COMPUTER BASED STATISTICAL STUDY OF CARTOGRAPHY IN MORTALITY UPTO AGE OF ONE YEAR

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ABSTRACT

Present cartography procedures for quantitative indicators are arbitrary on choice of the number of categories in which a particular area is to be divided. The choice of initial cutoff and the choice of the width of each category is also arbitrary. To remove this arbitrariness and thus to introduce objectivity, we propose use of a statistical procedure called cluster analysis. This procedure is easy to use on a computer. We also propose using computer based maps. We use these methods on mortality indicators upto age of one year for major states of India to devise objective maps. The terminology of mortality indicators upto age of one year has been used by UNICEF document(1). The mortality indicators analysed are infant mortality rate, neonatal mortality rate, postneonatal mortality rate, perinatal mortality rate and still birth rate. Different indicators reveal different pictures. In this paper, we also propose an innovation to obtain an integrated picture by simultaneously considering all the four indicators in a multivariate setting. Such mapping could help the health managers and planners to devise more effective strategies to control child mortality.

Key words: *Cartography, Graphics, Map in early deaths, Clusters.*

A picture is a graphical representation of an object. It serves the purpose of visible embodiment of a concept or feature which somehow is vivid and remains more permanently in the mind. It is also a very useful and important tool of visual aid in learning and teaching. Maps are special kind of pictures, generally identified by representation of geographical areas; though not necessarily restructured to such representation. In medical science, maps of cells, structure of tissues and organs and of routes followed by a drug in the body can all be shown by way of mapping. We, however, restrict ourselves to conventional mapping of geographical areas – in fact, India and her States, but give a new dimension to such mapping by introducing computer based statistical concepts in mapping of mortality indicators upto age of one year. The purpose is to achieve objectivity and to obtain an integrated picture on several indicators.

Current cartography procedures are arbitrary with respect to the following three features: (*i*) The number of categories in which a particular area is to be divided when the indicator to be mapped is quantitative. For example, if infant mortality rate (IMR) for states of India are to be shown on a map, it is arbitrarily decided that the number of categories of IMR to be depicted would be three, four or six; (*ii*) The choice of initial

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category, *i.e.*, the first category for IMR should be less than 60 or less than 70 or less than 80, *etc.*; and (*iii*) As a by product of the above two, the width of each category. Should it be 10, 15, 20 or what?

Such methodology obviously results in arbitrary pictures. It seems necessary that an element of objectivity is introduced so that the planners for strategy of control on mortality upto age of one year are on firmer grounds. Another problem in case of mortality upto age of one year is that there is no single comprehensive indicator to measure its magnitude. It is generally considered to be measured by a set of indicators comprising infant mortality rate (IMR), neonatal mortality rate (NMR), post-neonatal mortality rate (PNNMR), perinatal mortality rate (PNMR) and still birth rate (SBR). Each individually reveals a different map. Thus, if an integrated picture is required which somehow can take care of all the indicators simultaneously then we need to devise a method by which this can be achieved. We have drawn maps only for four indicators namely IMR, NMR, PNMR and SBR so that they can be accommodated on a single sheet. Maps for PNNMR can be drawn on similar lines.

We, in this paper, describe a statistical procedure which removes arbitrariness of the three types mentioned earlier and helps to get an integrated picture also. These statistical procedures are easily implemented with the help of computer software which are now commonly available. Or maps also are drawn with the help of computer packages. The principal advantage of computer maps is the ease with which they can be prepared from the properly arranged sets of data and in having data set from which individual maps drawn is that, it can be manipulated in different ways, allowing any number of special purpose maps to be created(2).

Material and Methods

Data on various components of mortality after 28 weeks of gestation till one year of age were obtained for the year 1988, from Sample Registration System report(3). Under this System, data are collected from selected specified areas, both urban and rural, from each state and Union Territory of the country. The data are supposed to be fairly accurate because of the in-built double check system. Even though this system produces birth rates and death rates for each state and Union Territory but the indicators on mortality upto age of one year are provided in the report only for major seventeen states of India. These states cover 97.39% of the population of the country based on 1991 census. Thus, the population left out is less than 3%. Statistical procedures used in order to remove arbitrariness and to get an integrated picture is as follows.

