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Dietary Diversity of Public Distribution System Beneficiaries Households in Villupuram District of TamilNadu, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aims: To assess the factors influencing dietary diversity of Pubic Distribution System Beneficiary Households in rural and urban areas.
Study Design: Purposive Random Sampling was used.
Place and Duration of Study: In Tamil Nadu, the Villupuram district was purposively selected for the study. The survey was conducted for the collection of primary data about the period April to May 2022.
Methodology: Based on the food security index of Tamil Nadu State Human Development Report 2017, the Villupuram district was selected for the study which falls under the low food security index. In this district, rural and urban households were randomly selected. The Simpson Dietary Diversity Index was used for the analysis. The Multiple Linear Regression method was used to understand the difference in food habits, quality of diet intake, and the socioeconomic and demographic determinants of the dietary diversity of public distribution system beneficiary households in the study area.
Results: The overall result of the Simpson Index of Dietary Diversity (SIDD) score of rural and

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urban households are 0.78 and 0.85 respectively. The results clearly showed that urban PDS beneficiary households had higher dietary diversity than rural PDS beneficiaries' households. Monthly income, age, household size, and distance of PDS shops may enhance dietary diversity, thereby improving the nutritional status of households.

Conclusion: The dietary diversity of rural PDS beneficiary households differs significantly from urban PDS beneficiary households, owing to a higher intake of nutritious foods in urban PDS beneficiary households for dietary diversity. Price subsidy on the staple food commodities has different effects on the consumption pattern and dietary diversity for low, middle, and higher-income people in Public Distribution System. This study suggests that PDS beneficiary poor people to buy cheaper items rather than high-value commodities such as fruits, milk, meats, and fish compared to high-income groups for dietary diversity.

Keywords: Dietary diversity; rural-urban households; multiple linear regression; food and nutritional security.

ABBREVIATIONS

SIDD : Simpson Index of Dietary Diversity
PDS : Public Distribution System
LIG : Low Income Group
MIG : Middle Income Group
HIG : High Income Group
FAO : Food and Agriculture Organisation

1. INTRODUCTION

Food security is a major concern for Asian countries, including India. India accounts for nearly 17.53 percent of the world's population and will surpass China by 2030, with a population growth rate of 1.58 percent. By the end of 2030, India is expected to have a population of more than 1.53 billion people [1]. Undernourishment and malnutrition have been major issues affecting the growth and development of many developing countries over time. In fact, solving these problems is one of the United Nations' Sustainable Development Goals (SDGs) [2]. Diet plays an important role in human life. Adequate diet and nutrition are important for good mental and physical health. Diet diversification is essential in overcoming malnutrition's triple burden: malnutrition (a lack of calories and proteins), micronutrient deficiencies, and excessive energy intake [3,4]. Inadequately diversified diets in terms of quantity and pattern in the food basket were always associated with less optimal growth, development, and long-term health outcomes [5]. Nutrition has decreased among adolescents, whereas overweight has increased significantly from 1.8% in 1999 to 7.5% in 2015 for boys and from 1.9% to 6.1% for girls during the same period. Accordingly, the prevalence of overweight and obesity, diabetes, and excess consumption has become more prevalent across all demographic people [6].

Tamil Nadu is a creative state in India for all types of food security programs. It has implemented a wide range of programs, from mid-day meal schemes to free or subsidized rice for all. The primary goal of these programs is to enhance food and nutritional security among households, regardless of income level [7]. In India, the Public Distribution System (PDS) is one of the most powerful and subsidized policies for alleviating hunger. Specifically, Tamil Nadu is a pioneer in implementing universal PDS (supplying free rice in notified quantities to diverse categories of people) as well as in all food security programs ranging from mid-day meal schemes to free rice distribution through PDS. In 2004, the state of Tamil Nadu started offering rice at a cost of Rs.2.00 per kg to people living in poverty, and the rice supply was extended free of charge in 2011.

