ORIGINAL ARTICLE

Developing Block Wise Composite Health Index in Yavatmal District, Maharashtra State, India: An Analysis of Available Data

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Abstract	Introduction	Methodology	Results	Conclusion	References	Citation	Tables / Figures

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Abstract

Introduction: Numerous health indicators from different domains and comprehensive systems for describing health of community at state or district level are in vogue. Some sub-district information is also available from Health Management Information System but the numbers of indicators are many. Here composite health index of sub-district level is calculated similar to documented procedure. **Objective**: To develop block wise composite health index in an average district, Yavatmal district using available data. **Methods:** We grouped health indicators in following four categories; health outcomes, health system, other determinants and utilization of services. From these categories we selected four, three, two and one indicator respectively. Almost all the information is collected from already available data. There are 16 blocks in Yavatmal district. Block wise information of all indicators was first compiled. The block having best value was given 100 marks and remaining blocks were given proportionately less marks. The block wise total marks were calculated. The total score was converted into index by dividing by 1,000. **Results:** The composite health index ranged from 0.369 to 0.794. The median was 0.425 and interquartile range was 0.126. Out of ten, nine health indicators had normal distribution. We observed positive correlation between urbanization and composite health index. The Yavatmal block obtained highest composite index 0.794 and was an outlier. Principal component analysis extracted four components which contributed 82.06% to total variance. **Conclusion:** Using only ten indicators and simple method blocks composite health index can be developed which may be used to compare blocks or even districts.

Keywords

Health System Indicators; Health Outcome Indicators; Other Determinants; Utilization of Health Services

Introduction

The 73rd and 74th constitutional amendments empowered local self-governments like Grampanchayats and Municipal Councils/Corporations. Naturally encouragement and competence building of the Panchayati Raj system for effective planning and implementation becomes obligatory. Planning process demands relevant information. There is paucity of reliable health related information at sub district level. Some block wise information about Reproductive and Child

Health indicators is available from National Rural Health Mission website. (1) National Health Mission expects plans at each administrative level and merging at higher level. Universal accomplishment of this ambition is difficult. Unavailability and reliability of data and multiplicity of health indicators are main challenges. Many health indicators and categories exist. Their relative importance is debated. (2,3,4) Naturally one desires to obtain a comprehensive picture. Many attempts have been made to develop composite health index, (5,6,7) which implies comparison between different geographical units. The national levels surveys gather and compile district wise enormous data but do not attempt direct comparison. International organizations publish country wise data and comparisons of plethora of indicators. On the other hand there is paucity of data and comparisons among blocks. National Health Mission expects Block Program Monitoring Unit (BPMU) to collect information, plan and monitor the activities.

Aims & Objectives

To develop block wise composite health index for an average district in Maharashtra State, taking Yavatmal as an example, using available data.

Material & Methods

The study is an analysis of available secondary data of Yavatmal district, carried out in 2016.

Study Location and Population: Yavatmal district is located in Eastern part of Maharashtra State. It has 16 blocks, 18 towns and 2,137 villages. Forest area in the district is 2,178 sq. km. accounting for 16.03% land in the district and almost all this area constitutes thick forest. The population of the district is 2,772,348 and the block wise variation is from 78,713 to 382,965 8. Population density is 204.12 (block wise range; 111.49 to 331.14). The overall urban population in Yavatmal district is only 21.58%. Yavatmal block contributes 19.86%. There are no towns in seven blocks and in rest blocks also urbanization is minimal. It is one of the notified tribal districts having 18.54% tribal population which varies from 6.8% to 38.6% in different blocks. The literacy rate (excluding 0-6 age group) is 82.82%. Per capita income is Rs.54, 497. The sex ratio in Yavatmal district is 952 which is highest in the state. The child sex ratio is 922. In the district 2,295 Accredited Social Health Activists (ASHAs) are functioning. The average house hold size is 4.55 members. There are 435 Sub Centers, 63 Primary Health Centers, 17 Community Health Centers and one Medical College Hospital.

