ln P_i) \quad (1)$$

Where SE is a Shannon entropy index, and P_i is the provincial average of the share of each food group in the total energy consumption of households.

As such the same method can be applied to measure the relative abundance of each food group in a region without explicit consideration of their nutrition (Remans *et al.* 2014). It should be noted that in food production diversity calculation P_i is the provincial average of the share of each food group in total food production in each province.

Econometric Approach

Our particular interest is to investigate the impact of food production diversity on dietary diversity in the rural and urban areas. In order to evaluate the effect of control variables on dietary diversity; we use the following regression model in rural and urban areas:

$$SDDit = f\ (FPD_{it}, HI_{it}, HFE_{it}, HHA_{it}, HS_{it}, LR_{it}, FPI_{it}) \quad (2)$$

Where SDD_{it} is an average of household Shannon dietary diversity index in province *i* in year *t*, FPD_{it} is the provincial food production diversity, HI_{it} is average of Household income in the *i* province in time *t*, HFE_{it} is the provincial average of the share of food in household expenditure, HHA_{it} is the provincial average age of the household head, HS_{it} is a provincial average of household size, LR_{it} is a provincial average of Literacy rate, and finally FPI_{it} is a provincial average of the food price index. All the control variables are extracted from the previous studies which are presented in the background section.

In this study quantile regression for panel data chosen In order to investigate the impact of control variables on the entire distribution of dietary diversity of rural and urban areas, this approach provides a more thorough picture of the relationship between the dependent and independent variables (Tilov *et al.* 2020). Quantile regression first

introduced by Koenker and Bassett (1978) as a robust alternative of OLS method when the error term does not follow the normal distribution. This method has been widely used in social science; however, because household dietary diversity is sensitive to small changes in food consumption composition some researchers applied quantile regression in dietary diversity studies (Ayenew *et al.* 2018; Das 2014; Drescher *et al.* 2011). The quantile regression for dietary diversity is expressed as follow:

$$Q_q(DD_{it} \mid X_{it}) = X'_{it}\beta_{(q)} \quad q \in (0,1) \qquad (3)$$

Where DD_{it} is a dietary diversity, $Q_q(DD_{it}|X_{it})$ identifies the qth conditional quantile of DD_{it} and $\beta_{(q)}$ is a specific coefficient of control variables in each quantile and X_{it} is a vector of regressors.

So far, various approaches were developed for the estimation of quantile regression in panel context. However, most of these techniques use additive fix effect components and considered restricted assumptions about the individual fix effects (Tilov *et al.* 2020). The inclusion of additive fix effect components alters the interpretation of the parameters of interest by separating the disturbance term into different components and assuming that the parameters do not vary based on the fixed effect (Powell, 2015). Because of this restriction, the model introduced by Powell (2015) was applied to estimate the coefficients. In this approach, within-group variation has been used for identification purposes. This approach provides a condition for maintaining the non-separable disturbance term generally related to quantile estimation (Aldieri and Vinci 2017). Also, in the Powell approach, the fix effects are never estimated and, the coefficient is consistent for the short-time period (Powell, 2015).

Results and Discussion

Results of quantile regression for three quantiles of the conditional distribution of dietary diversity in rural and urban areas are presented in table 2. According to results and an increase in food production diversity, increase the dietary diversity in all quantile of the conditional distribution in rural and urban areas; however, its' impact much more substantial in the rural areas. These results imply that in the same area, rural households rely on local food production to reach diet diversity more than the urban household. On the other hand, the importance of food production diversity decline in the third quantile in both rural and urban areas. These results specified that households with the highest level of dietary diversity do not depend on local food production. According to estimated coefficients, the food system in the rural area is dependent on local food production. Also, the food supply chains do not develop in these areas. Therefore, household production and consumption are dependent on each other. On the other hand, a smaller impact of food production diversity on diet diversity showed that food supply chains are developed in urban areas and, household's diet are not dependent on local food production. These results are in accordance with the results of Ayenew *et al.* (2018) and Ecker (2018); which, indicated the improvement of food production diversity led to a more diverse diet.

According to estimation results increase in household income can improve household dietary diversity in both rural and urban areas. As a matter of fact, increase in household income upsurge the ability of the household to buy vegetable, fruits, and meat which are the expensive sources of energy for household especially in rural areas (Taruvinga *et al.* 2013). However, it should be noted that the influence of income improvement on dietary diversity in rural areas is greater than the urban regions. These results imply that rural households are willing to devote a higher share of their income increase to provide a more diverse diet. Since the level of dietary diversity in rural areas are lower than the urban

areas, allocating a considerable share of income increase to achieve a more diverse diet is not surprising.

In agreement with the other studies (e.g., Obayelu and Osho, 2020) Increase in the share of food in household expenditure has a positive and significant impact on household dietary diversity in both rural and urban regions and impact of this variable decrease from the first to third quantile. In other words, an increase in the share of food in the household expenditure not only allocated to provide sufficient energy for household members but also used to buy a variety of different food groups with higher expenditure. Base on the results it seems that households with lower dietary diversity allocate a greater amount of the new budget in order to consume a diversified diet.