Dietary habits have a significant impact on the population's quality of life. Dietary diversity, represented as the variety of foods across and within food groups capable of providing adequate intake of essential nutrients that can promote good health, can be defined as the variety of different types of food items included in a food basket [8,9]. The degree of diversity in household dietary habits is an indirect measure of diet quality or the amount to which households' nutritional needs are met. Diets with a higher range of foods or foods containing have higher energy and nutrient intake [10]. Understanding household dietary diversity might therefore be an alternative and convenient path to evaluate household-level food security. Dietary diversity scores (DDSs), which allow us to quantify diet diversity, have grown in popularity due to their

relationship to a variety of well-being outcomes, including nutritional and health outcomes [11,12].

This study [13] stated that PDS has helped to alleviate hunger, but nutritional aspects remain unknown. Few recent studies have revealed that increased PDS coverage also increased calorie intake but also increased dietary diversity mostly through income effects [14-17]. PDS may also result in the substitution of more nutritious superior coarse cereals and millets for PDS-subsidized wheat [18]. The dietary diversity of people in a geographical area is determined by a variety of factors, including production diversity [19], household income/expenditure levels, and demographic and socioeconomic characteristics of households [20]. To be adequately nourished and have food security, it is crucial to know what represents an appropriate diet for a health condition, as well as the resources, skills, and motivation to make good food choices. To address this gap, the current study attempts to determine the factors that influenced dietary diversity in Tamil Nadu of Public Distribution System beneficiary's households.

2. METHODOLOGY

Primary data have been employed in this study. The data consisted of general characteristics about the household size, age, gender, education, monthly income, monthly expenditure menu and quantity of the food prepared, food habits, Distance of fair price shop, livestock, and other variables were recorded based on seven days recall method for both rural and urban areas in Villupuram district of Tamil Nadu during April to May 2022.

2.1 Sampling Design and Method of Data Collection

The study majorly relied on primary data collected through well-structured and pre-tested personal interviews. The multi-stage random sampling approach was used to gather the data. In the first stage, according to the food security index of the Tamil Nadu State Human Development Report 2017, the Villupuram district has been selected which falls under the low food security index used for analyzing dietary diversity. During the second stage, one block for rural and one block for urban were randomly selected. In the third stage, four rural villages and four urban wards were selected at random. Finally, rural respondents were chosen from 30 PDS beneficiary rural households in each Village comprises of 120 household respondents. For urban respondents, in each ward 30 PDS beneficiary households were selected and comprise of 120 household respondents. Thus, the total sample consisted of 240 respondents (120 rural and 120 urban). Based on monthly household income, the selected households were post-stratified into three income groups: Low Income Group (LIG), Middle Income Group (MIG), and High-Income Group (HIG). The "Chapter on Housing Requirement Projection for IX Plan" reported on the Income categories of households (2007-2012). LIG households earn less than Rs.3301 and between Rs.7500; MIG households earn between Rs.7501 and Rs.14500, and HIG households earn more than Rs.14501.

2.2 Tools of Analysis

2.2.1 Percentage analysis

Percentage analysis was used to study the general characteristics of the respondents which included age, education, gender, and occupational status.

2.2.2 Simpson index of dietary diversity

The Simpson Index of Dietary Diversity (SIDD) was developed to assess household food consumption diversity. Except for beverages and processed foods, the index considered all food items. Edward Simpson proposed the index in 1949 for measuring species diversity [21]. In 1950, Orris C. Herfindahl developed and modified the Simpson index of dietary diversity for use in economic research [22]. Katanoda et al. (2006), Thiele and Weiss (2003), and Shinoj et al. (2015) conducted studies on dietary diversity [23,24]. In the study, the Simpson Index of Dietary Diversity (SIDD) technique was used to analyze diversity in respondent consumption baskets. The Food and Agricultural Organization (FAO) classified food into 12 categories in 2013. This study considers all ten groups to determine the Simpson Index of Dietary Diversity (SIDD) based on these groups. The ten food groups include cereals, fruits, sugar, meat, eggs, legumes, vegetables, oils and its product, milk, and other foods. The remaining two food groups are fish products, and roots and tubers were ignored in the classification because consumption of meat products is low then combined the food items with meat and vegetables respectively. The diversity in terms of the number and distribution of various food items

in the households' consumption baskets was calculated. Thus, dietary diversity is calculated as follows:

$$SIDD = 1 - \sum_{i=1}^{n} P_{i^2} \quad (1)$$

SIDD = Simpson Index of dietary diversity,
P_i = proportion of the i^{th} food item in total monthly consumption food items by members of the household.

