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Original Article

Developing a household socioeconomic status index tool for health studies in Iran: An analytic hierarchy process approach

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Abstract

Background: Socioeconomic status (SES) is a criterion consisting of several components that encompass socioeconomic and cultural dimensions. This study aimed to design and develop a methodological guideline for calculating a single summary index (SSI) using the contributing variables of SES in a family unit.

Methods: The data consisted of 18 700 urban and 19 200 rural households. Effective components of SES were extracted using two-step factor analysis and the structural equational modeling (SEM) method for both populations separately with AMOS software. Then, in order to customize and validate the weight of each component, the analytic hierarchy process (AHP) method was performed by a panel of experts. Finally, the SES index computational tool was developed as an SSI using all effective components by Excel software. Statistical analysis was done with SPSS software version 21.

Results: In rural areas, the four wealth components of education, job, income, and family size were recognized as effective socioeconomic factors. Yet, in urban areas, family size was disregarded as an effective factor. In both rural and urban communities the three welfare components of appropriate nutrition, appropriate home appliance, and appropriate housing were similarly effective. The SES of rural population had a homogeneous distribution, while urban population did not follow a particular trend.

Conclusion: The SES index impacts all aspects of life, especially health status. The introduced method is comprehensive and applicable to both rural and urban populations. Due to ever-changing lifestyles, constant technological advances, and socio-political changes in each society, the tool requires modification in a specific time intervals.

Keywords: Health, Lifestyle, Inequality, Socioeconomic status, Wealth, Welfare

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Introduction

Socioeconomic status (SES), which is also termed SES index, deprivation index, and inequality index, is defined as the level of access of people to financial, social, and cultural resources.[1] It has a major impact on all aspects of a society's quality of life, especially on health-related issues. This is why using an accurate SES index can prevent inappropriate distribution of healthcare services, risks of catastrophic expenditures, and hidden subsidies of poor to rich, particularly in developing or less developed countries.[2]

In many studies, the association between SES components and health indices has been examined, using a variety of indicators such as mortality index among different age and gender groups, maternal mortality index, communicable and non-communicable disease patterns, nutritional disorders index, health related behavior index, index of productivity, and access to health services in societies.[2,3] In addition to health-related issues, SES components have been widely used in studies focused on social and behavioral topics and on educational systems.[4,5] Other studies have also investigated the impact of SES on academic achievement, learning disabilities, risk-sharing age groups, depression, anxiety, committing crimes, and so forth.[6,7]

The SES index consists of several components involving socio-economic and cultural dimensions. In different studies, various components have been used

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according to the geographical location and purpose of the study. Almost no study has suggested comprehensive recommendations with high applicability for the use of any of the components. This is due to cultural, social, economic, and political diversity in different societies.[6-8]

Different domestic investigations have used various components in their studies to evaluate the SES index. These studies have been performed in Iran in different social groups related to this subject. The relationship between SES and stress during pregnancy period, life expectancy, students' quality of life, and mortality rate of children under 5 years old are examples of such scrutiny.[9,10]

The measuring tools of SES index are not globally similar, and different countries may choose different indicators for its assessment. For example, the structural format is called the Carstairs index in England,[11,12] the Jarman index in Germany,[13] the New Zealand index of socio-economic deprivation (NZiDep) in New Zealand,[14] and the socio-economic indices for Australia (SEIFA) in Australia.[15,16]

In a study conducted by Bhuiya et al[17] in rural areas of Bangladesh, variables such as food, clothing, education, shelter, and health have been used to measure the SES index. In another study in Iraq, the three criteria of education, occupation, and wealth/income were selected to quantify the SES index.[18] The SES Index in India is recognized as the Kuppuswamy scale, which is updated annually.[19] Nevertheless, this index generally contains several constant components. These components are income, occupation, and education of the head of the family.[19] Lalloué and colleagues[20] have used 20 variables while Kumaranayake and Vyas have used 26 variables to estimate the SES index in their studies.[8]

In Iran, for the first time in 2010, Garmaroudi and Moradi[21] used the components of: education, occupation, and income for spouse and the head of households as influential factors to measure the SES index. Furthermore, they consider other major indicators such as their place of residence, family size per household, value of the house per square meter, home appliances (e.g. computer), and motor vehicle ownership (number and type).