Difference between value of an indicator for one state with the other state is considered as a measure of their dissimilarity. Thus those states, for example, with respect to IMR, are considered similar in which the value of IMR is same or nearly the same. Conversely, a state which has entirely different IMR from the other state, would be considered dissimilar. The endeavour is to divide 17 states into three or four or five or six natural groups, such that the IMR within each group of states is nearly the same, while the IMR in states belonging to different groups are very much different. This is obtained by using statistical procedure called cluster analysis. This analysis allows us not only to discover natural groupings but also to determine the boundaries of each group. This means that number of

categories, initial cut-offs and width of each category are all objectively determined by this technique. This procedure can be easily adopted by using a relevant computer package. We have used SPSS PC+ package to carry out cluster analysis on mortality indicators data upto age of one year.

Cluster analysis is essentially a multivariate technique so that natural clusters can be discovered even when several indicators are considered simultaneously. This has allowed us to get an integrated picture using five indicators of mortality upto age of one year listed earlier. However, in this case, our SPSS PC+ package did not have adequate provision to objectively determine the number of clusters. To overcome this problem, we first developed an index of child health using the factor analysis method of Chandersekhar *et al.*(4) and then calculated value of Wilk's lambda. This statistic can be interpreted as ratio of determinant of sum of squares and cross products within clusters to determinant of total sum of squares and cross products(4). Wilk's lambda is known to be multiplicative in nature. Therefore, that number of clusters has been considered optimum where the change in ratio of successive Wilk's lambda values is maximum in absolute sense. This procedure is an improvement over the method used by Indrayan(6) for various health indicators. All this procedure is easy to adopt when computer and the relevant software is available, otherwise the calculations become very intricate.

For drawing maps also, we have taken help of computer. These maps are not very exact but serve our purpose of depicting the inter-state differentials and similarities. Such computer maps are a new method in cartography. The software package used for drawing maps is a fantasy. This package has provision to draw lines and curves at will by appropriately moving around the cursor. This also has facility to fill up each enclosed area - in this case state - with any of the several available patterns.

Results

Figure 1 gives four maps on neonatal mortality rate with arbitrary number of categories and arbitrary cut-offs. It is easily seen that the picture emerging from different maps is different. For example, in *Fig. 1(a)*, where a categories have been used and the first category is <30, Madhya Pradesh and Orissa belong to the highest NMR category, while in *Fig. 1(d)*, where the number of category is 3, Uttar Pradesh, Rajasthan and Assam also join this category. This underscores the need to introduce objectivity. In *Fig. 2*, the number of categories has been fixed as four - which again is arbitrary - but the inital cut-off and the width of each category is changing from map to map. In *Fig. 2(c)*, only Kerala belongs to the lowest NMR category, while in *Fig. 2(a)*, Maharashtra, West Bengal, Punjab, Haryana, Himachal Pradesh and Jammu and Kashmir are also added to this category. Again the picture depicted by four maps is far from uniform. Thus, even if the number of categories is fixed in advance, it is essential to objectively determine the initial cut-off and width of the category. These maps illustrate why there is a need to obtain natural clusters.

Figure 3 gives maps obtained by natural clustering of five different indicators of mortality upto age of one year using our method of cluster analysis. This figure is based on *Table I*, where various states and their values in natural groups are shown. A look at these maps easily shows that different indicators reveal different pictures. Thus, there is an additional need to get an

integrated picture by simultaneous consideration of all the five indicators. In order to get this integrated picture, we carried out cluster analysis in a multivariate setup using the method described earlier. The number of natural clusters obtained is five. Their rank has been determined on the basis of comprehensive index of health obtained by using the method of Chanderasekhar *et al.* (4). The natural grouping and their ranks are shown in *Fig. 4*. This map tells us that the states of Madhya Pradesh, Uttar Pradesh and Orissa are similar with respect to mortality indicator upto age of one year and are at the bottom of the spectrum. The states Andhra Pradesh, Rajasthan and Assam form