Table 2 - Results of Quantile Regression for Panel Data

VARIABLES	RURAL AREA			URBAN AREA		
	$q_{0.25}$	$q_{0.5}$	$q_{0.75}$	$q_{0.25}$	$q_{0.5}$	$q_{0.75}$
Food Production Diversity	0.14***	0.13***	0.017Ns	0.054***	0.054***	0.022***
	(0.027)	(0.03)	(0.019)	(0.022)	(0.026)	(0.011)
Household Income	0.29***	0.27***	0.13***	0.17***	0.16***	0.1***
	(0.015)	(0.009)	(0.022)	(0.013)	(0.023)	(0.017)
Share of Food in Household Expenditure	0.22***	0.19***	0.11***	0.12***	0.11***	0.07***
	(0.016)	(0.01)	(0.006)	(0.004)	(0.02)	(0.01)
Age of the Household Head	-0.21**	-0.15***	-0.06*	0.2***	0.044***	0.07*
	(0.11)	(0.047)	(0.04)	(0.03)	(0.01)	(0.044)
Household Size	-0.29***	-0.14***	-0.14***	0.011Ns	-0.02Ns	-0.011Ns
	(0.067)	(0.05)	(0.03)	(0.06)	(0.07)	(0.023)
Literacy Rate	0.46***	0.41***	0.33***	0.81***	0.82***	0.52***
	(0.11)	(0.12)	(0.05)	(0.03)	(0.12)	(0.15)
Food Price Index	-0.35***	-0.12***	-0.1***	-0.16***	-0.13***	-0.07***
	(0.042)	(0.04)	(0.027)	(0.023)	(0.033)	(0.02)
Constant	Yes	Yes	Yes	Yes	Yes	Yes
Fix Effect	Yes	Yes	Yes	Yes	Yes	Yes
pseudo-R^2	35.3	35.8	32.4	42	43.4	44.1

Source: Research Findings, Standard errors reports in (),, ** and *** present the level of significance in 10, 5 and, 1 Percent and, Ns shows the non-significant coefficients.*

An increase in the age of household head in the rural area has a negative impact on household dietary diversity. On the other hand, this variable in the urban area has a positive and significant impact. It seems that in the rural areas, the level of household income would fall as the age of head of household increases, and it might be caused by the improper retirement service in the rural area of the country. Likewise, an increase in the household size in the rural area has a negative and significant influence on diet diversity; the estimated coefficients for this variable in the urban area are not statistically significant. In other words, increasing the family size puts an extra burden on the household expenditure of rural households; therefore, this condition might force the household to consume a less diverse diet. According to estimated coefficients increasing the literacy rate has a positive and significant impact on dietary diversity of rural and urban areas. This result can interpret from two aspects. First, an increase in the level of education can make available better job opportunities and improve the level of household income. Secondly, it can increase the level of household knowledge about the importance of dietary diversity. The results conform to the findings of Mango *et al.* (2014) and Dillon *et al.* (2015). Finally, an increase in the food price index has a negative impact on the dietary diversity in all the quantile of conditional distribution in rural and urban areas. An increase in food item prices has a direct impact on the affordability of food items and

both quality and quantity of diet. In order to verify statistical variation of coefficients along conditional distribution, a graphic display of all the estimated coefficients and their confidence intervals are presented in Figure 1.