These investigations denote that the SES index is a multidimensional scale due to different criteria used with diverse weights according to the time, geographical location, and purpose of each study. Thus, the final composite index used in such studies addresses all aspects of SES. Obviously, the use of multiple variables in a study also causes multicollinearity in computation.[8,20] However, to resolve this complexity, conventional methods such as principal component analysis (PCA) and principal factor analysis (PFA) can be used to reduce the number of variables while keeping the effective ones. In addition, the most preferable approach of the PCA method is the two-stage process.

Depending upon the type of variables and goal of a study, researchers may use other methods such as correspondence analysis, multiple correspondence analysis, multivariate regression, and fuzzy analysis.[8,20,22] Plus, not all of the discussed components comprising the SES index can be applied in all geographic areas. Furthermore, not all dimensions of the SES index are accessible for data collection in all countries, e.g., the real income of individuals. Thus, a number of queries should be designed and included in the questionnaire to figure out the level of income of a household. As a consequence, a composite tool whose use is simplified and facilitated can direct researchers to achieve a relatively accurate measure in health investigations. For this reason, the use of appropriate components as well as a valid computational method should be considered by researchers as a principle to determine the composite index. Moreover, these components may vary in different time periods and places, depending on the study that they are designated for.

The purpose of this study was to design and develop a methodological guideline for calculating a single summary index (SSI) from contributing variables of the SES of a family unit, based upon the comprehensive data collected by the Statistical Center of Iran (SCI). This study also provides separate reports on the SES for the rural and urban population of Iran.

Methods

Study population

In this study, data recorded in 2019 was retrieved on 18 700 urban and 19 200 rural households from the SCI, to design a tool to calculate the SES index. This national consensus takes place every 5 years countrywide.

This investigation was a retrospective study using archived data. This data is initially collected privately, but it is accessible to the public anonymously.

The Household Income and Expenditure Survey (HIES) has been implemented in rural areas since 1963, and in urban areas since 1968. The survey includes 234 tables in two separate publications for urban and rural areas and can be accessible to interested parties, planners and researchers. A three-stage cluster sampling method with strata is used in the survey.

Stages of development of the tool

a. Development of framework

In the first stage, the criteria of economic and social status consisting of welfare and wealth indicators were extracted from the mentioned national data.[22] The conceptual framework of determining criteria for wealth and welfare was developed accordingly. Later on, using exploratory and confirmatory factor analysis (CFA), the number of effective factors was adjusted for the rural and urban population in AMOS software.

b. Panel of experts evaluation

In the next stage, two models consisting of the above criteria and sub-criteria were plotted for the rural and urban population (Figures 1 and 2). A panel of 10 experts qualitatively and quantitatively evaluated the importance and priority of the criteria and sub-criteria using the analytic hierarchy process (AHP) method, determining the indigenous weight validity. It is worth noting that AHP is one of the powerful methods of multiple decision-making criteria for analyzing complex decisions.[23]

c. AHP analysis

The analytical hierarchy process is a technique for decision making where many variables or criteria are considered in prioritizing and selecting options. The process of ranking and prioritizing tools for making

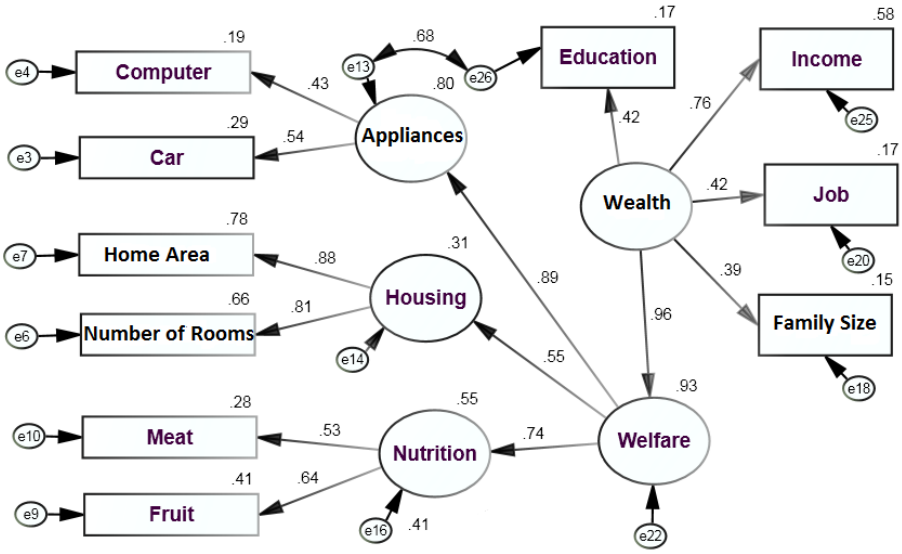

Figure 1. The model consisting of the criteria (wealth & welfare) and sub-criteria (the rest) was plotted for the rural population reporting the standard coefficient estimation. *Note:* The variables that are in rectangles are observed variables and the variables that are in circles are conceptual variables (a conceptual variable is obtained from the combination of several observed variables). Curved double-arrows show the correlation between two factors and the numbers on the arrows are the covariances. Straight arrows show causal relationships and the numbers on the arrows are the standardized coefficients