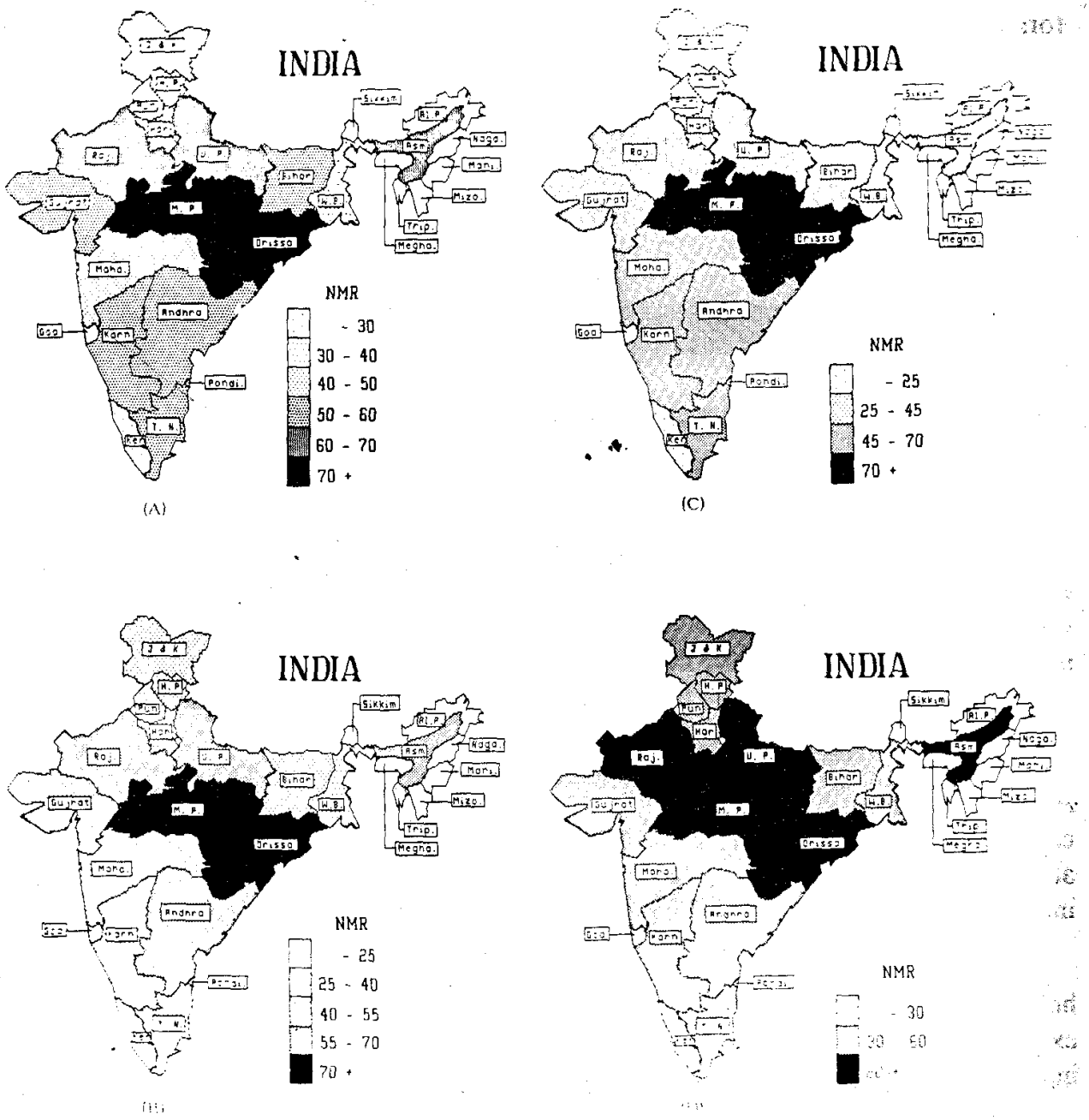

Fig. 1. Neonatal mortality rate in Indian states (1988) –Maps obtained with different number of categories.