The index has a range of 0 to 1, and its maximum value approaches 1 as the number of food items (n) increases. If it is zero, it signifies that the individual consumes very few food items. SIDD scores were collected for households of different income levels for comparison.

A multiple linear regression model was utilized to further explain the variation in diversity scores across various groups of households and to correlate their variation to PDS household dietary diversity, and socioeconomic and demographic characteristics.

$$SIDD_i = \alpha_0 + \alpha_1 Z_i + \alpha_2 E_i + \alpha_3 O_i + u_i \quad (2)$$

Where,

$SIDD_i$ - Dietary diversity score is indicated by dependent variables (ranges 0 to 1)
Z_i - Vector based on sociological and demographic characteristics like age (Years), gender (Male=1, Female= 0), education (Primary-0, secondary-1, Higher secondary-2, Graduate-3, and Illiterate-4), household size (Numbers), Distance of PDS shop and food consumption habits (non-vegetarian-1, Vegetarian-0)
E_i - Vector of the economic status of households like monthly income and monthly expenditure (Rs/ Month).
O_i - Vector of household ownership like Farmland (ha) and livestock (Numbers).
u_i - Error term

3. RESULTS AND DISCUSSION

3.1 General Characteristics of the Sample Households

Among 240 PDS beneficiaries, 120 were from rural households and 120 were from urban households. The average monthly income and number of earners could be seen in Table 1.

According to the results, the average monthly income of urban and rural households is Rs. 14,167 and Rs. 16,621, respectively. In the rural sector, the average number of earners was 1.90 compared to 1.65 in the urban sector. Even though the number of earners in the urban sector was lower, urban household income was higher than rural.

Table 2 shows the age of the households, 50 per cent of the sample households in the rural sector, belonged to the 36-50 age group (53.3%), followed by the 51-60 age group (15.8%) in the rural sector. In urban households, more than 50 per cent of the population belongs to the 36-50 age group (60%) followed by the 20-35 age group (25.8%). Age is a major factor influencing the household's decision, taste, and preference for food items.

Table 1. Average monthly income and number of earners

Sector	Household income (Rs/Month)	Number of earners
Rural	11670	1.56
Urban	13958	1.33

Table 2. Age of the households

Age (Years)	Rural		Urban	
	Number	Percentage	Number	Percentage
20-35	24	20.0	31	25.8
36-50	64	53.3	72	60.0
51-60	19	15.8	13	10.8
Above 60	13	10.8	4	3.3
Total	120	100	120	100

Table 3. Education of the headed households

Education of the respondents	Rural		Urban	
	Number	Percentage	Number	Percentage
Illiterate	6	5.0	0	0.0
Primary	27	22.5	17	14.2
Secondary	59	49.2	42	35.0
Higher Secondary	21	17.5	37	30.8
Graduate	7	5.8	24	20.0
Total	120	100	120	100

Table 4. Family size of the households

Family size	Rural		Urban	
	Number	Percentage	Number	Percentage
1 to 3	40	33.3	51	42.5
4 to 5	66	55.0	65	54.2
6 and above	14	11.7	4	3.3
Total	120	100	120	100

Table 5. Occupational status of the households

Occupation	Rural		Urban	
	Number	Percentage	Number	Percentage
Farming	48	40.0	8	6.7
Agricultural Labour	27	22.5	7	5.8
Office Workers	8	6.7	31	25.8
Business	10	8.3	29	24.2
Non-Agricultural Labour	12	10.0	24	20.0
Others*	15	12.5	21	17.5
Total	120	100	120	100

** Indicates the Tailoring, Construction workers, Drivers, and Pensioners*

According to education level, 49.2 per cent of rural and 35 per cent of urban households have a secondary education, while 22.5 per cent have primary education in rural households and 30.8 per cent have higher secondary education in urban households as shown in Table 3. Household heads with a higher level of education are expected to further improve their understanding of the quantity and quality of consumable food items.