Selection of Indicators

We conducted interactive meetings with medical officers and senior district level officers. They were encouraged to speak and share their experiences, opine about the existing problems. Then a tentative list of health indicators was prepared and discussed among public health experts. It was agreed to use already acknowledged list of indicators9, with slight modification. The modification was inclusion proportion of fluoride affected villages and deletion of prevalence of sickle cell anemia. We grouped health indicators in four categories; health outcome, health system, other health determinants and utilization of health services. All indicators were given equal weightage but categories were given differential weightage as given below. All selected indicators are well-known and typical. Proportion of latrine use was deduced from subtracting proportion of open air defecation from 100. Use of fire wood, crop residue, cow dung cakes, coal and kerosene was considered unsafe and was combined together. The category of health outcomes was given 40% weightage, health system 30% weightage, other determinants 20% and only 10% weightage was given to utilization of health services.

Selected indicators and sources of data

A. Health outcome

1. Infant mortality rate: Mean of statistics from Survey of Cause of Death (SCD) 2013 and 2014 (10)
2. Birth rate: Mean of statistics from SCD 2013 and 2014 (10)
3. Annual Parasite Incidence of malaria: Mean of statistics from HMIS 2014-15 and 2015-16 (11)
4. Proportion of fluoride affected villages: District Health Office (12)

B. Health System

5. Doctor population ratio (Number of doctors per 10,000 population): Maharashtra Medical Council Register of MBBS doctors, as on 31st December 2014 (13)
6. Nurse population ratio (Number of nurses per 10,000 population): District Socio Economic Survey 2013 (14)
7. Bed population ratio (Number of beds per 10,000 population): District Socio Economic Survey (14)

C. Other health determinants

8. Use of latrine: Census 2011 (8)
9. Use of unsafe fuel: Census 20118,(15)

D. Utilization of health services

10. Proportion of institutional deliveries: Mean of statistics from HMIS 2014-15 and 2015-16 (1)

Composite index calculation and ranking of blocks

Block wise values of each indicator were calculated. If information was available from more than one source reasonably valid value was taken. For four indicators as mentioned above, mean of two years was calculated for smoothening of variation. For each indicator the block having best value was given 100 marks and rest blocks were given proportionately less marks. This process was repeated for all ten indicators. Then total marks for each block were calculated. Maximum possible total score was 1,000 and was equated to health index one. Accordingly, total of each block was converted in to composite index. Then blocks were ranked according to the composite index.

Data analysis

The data was analysed by using Statistical Package for Social Sciences (SPSS- version 25). The normal distribution of block wise marks of all indicators was checked by applying One-Sample Kolmogorov-Smirnov (OSKS) Test. As these marks are ranging from 0 to 100, they are implicitly continuously distributed. The correlation between each pair of variables was tested for linear relationship.

Adequacy of the sample was checked by Kaiser Meyer Olkin (KMO) test. Then Bartlett's test of sphericity was also applied. Extraction criterion having the Eigen values more than one by principal component analysis method was used for determining the number of factors. A cut off of 0.5 on the rotated factor loadings was considered. Rotation method by Varimax with Kaiser normalization was used

Results

Block wise reliable information of 36 health indicators was collected. Some estimates were grossly over or under reported. Some estimates have tremendous block wise variations. The block wise data of finally selected 10 indicators is given in Table 1.

Although only 12.8% villages were affected by excess fluoride in water; each affected village was having mean 1.73 affected sources. One village each in Umarkhed and Zari-Jamani, two villages each in Ghatanji, Kelapur and three villages in Ralegaon had 5-10mg/l fluorine level in water. One village each in Ralegaon, Kelapur, Umarkhed and Mahagaon, two villages in Kalamb have recorded more than 10mg/l. The highest content fluoride observed was 14mg/l. Under Bombay Nursing Home Registration Act, 192 private hospitals are registered with Civil Surgeon. Maximum private hospitals were in Yavatmal city. Doctor population ratio considering allopathic doctors is given in Table 1; however, after inclusion of Ayurvedic doctors the district ratio improves to 3.41. The doctor nurse ratio is about 1:1. All three indicators related to health system were best in Yavatmal block due to Medical College Hospital in Yavatmal city. The marks obtained by each block in each indicator and their index based on total marks are given in Table 2. The composite index is calculated by dividing the total score by 1,000; hence the rank of block does not change.