TABLE I—*Summary of Cluster Analysis*

Cluster number	Indicator			
	IMR	NMR	PNMR	SBR
1.	Kerala	Kerala	Kerala, and Him. Pradesh	Rajasthan, Gujarat, Him. Pradesh, Bihar, Uttar Pradesh
2.	Punjab, Tamil Nadu, Karnataka, West Bengal, Maharashtra, and Jammu & Kashmir	West Bengal, Punjab, Him. Pradesh, Haryana, Maharashtra, and Jammu & Kashmir	Punjab, Maharashtra, West Bengal, Haryana, Gujarat and Bihar	West Bengal, Tamil Nadu, Maharashtra, Haryana, Madhya Pradesh, Andhra Pradesh, Assam and Kerala
3.	Bihar, Assam, Rajasthan, Haryana, Gujarat, Him. Pradesh and Andhra Pradesh	Gujarat, Tamil Nadu, Karnataka, Andhra Pradesh and Bihar	Orissa, Madhya Pradesh, Rajasthan, Assam, Tamil Nadu, Andhra Pradesh, Karnataka and Jammu & Kashmir	Orissa and Karnataka
4.	Madhya Pradesh, Orissa and Uttar Pradesh	Orissa Madhya Pradesh, Rajasthan and Assam		Punjab and Jammu & Kashmir

one group and are next in order. The best group consists of only one state Kerala, which otherwise is known to be a class by itself.

Discussion

Cartography in health is not new and must be in practice for long time. For highly prevalent infectious diseases like leprosy and goiter maps have been effectively used to devise strategies for their control. Latest maps for these two diseases are in Park(7) and Pocket Book of Health Statistics(8). Maps on calorie malnutrition(9) and on pattern of cereal consumption(10) were also drawn. Recently, UNICEF sponsored a project on Child Atlas of India(11). The Registrar General of India publishes maps

on various socio-economic indicators from time to time. An example is level of urbanization for each state of India which is shown in a recent paper on 1991 census(12). UNICEF has published a map on IMR in various states of India with categories–75, 75-99, 100-124 and 125+(13). All these maps severely suffer from arbitrariness as indicated earlier. Also, these maps consider one indicator at a time and do not provide an integrated picture obtained by simultaneous consideration of several indicators. An attempt in this direction has been made by Raza and Nangia(11) who have superimposed one indicator over the other using symbols and colors to depict situation with