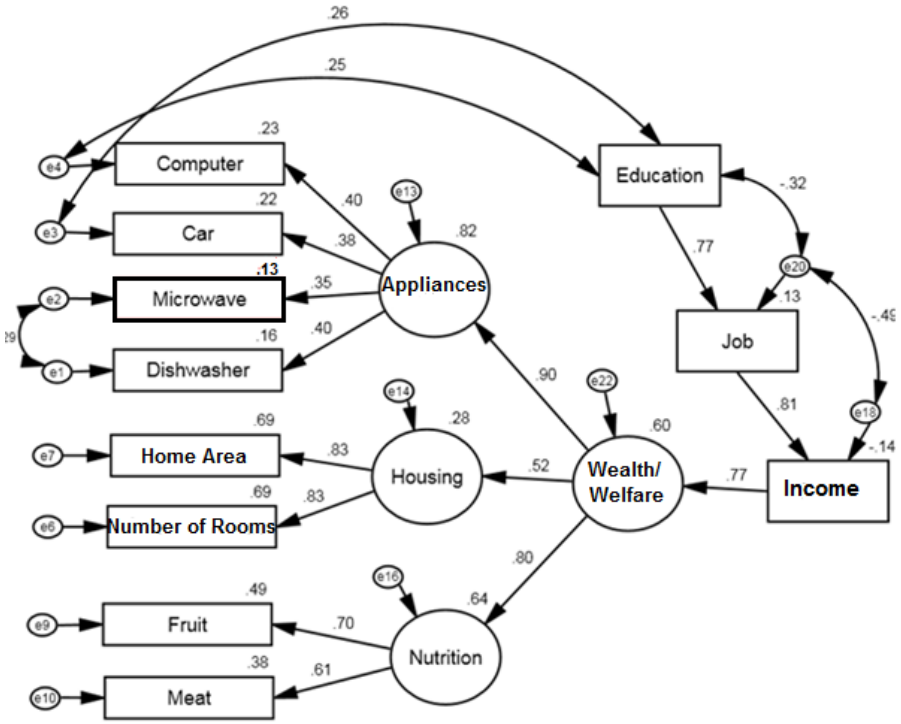

Figure 2. The model consisting of the criteria (wealth & welfare) and sub-criteria (the rest) were plotted for the urban population reporting the standard coefficient estimation. *Note:* The variables that are in rectangles are observed variables and the variables that are in circles are conceptual variables (a conceptual variable is obtained from the combination of several observed variables). Curved double-arrows show the correlation between two factors and the numbers on the arrows are the covariances. Straight arrows show causal relationships and the numbers on the arrows are the standardized coefficients

options for calculating the SES index in this research using this method is as follows:

1. Drawing a decision tree containing branches and subcategories (Figure 3).
2. Drawing comparison tables for weighing the criteria based on Saatys' nine-scale format[24] or structuring the criteria matrix (homogeneity and clustering to range the scale from 1 to 9) (Table 1 and Figure 4, Section 1).
3. Calculating normalized weights of all criteria and finalizing the weight of each individual criterion (Figure 4, Sections 2–4).
4. Finally, summation of the given weight of all criteria to define the SES index for a family household (Figure 4, Sections 5 and 6).

d. Normalization of data

The data were normalized using the following fuzzy formula: (Equation 1).[25]

For positive attributes where more is better

$$\hat{R}ij = \frac{Vij - min_i Vij}{max_i Vij - min_i Vij}$$

For negative attributes where less is better

$$\hat{R}ij = \frac{\max_i Vij - Vij}{max_i Vij - min_i Vij}$$

Finally, the SES Index was calculated between the normal range of 0 and 1 for each household. Statistical analysis, mean indices, and SES index plots were performed separately for the rural and urban population in SPSS version 21.

e. Validity

The simultaneous employment of the two-stage PCA and AHP methods strengthens the validity of the proposed tool as this tool was tested on the National Data from the SCI.