The family size would be useful in determining the family's dietary diversity and quantities purchased. The distribution of the family size of the households was presented in Table 5. The results revealed that 55 per cent of rural PDS beneficiary households and 54.2 per cent of urban PDS beneficiary households have 4 to 5 persons in the family. In addition, 33.3 percent and 42.5 per cent of rural and urban PDS beneficiary households have 1 to 3 members in the family, and also 11.7 per cent and 3.3 per cent of rural and urban PDS beneficiary households have more than 6 members in the family.

From Table 5 results showed that about 62.5 per cent of rural households were engaged in Farming activities. In the case of the urban sector, 25.8 per cent were from government and private employees followed by businessmen with 24.2 per cent and non-agricultural labor with 20 per cent. The occupation was more diversified in the urban sector, whereas in the rural sector, agriculture formed the major share since cultivators and agricultural laborers constituted nearly 62.5 per cent of the rural households. Thus, urban households had more economic opportunities, a fact historically established.

Table 6 represents the distribution of households based on income. The sample households were post-stratified into three income groups based on the "Chapter on Housing Requirement Projection for XI Plan" to understand the pattern of household dietary diversity (2007-2012). They

were i) LIG (Low Income Group) (Earning less than Rs.7500 per month) (ii) Middle Income Group - MIG (Monthly income of Rs.7501 to 14500) and (iii) High Income Group - HIG (Earning more than Rs.14500 per month). In rural households, 45 per cent were low income, followed by 42.5 per cent who were middle income. However, in urban households, the middle-income group contributes 52.5 per cent followed by 25 per cent of the low-income group. The high-income group contributes 12.5 per cent and 22.5 per cent to rural and urban households respectively.

From the Table 7 shows the distribution of smart card details of the households which reveals that 79.2 per cent and 98.3 per cent have a Non-Priority Household (NPHH) in rural and urban households respectively. Meanwhile, priority households of Antyodaya Anna Yojana cards contribute 20.8 per cent and 1.7 per cent in rural and urban households respectively.

Table 8 shows the quality and quantity distribution of essential commodities in the households. In rural households, quality satisfaction for rice and wheat contributes 81.7 per cent, and 91.7 per cent respectively, while in urban Households, quality satisfaction for rice and wheat contributes 53.3 per cent, and 60.8 per cent respectively Sugar and Toor Dhal were also 100 per cent quality satisfied in both the rural and urban sectors. The quantity adequacy for rice and wheat was 79.2 per cent and 93.3 per cent in rural households and 77.5 per cent, and 100 per cent in urban households respectively.

3.2 Household Dietary Diversity across Rural and Urban Areas

Dietary diversity is essential for diet nutrient adequacy and individual dietary status. Higher household income levels increased access to different food categories, resulting in greater dietary diversity. This study now finds a relationship between dietary diversity and household monthly income. Table 9 shows the Simpson index of dietary diversity score for rural and urban areas across different income levels. The variety of food items consumed by households in urban areas was greater than in rural areas. However, the consumption of PDS products was higher in rural households than in urban households. The SIDD value of food items was different in rural areas for LIG (0.78), MIG (0.76), and HIG (0.85), and in urban areas for LIG (0.82), MIG (0.86), and HIG (0.85). (0.88). The high-income group consumes a wider range of food products than other income groups in both rural and urban areas. However, urban households consume a wider range of food items and have greater access to buy a wider range of food items, which could be attributed to easy and reliable market accessibility as well as the households having a high and consistent income.

3.3 Factors Influencing the Dietary Diversity of Households in Rural and Urban Areas

To examine the impact of various factors on dietary diversity, the SIDD score was used as the dependent variable, and socio-demographic, asset ownership, and economic factors were used as the independent variables. Table 10 and Table 11 shows the parametric estimates of dietary diversity for rural, urban, and overall areas using a multiple linear regression model.

The STATA 15 software is used to assess the influence of different factors on dietary diversity, the SIDD score was used as the dependent variable, and socio-demographic, ownership of assets, and economic factors were used as independent variables. Moreover, the coefficient of independent variables like age of the households (0.0002), Food habits (0.001), Education of the respondent households (0.002), monthly household income (0.0005), farm size (0.002), fair price shop distance (0.005), Ownership of cattle (0.004), Monthly food expenditure (0.003) was positively related except gender of the household (-0.015) and household size (-0.007) were negatively related in rural areas.