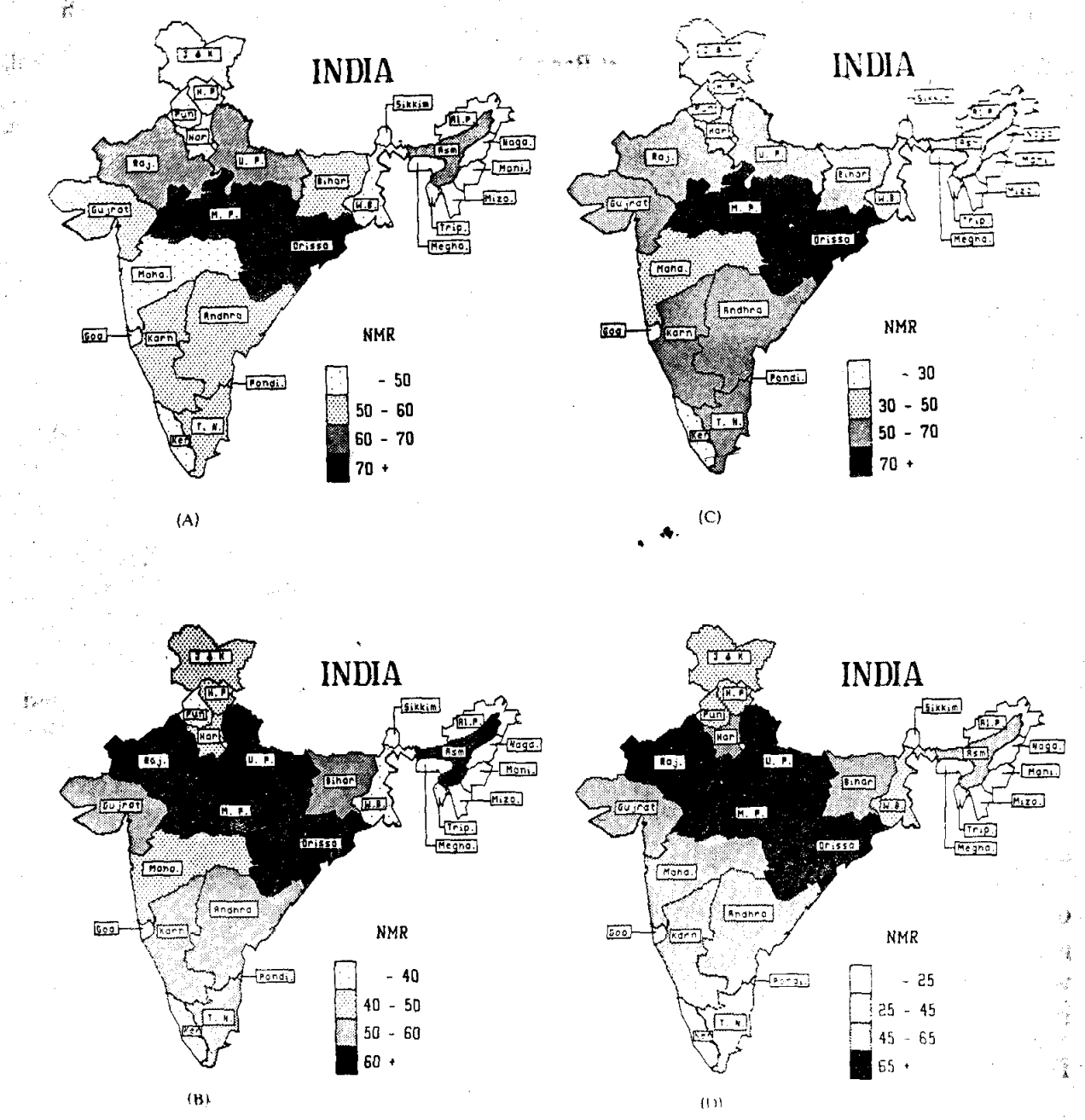

Fig. 2. Neonatal mortality rate in Indian states (1988) – Maps obtained by using different cut-off.

regard to two or three indicators simultaneously. However, arbitrariness with regard to the number of categories and iniital cut-offs remain even in this attempt. Our method of discovering natural clusters for each indicator individually or in combination may seem intricate on paper but is easy to implement when computer and relevant softwares are available. Modern era belongs to computer and more and more institutions are now getting access to this facility. The advantages in terms of removing arbitrariness and in getting an integrated picture far outweigh the intricacies involved.

A clear advantage of such natural groupings and integrated picture is that it gives