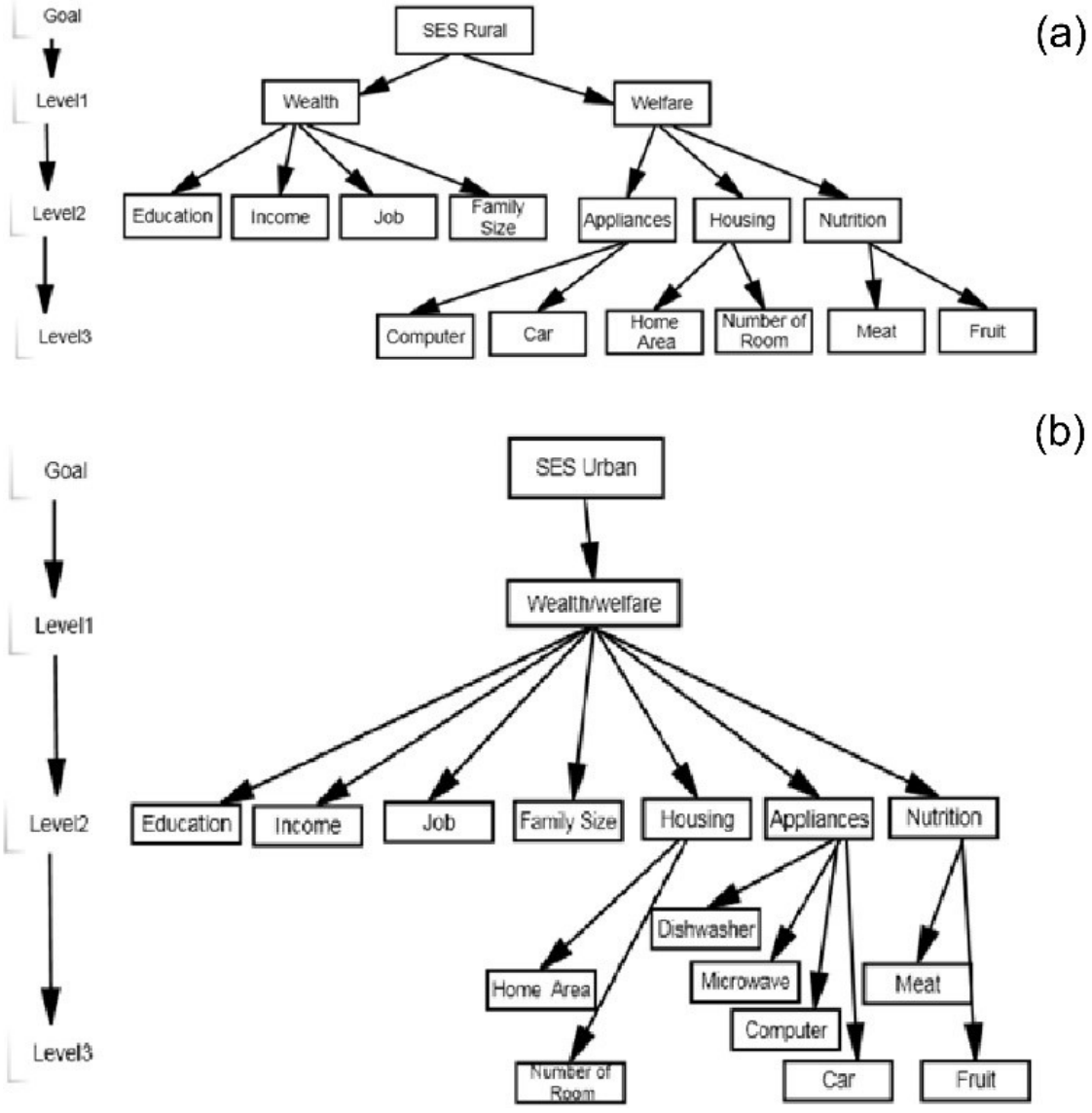

Figure 3. Decision tree drawing containing branches and subcategories in rural (a) and urban (b) communities

Results

Initial criteria extracted from the SES are included in the welfare and wealth components (Figures 1 and 2). Accordingly, in rural areas, the four wealth components were comprised of education, job, income, and family size. Also, the three welfare components included appropriate nutrition, appropriate home appliance, and appropriate housing. However, in urban regions the three wealth components consisted of education, job, and income. In addition, the three welfare components were appropriate nutrition, appropriate home appliance, and appropriate housing. Nevertheless, it should be noted that in the urban community, the two welfare and wealth components do not overlap.