Table 6. Distribution of households based on income

Monthly income group	Rural		Urban	
	Number	Percentage	Number	Percentage
LIG (< Rs.7500)	54	45.0	30	25.0
MIG (Rs.7501- 14500)	51	42.5	63	52.5
HIG (> Rs.14500)	15	12.5	27	22.5
Total	120	100	120	100

Table 7. Distribution of smart card details of the sample households

Particulars	Rural		Urban	
	Number	Percentage	Number	Percentage
NPHH	95	79.2	118	98.3
PHHA	25	20.8	2	1.7
Total	120	100	120	100

Table 8. Quality and quantity of essential commodities distributed to the households

Name of the commodities	Rural		Urban	
	Quality satisfied (No)	Quantity adequacy (No)	Quality satisfied (No)	Quantity adequacy (No)
Rice	98(81.7)	95(79.2)	64(53.3)	93(77.5)
Wheat	110(91.7)	112(93.3)	73(60.8)	120(100)
Sugar	120(100)	120(100)	120(100)	120(100)
Palm Oil	89(74.2)	95(79.2)	53(44.2)	89(74.2)
Kerosene	99(82.5)	106(88.3)	67(55.8)	87(72.5)
Toor Dhal	120(100)	120(100)	120(100)	85(70.8)

Table 9. SIDD value of rural and urban areas across different income groups

Income groups	Rural	Urban
Low income	0.78	0.82
Medium income	0.76	0.86
High income	0.85	0.88

Table 10. Factors influencing the dietary diversity of households in rural areas

Variable Code	Variable Name	Rural	*P*-value	Std. Error
a_0	Intercept	0.789	3.1E-52	0.016
AGE	Age of the head of household (Years)	0.0002*	0.0954	0.000
GEN	Gender of the head household (Male=1, Female=0)	-0.015	0.153	0.003
HHSIZE	Household Size (Numbers)	-0.007***	0.001	0.002
FH	Food Habit (vegetarian=0, non-Vegetarian=1)	0.001	0.875	0.004
EDU	Education of the respondent households (primary=0, secondary=1, Higher secondary=2, Graduate=3, Illiterate=4)	0.002	0.392	0.002
MINCOME	Monthly Household Income (Rs/month)	0.0005***	0.000	2.18E-07
FSIZE	Farm size (ha)	0.002	0.317	0.001
PDS DIST	Fair price shop Distance (km)	0.005*	0.079	0.0007
LIVESTOCK	Ownership of cattle (Numbers)	0.004*	0.094	0.002
MFOODEXP	Monthly food expenditure (Rs/month)	0.0002***	0.003	9.5E-06
R^2	0.75			
F value	22.84			
Number of observations	120			

****, ** and * Significance level at 1%,5% and 10% respectively*

The Table 10 results revealed that 75 per cent of the variation in the overall performance of dietary diversity for rural households has been explained by the independent variables. The age of the headed household was statistically significant, indicating that they have better knowledge of different food groups as well as the nutritional content of an active healthy life. At one percent level, household size was highly significant. The gender, farm size, and education level of the household head were found to be insignificant, with no effect on the dietary diversity of the household.

The monthly household income was found to be highly significant at the one percent level due to the main source of income in rural areas both on-farm and off-farm income. In rural areas, the distance between fair-price shops was significant. It clearly shows that a greater distance from the market means less market access, which affects the food basket and the occurrence of consumption of various food items. The owning of cattle had a significant influence on dietary diversity at the 10% level. In rural areas, increasing animal milking by one unit would significantly raise the SIDD score by 0.004.

Similarly, for urban PDS beneficiaries, households could be seen from Table 11 results of the SIDD index variables. The R^2 signifies that 64 per cent of the variation in the overall performance score has been explained by the independent variables. The coefficient of independent variables like the gender of the households (0.001), Food habits (0.003), Education of the respondent households (0.001), monthly household income (0.000), farm size (0.001), Fair price shop distance (0.0007), household size (0.008), Monthly food expenditure (0.0005) were positively related except the age of the household head (-0.001) and ownership of cattle (-0.008) were negatively related for urban areas.