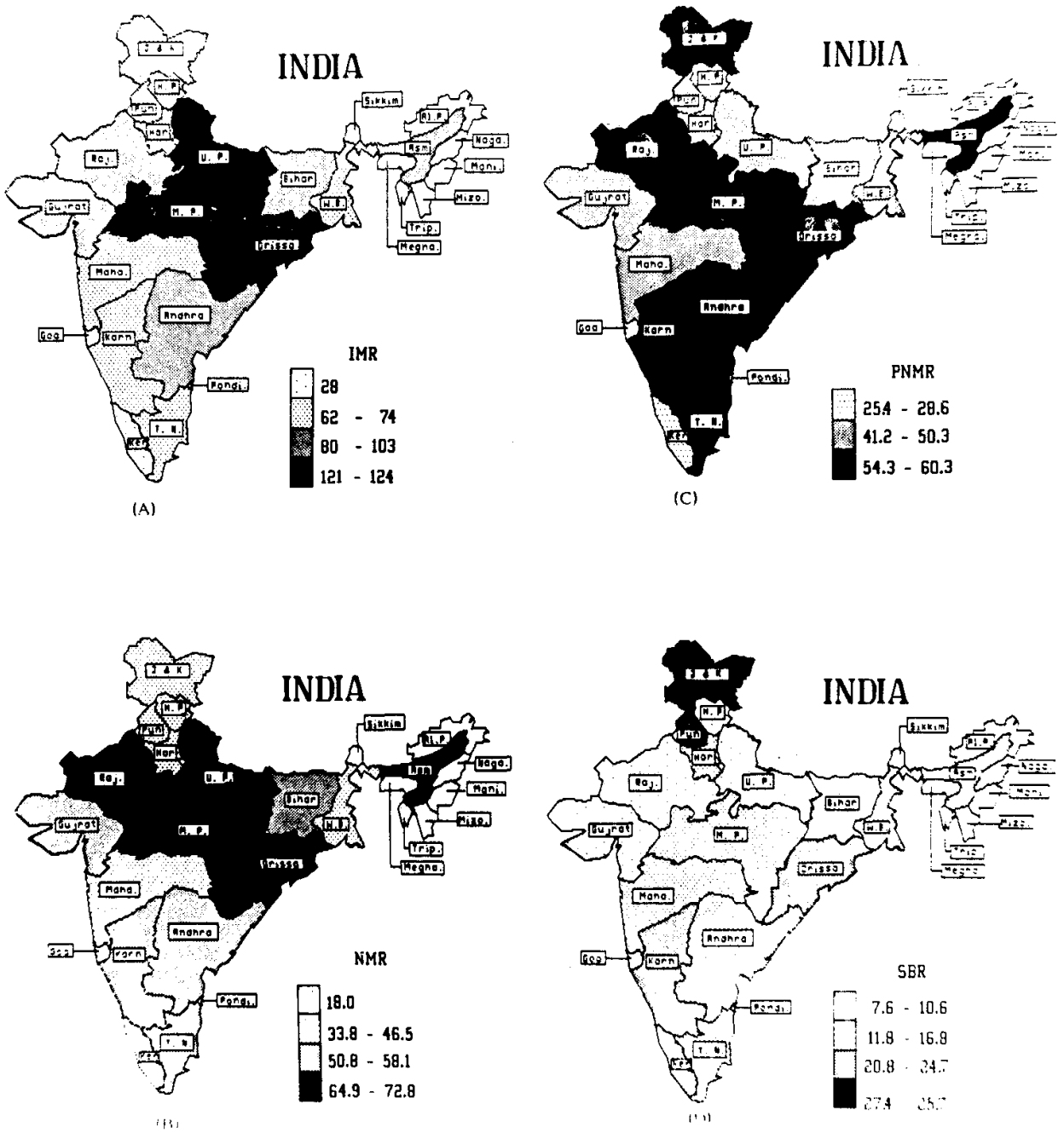

Fig. 3. Clusters of states obtained by "natural" categorization of individual indicators.

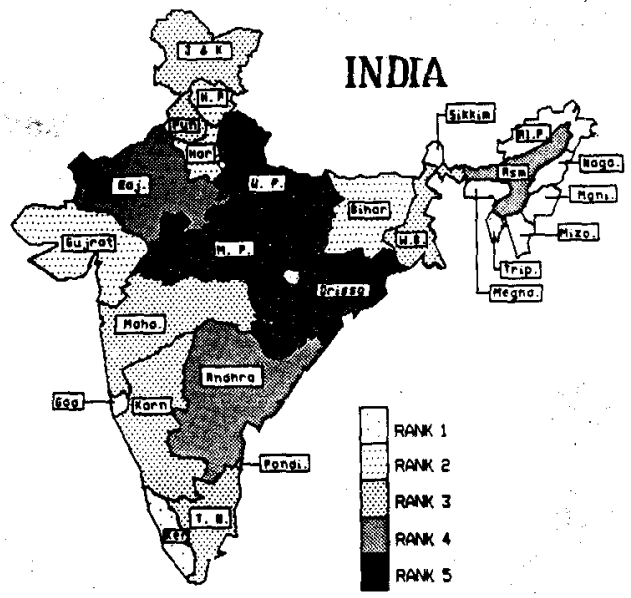

Fig. 4. Clusters of states obtained by simultaneous consideration of all the five indicators.

much more confidence to the planners and health managers to devise strategies for control of mortality upto age of one year at national level. Resource allocation to the States can be done in a much more equitable manner, thus helping to reduce vast spatial differentials seen at present.

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