Initially, after factor analysis for adjusting factors that affect the SES level of the rural household population, the three variables of type of home ownership, dishwasher, and microwave were removed due to factor load of less than 0.3. Factor analysis was also done for the urban population. In this population, the components of type of home ownership and family size were removed because

Table 1. Saaty's nine-scale format (1997) of absolute numbers for pairwise comparison

Intensity of importance/ preference	Definition: experience and judgment one requirement over another
1	Equally preferred/important
3	Moderately preferred/important
5	Strongly preferred/important
7	Very strongly preferred/important
9	Extremely preferred/important
2, 4, 6, 8	Intermediate

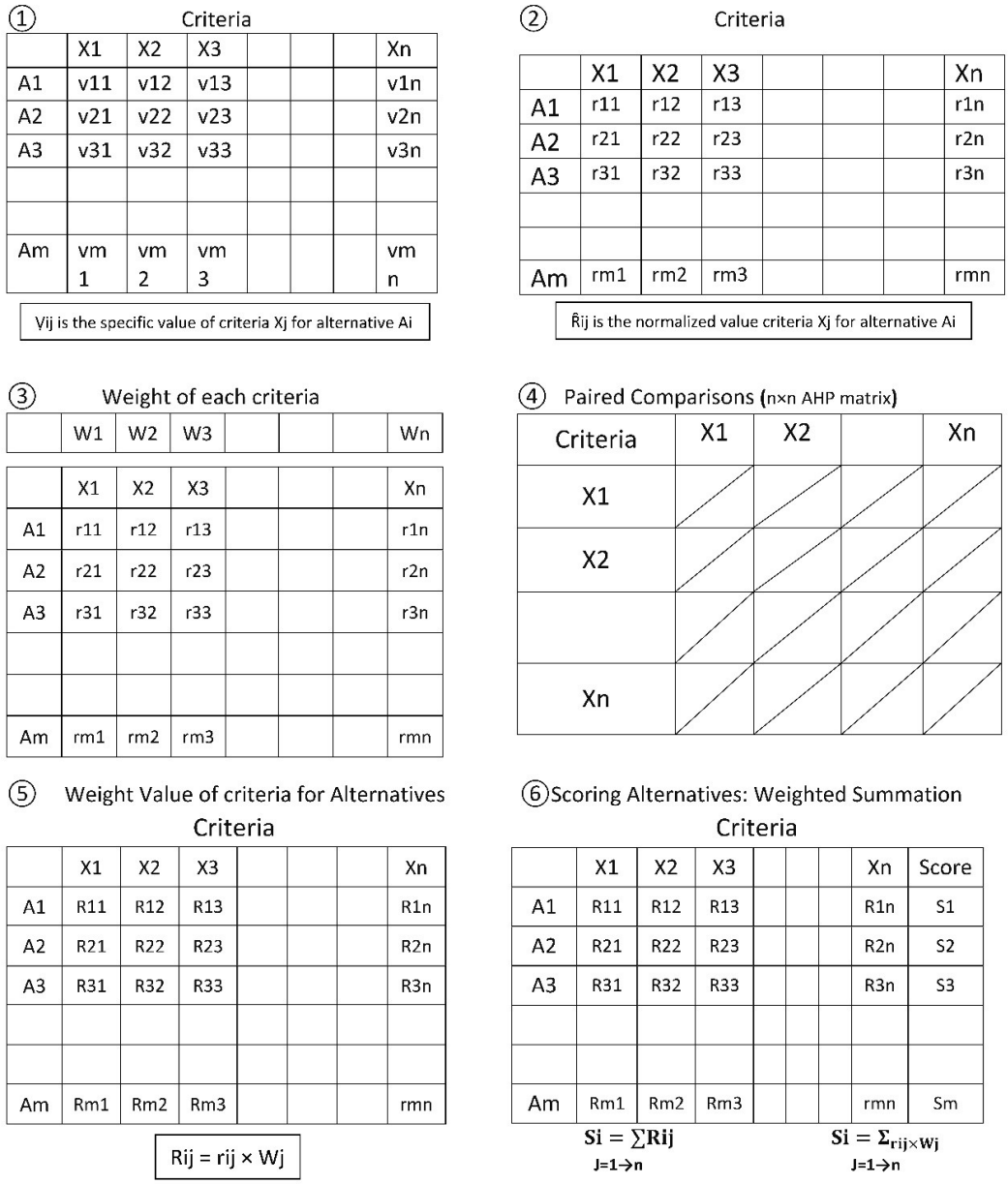

Figure 4. The ranking and prioritizing steps of the analytic hierarchy process (1-6) to build options for calculating the socioeconomic status index

of factor load of less than 0.3.