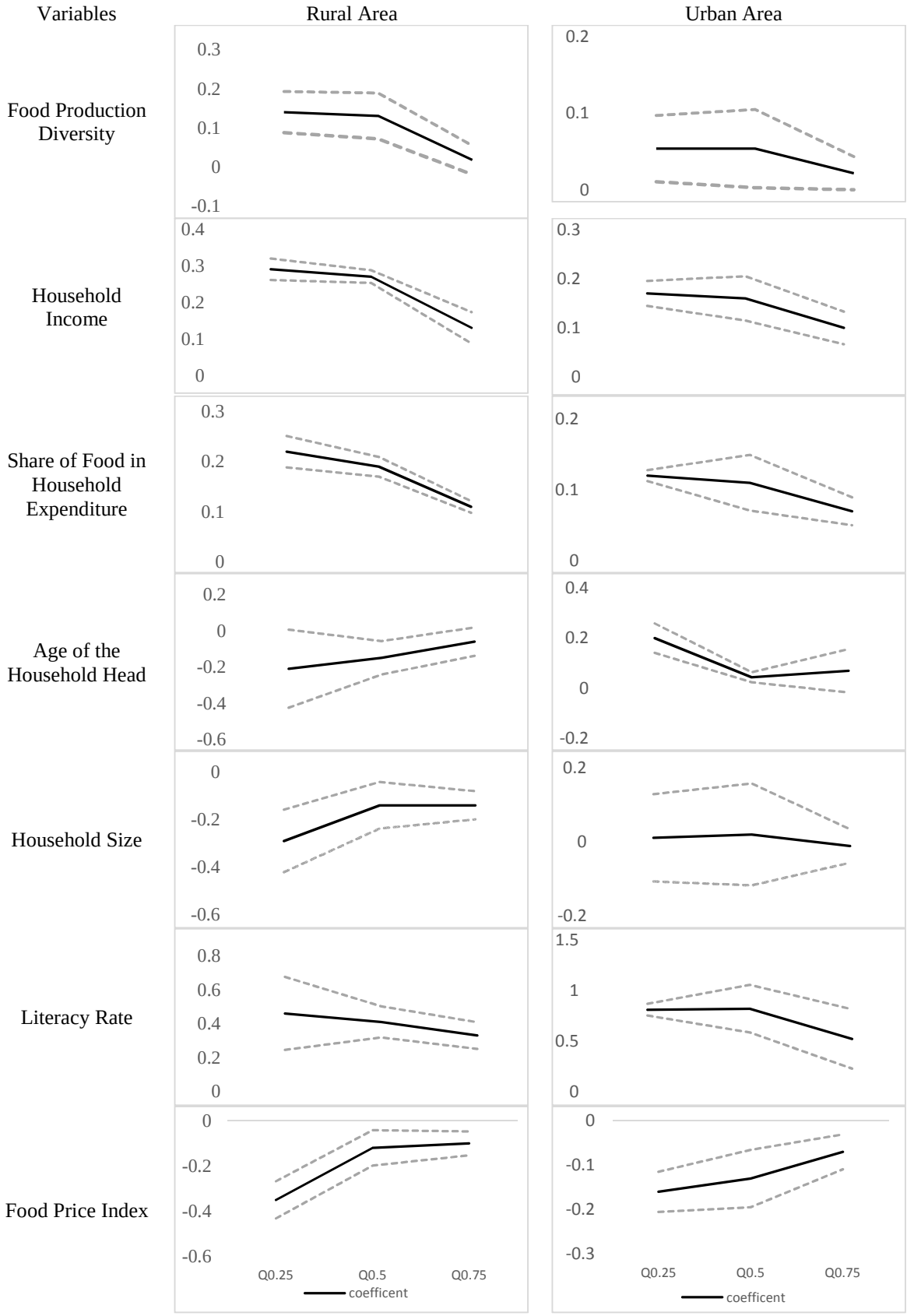

Figure 1 - Quantile Regression Coefficients and confidence intervals in different quantiles.

Conclusion

Nowadays, per capita energy intake reaches a satisfactory level around the world; therefore, the food security paradigm shifted from diet quantity to diet quality and consumption of a sufficient amount of micronutrients. Improvement of diet quality is achievable through better dietary diversity and the consumption of different food groups (Ayenew *et al.*, 2018). Low dietary diversity and imbalance consumption of food groups are the main characteristics of Iranian households at different income levels and between different subpopulation groups (Abdollahi *et al.*, 2014; Nachvak *et al.*, 2017). Food production diversity can be an important determinant of dietary diversity in Iran; therefore, this study concentrated on investigating the impact food production diversity alongside the socioeconomic and sociodemographic determinants on dietary diversity in rural and urban areas of the country.

The empirical analysis in this study shows that food production diversity is an important determinant of dietary diversity in rural areas. However, it's not a vital factor in urban areas. This result proved that rural farm production and household income, still matters for dietary diversity. Based on these results in the short term government should encourage small-scale framers a more diverse production pattern thorough redirecting current support policies. Moreover, policymakers could provide financial and support and learning procedures for poor nonfarmer rural households and poor urban residents to contribute to the creative method of vegetable products such as barrel gardening to produce vegetables for self-consumption (Walsh and van Rooyen, 2015). This method can improve dietary diversity in a poor household and do not put pressure on the government budget. However, in the long term pursuing multidimensional approaches such as the promotion of agricultural value chain especially in rural areas should be considered by policymakers, this policy help the household to sepreat the production and consumption decision and the income impact of diverse production dominate to its self-consumption effect (Zanello *et al.*, 2019).

The results also indicate that elderly and extended families in rural areas may not have a diverse diet and probably face micronutrient deficiency. The former may cause by inefficient retirement service in the rural areas, and the latter cause by the increasing cost of providing a diverse diet for a larger family. Thus, the establishment of rural retirement found by the government could be a suitable policy approach to secure elderly income and micronutrient consumption during their retirement. Furthermore, income subsidies which are currently distributed between all the Iranian household can be redistributed in favor of extended families in rural areas (Farsi Aliabadi *et al.*, 2020). Finally, the increase in food index price has a negative impact both on the rural and urban household (Krishna Bahadur *et al.*, 2018). Based on these results, it is suggested that the government design a price monitoring approach alongside a flexible trade strategy to manage the food market prices (Daneshvar *et al.*, 2019). This strategy help households to consume the appropriate diet with enough micronutrients.

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