The age of the headed household was statistically significant which indicates that have better knowledge of different food groups and also the nutritional content of active healthy life. However, a similar result was found [19]. The household size was highly significant at the one percent level that determines the dietary diversity of the households. Similarly, food habit was significant and positive which indicated that non-vegetarian households have more varieties of food than vegetarian households. It was observed that the monthly household income was highly significant at a one percent level due to the main source of income from the office workers and business people in urban areas. The Fair price shop distance was significant in urban areas. It shows that a larger distance from the market means worse market access, which in turn affects the food basket and frequency of consumption of different food items. A similar result was found [19,25]. The ownership of cattle was significant at one percent level influences on dietary diversity. However, higher-income households would access a greater variety of items in their consumption basket as compared to low-income households. The F-Statistics showed the overall significance of the model was significant. The gender, farm size, and education of the household were found to be insignificant and does not have any influence on the household dietary diversity.

Table 11. Factors influencing the dietary diversity of households in urban areas

Variable code	Variable name	Urban	*P*- value	Std. Error
a_0	Intercept	0.838	4.68E-67	0.023
AGE	Age of the households (Years)	-0.001***	0.008	0.000
GEN	Gender of the households (Male=1, Female=0)	0.001	0.833	0.005
HHSIZE	Household Size (Numbers)	0.008***	0.0003	0.002
FH	Food Habit (vegetarian=0, non-Vegetarian=1)	0.003**	0.0432	0.005
EDU	Education of the households (primary=0, secondary=1, Higher secondary=2, Graduate=3, Illiterate=4)	0.001	0.703	0.002
MINCOME	Monthly Household Income (Rs/month)	0.000***	2.80E-08	3.35E-07
FSIZE	Farm size(ha)	0.001	0.718	0.001
PDS DIST	Fair price Shop Distance (Km)	0.0007*	0.0596	0.021
LIVESTOCK	Ownership of cattle (Numbers)	-0.008	0.391	0.001
MFOODEXP	Monthly food expenditure (Rs/month)	0.0005***	0.001	3.85E-06
R^2	0.64			
F value	16.24			
Number of observations	120			

****, ** and * Significance level at 1%,5% and 10% respectively.*

It could be reasonable to infer that urban household size, age of the household in rural areas, the distance of fair price shop, monthly household income, and monthly food expenditure of the households have a positive and significant influence on dietary diversity in rural and urban areas that have a good diet and a healthy life. Contrarily, age of the household, cattle ownership in urban areas and gender of the households, household size in rural areas have a negative influence and do not determine the dietary diversity of the households.

4. CONCLUSION

The study found that empirically examining the influencing factors on the dietary diversity of PDS beneficiaries' households in the Villupuram district based on the socio-economic characteristics of the low, medium, and high-income households in the study areas would reveal that income is a major factor influencing the household dietary patterns. The majority 79.2 percent of rural households and 98.3 percent of urban households have a non-priority household (NPHH) smart card rather than a priority household (PHH) smart card. Monthly income, age, household size, and distance from the fair price shop may enhance dietary diversity, thereby improving the dietary diversity of households. Due to a higher intake of nutritious foods in urban areas, rural PDS beneficiary households have a significantly different dietary diversity pattern than urban PDS beneficiary households.

Price subsidy on staple food commodities has different effects on the consumption pattern and dietary diversity of poor, middle, and higher-income people in Public Distribution System. For low-income people, the distribution of price subsidies for the staple food of rice, wheat, and pulses was more constrained for other commodities in the Public Distribution System beneficiary households. This suggests that PDS beneficiaries of poor people buy cheaper items rather than high-value commodities such as fruits, milk, meats, and fish. A variety of food baskets could provide food security while also improving quality of life by increasing nutritional security and dietary diversity. Since rice incentives caused poor people to switch away from high-value commodities such as milk, meat, fish, and fruits reducing dietary diversity, extending price subsidies for nutritionally rich food items other than rice is expected to assist poor people in diversifying their diet toward healthy and nutrient-dense foods. From the policy perspective, it is important to focus on dietary diversity with the proper understanding of the socio-economic characteristics to provide nutrient-rich foods like ragi through the Public Distribution System which enhances the dietary diversity of the low-income group compared to the high-income group people. To increase the level of income to implement the new schemes like MGNREGS for women or suggesting to increase the number of working days for MGNREGS and also promote the income generating activities for SHG members.

CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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