In the second confirmatory stage of factor analysis, the selected and removed items from the first stage were reaffirmed once more. Thee selected final variables (with factor loads ≥ 0.3) in rural and urban populations are separately shown in the final models in the CFA graphs and SEM analysis (Figures 1 and 2). The final model presented acceptable level of fitness indices (Table 2). The result of AHP calculation is also separately presented for the rural and urban population (Figure 5).

As shown in Table 3, the SES Index in the urban population was 0.30 ± 0.188, which was higher than that of the rural population with 0.18 ± 0.096. The results showed that the SES index of 25% of the urban population was below 0.170 but for the rural population, this value was 0.11. The SES index of 50% of the population was 0.29 for the urban group, while the value was 0.17 for the rural population. The results for 75% of the population was 0.45 for the urban community and 0.24 for the rural community (Table 3).

Distribution of the SES index in the urban community has a wider range, from 0 to 92%, compared to the rural community, which ranges from 0 to 70%. Figure 6 shows that the SES index of rural households are in a more normal range of distribution compared to that of the urban population. This indicates that the distribution of the SES index in the urban community is more heterogeneous than in the other group. Furthermore, this distribution for the urban population contains three peaks of accumulation. It is noteworthy that the highest peak of the SES index is below 0.2 in urban households.

Table 2. The measures of fitness

Coefficient/Index	Rural	Urban
Chi-square	*P* value = 0.000	*P* value = 0.000
RMSEA	0.072	0.051
NFI	0.908	0.963
AGFI	0.937	0.968
GFI	963	982

RMSEA, root mean square error of approximation; NFI, normed-fit index; AGFI, adjusted goodness-of-fit index; GFI, goodness-of-fit indices.

Discussion

The present study aimed to develop a computational method to provide a tool for estimating an SSI from the definitive pool of components of SES factors. This study used data models of income and wealth, simultaneously. The results showed that in rural areas, the four components of education, job, income, and family, and in urban areas, the three components of education, job, and income were recognized as wealth components. Also, the three components of suitable nutrition, suitable household appliances, and suitable housing were identified as welfare components in both rural and urban areas.

The most recommended method proposed by researchers to calculate the SES of a community is PCA, which has been performed in either a one-stage or two-stage process in many studies.[15,20] For example, Lalloué and colleagues used successive principal components analysis and hierarchical clustering to achieve the desired economic and social indicators.[20] The advantage of the

Table 3. Descriptive characteristics of the socioeconomic status index in urban and rural households

Value		Urban	Rural
N	Valid	18700	19292
	Missing	450	7
Mean		0.30	0.18
Median		0.29	0.17
Standard deviation		0.19	0.096
Mode		0.09	0.15
Minimum		0.000	0.000
Maximum		0.92	0.70
Percentiles	25	0.17	0.11
	50	0.29	0.17
	75	0.45	0.24

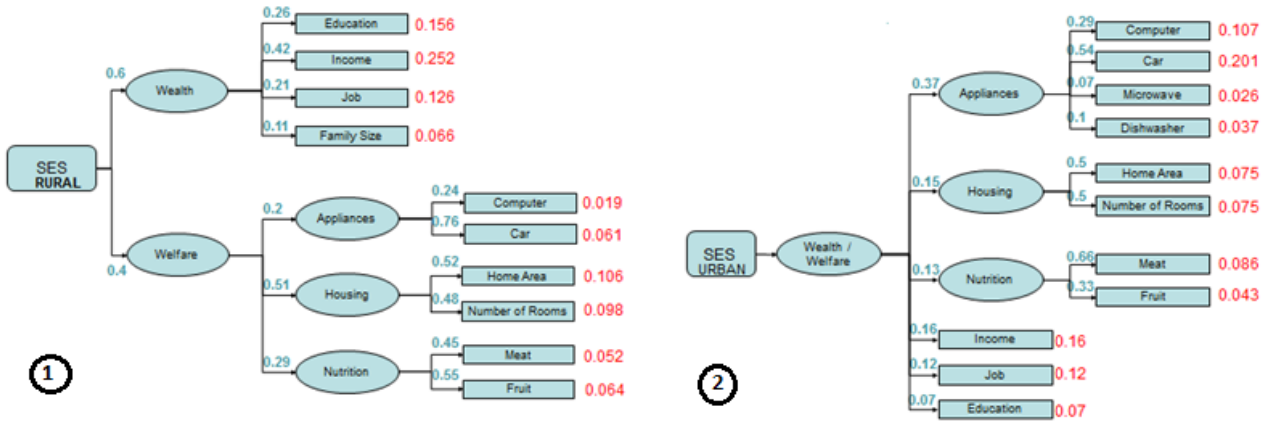

Figure 5. Results of the analytic hierarchy process model in rural and urban adjusted weights

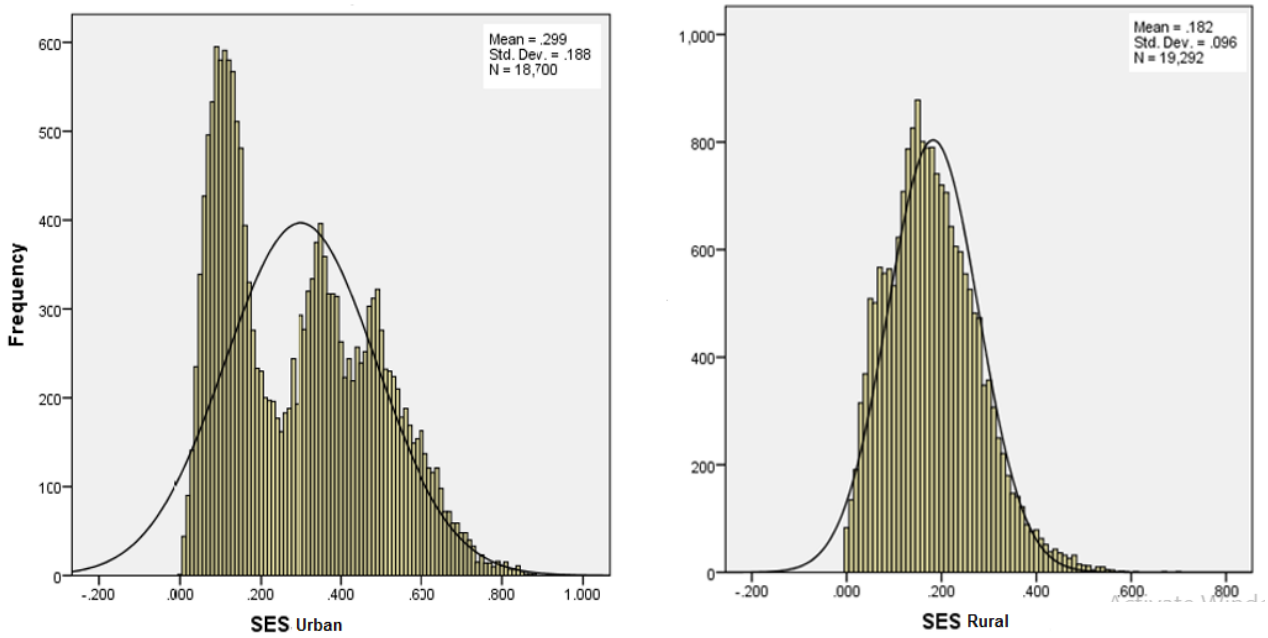

Figure 6. The distribution of the socioeconomic status index in the urban compared to rural population

present study over the other similar studies is that in addition to performing the two stages of exploration and CFA, the weight of each criterion was promoted by localization using the AHP method. Accordingly, the weight and share of each variable is more realistic in the SSI indicators.

Another advantage of the present study is the introduction of a separate index for the urban and rural populations, which is similar to the modified Kuppuswamy scale compiled by Kuppuswamy in 1967 as an index of socioeconomic evaluation in rural and urban areas in India. The Kuppuswamy index is revised every year based on changes in the consumer price index. Considering the dependence of incomes on differing factors over time in IRAN, it is necessary to think of an approach to validate these calculations at different times.[15,20]

In most studies, the three criteria of family income, parental educational attainment, and parental occupational status are considered the most effective components or 'the so called three big variables' for evaluation.[11,19,20,26,27] These three components were also included in the present study.

However, the income rate may not be desirable for most households or may be optimistically far from the reality. Thus, researchers usually employ wealth components for SSI development. This way, the outcome may be directed to a more truthful result.[28-30] Inspired by similar research, the parallel question method was used for data collection in order to reach a reliable outcome.[8,14]

As the SES index is also employed in behavioral and social science studies, related components, such as individual and psychological factors, were additionally considered to construct the final comprehensive tool for calculation of SSI.[26] In this study, the SES of the households was calculated using the SSI method for both the rural and urban populations. It is worth mentioning that the SSI method has some advantages and disadvantages. Nevertheless, there are some studies that have shown that its benefits outweigh the disadvantages. Indeed, using this method has advantages such as clarity and ease of effective retrieval of information to establish efficient relationships. Additionally, the use of the SSI method has the benefit of increasing the stability and the reliability of the tool. This may lead to the ability to employ a wide range of effective components for evaluation, reporting results, and performing calculations.[8]

One of the disadvantages of the combinational method is that in this method, some factors may have a greater power than others, affecting the research outcome, e.g., the role of academic achievement on using health services should be emphasized, which can lead to bias in the results of a study. To solve this problem, it is necessary to weigh and validate the method of each individual study on the basis of its objective.[8] However, using the present comprehensive method reduces inevitable errors as opposed to methods that contribute a limited number of components for evaluation.

As a complementary result of this study, it was found that the SES curve of the rural household has a normal distribution. On the other hand, in the urban population, the SES distribution showed multiple heterogeneous peaks, reflecting the dissimilar distribution of the SES. The largest SES peak is related to the low SES level (0.2) in the urban group. This value is also lower than the average SES level (0.30 ± 0.19) for urban households. This may

be due to the migration of rural residents to cities, which may oblige them to settle in the sub-standard conditions of suburban areas. However, for better interpretation, it is more logical to compare the present SES index trend with those of previous years. If the goal is to measure the relationship of SES with health rank, mediating factors, such as individual and social factors and protective factors, should also be considered.

Strengths and Limitations

This study had the privilege of using governmental national data. The comprehensive survey that collected this data is performed nationwide by calibrated interviewers. It should be emphasized that SES assessment is time-dependent because the variables influencing this index are subject to change based on economic, social, cultural, and other variables in every society. This study is a platform that can easily be updated accordingly. Some unpredicted events, e.g., the COVID-19 pandemic, may only necessitate minor adjustments to the tool. The present tool can be employed for health policymaking at the national level.

Given the goals of this study for measuring the household SES index, this study faced limitations inherent to the data used. These restrictions were as follows: (a) The occupation of the other members of households is not recorded in the SCI national data. It is quite obvious that the combined income of all family members has a definite role in the level of welfare of a household unit. (b) The other restriction was the cross-sectional nature of the present data that may weaken SSI development. In other words, some components of SES may not have been evaluated at the time of the interview, e.g., the unemployment of a recent graduated head of household. (c) The absence of price clarification for living facilities in the data. There are a wide range of brands and models within each brand with a wide range of prices based upon the features a piece of equipment offers. (d) The final limitation was the probability that some residence ownerships in other geographic areas were not reported. This may also be the case for the number of cars and/or land owned by the household.

Conclusion

This computational approach seems to be a reliable proposition for creating an SES tool and estimating an SSI format extracted from multiple determining factors. Therefore, this tool can also be implemented to determine the impact of SES on health indicators or to determine guidelines for policy making in the health system. This method is comprehensive and applicable to both rural and urban populations. Finally, due to cultural variations, technological advances, and socio-political changes in each society, this tool may require updating in specific intervals.

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Authors' Contribution

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Data curation: Shahram Yazdani, Sareh Shakerian, Sediqe Shafiei.
Investigation: Shahram Yazdani, Sareh Shakerian, Sediqe Shafiei.
Formal analysis: Shahram Yazdani, A. Hamid Zafarmand, Sareh Shakerian, Sediqe Shafiei.
Methodology: Shahram Yazdani, A. Hamid Zafarmand, Sareh Shakerian, Sediqe Shafiei.
Project administration: Shahram Yazdani.
Supervision: A. Hamid Zafarmand, Shahram Yazdani
Software: Sareh Shakerian.
Resource: Shahram Yazdani, Sareh Shakerian, Sediqe Shafiei.
Validation: Shahram Yazdani, A. Hamid Zafarmand, Sareh Shakerian, Sediqe Shafiei.
Visualization: A. Hamid Zafarm, Sediqe Shafiei.
Writing- original draft: Sareh Shakerian.
Writing- review & editing: A. Hamid Zafarmand, Sediqe Shafiei.

Competing Interests

The authors declare that they have no competing interests.

Data Availability Statement

The datasets used and/or analyzed in the current study are available from the corresponding author on reasonable request.

Ethical Approval

All procedures/experiments were performed in accordance with the required guidelines and regulations. The Research Institute of Dental Sciences and the Research Ethics Committee have granted the ethics code IR.SBMU.RIDS.REC.1396.447 for the execution of the study.

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