Table 2 clearly shows that data of nine indicators were normally distributed though outlier values were present in seven indicators. Yavatmal block was outlier in four indicators. Consequently, it was an outlier in composite index also. The box plot of block wise composite index is given in figure 1. The median was 0.425 and inter quartile range was 0.126 (0.377 to 0.501).

The Pearson Correlation Coefficients between composite index and following four social determinants, population density, urbanization, proportion of Scheduled Tribes/Caste population were calculated independently. Only population density/sq. km. had positive correlation with composite health index (r=0.65; 95% C.I. =0.23-0.88). The correlation coefficient values among pair of indicators are shown in Table 3. It clearly shows that most of the coefficients are more than 0.3. Highest positive correlation was found between doctor population ratio and bed population ratio and highest negative between bed population ratio and API

Correlation coefficient values between pairs of variables indicated that data were suitable for reduction. By OSKS test all the p-values were >0.05; except for unsafe fuel which is not normally distributed (p<0.05). KMO value is 0.416 indicating borderline adequacy; while is Barlette test is significant. Bartlett's test of sphericity showed, P < 0.01. This indicates that the factor analysis is valid.

After principle component analysis four components were extracted and they are shown below in Table 4. The cumulative variance contributed by these four components was 82.06%.

Discussion

The role of socio-economic factors in determination of health status is undisputable. However, we intended to consider factors from health domain only. Otherwise the model will be a modified miniature of human development index. We have identified only ten important indicators from four categories and have given differential weightage similar to already documented work9. One different indicator, proportion of villages affected by fluorosis was included as a representative of local specific non-communicable disease. In Yavatmal district high levels of fluoride are reported. (16, 17, 18, 19) Even patients with mottled teeth, stiff joints and muscular pains have been reported in some villages.

Numerous health indicators and their categories are in vogue. Many international agencies have identified health indicators of importance and grouped them in few categories. WHO had identified 100 core indicators and categorized them in four groups; Health status, Risk Factors, Service Coverage and Health Systems and many sub groups. They have also been grouped into four categories; inputs and processes, output, outcome and impact.(2) European commission has acknowledged 88 indicators in five categories.(3) Although now 42 indicators from two main and six sub categories have been suggested by CDC for community health assessment, the journey in United States started from identified (18) indicators in 1991.4, (20) Although CDC has suggested these indicators, a review clearly reveals that the States regularly publish reports having different categories and indicators also.(21) Every year county health ranking key findings reports are published in United States of America. In these reports' health outcome is divided into two giving equal weightage to length of life and quality of life. Among the four categories, weightage is given to social and economic factors, health behaviors, clinical care and physical environment in that order. (22) Although the categories of health factors remained same; the weightage system varies in different States and at different times. As a best policy equal weightage to all four groups is recommended. (23) Government of India has given guidelines to rank district or block, developing composite index based on 16 indicators covering four phases of life cycle. The recommended process is similar to Human Development Index (HDI) calculation. The information about the 16 indicators is available from HMIS.(24) National Institute for Transforming India (NITI Aayog) has evolved yet another system of calculating Health Index based on 28 indicators from three main groups following similar procedure as HDI. The maximum total score is 1400.(25) The list also includes governance aspect which is not included in any other system. The comparison of categories of indicators, advocated by different organizations is given in Table 5. It clearly indicates although the groups have some similarity the number of indicators vary. All systems have identified large number of indicators than present study. Our study has used typical categories and very small number of indicators. All three Indian systems including our study have lesser number of indicators. Differential weightage to groups have clearly mentioned only in guidelines by Wisconsin University and NITI Aayog.

In India vertical programs like Revised National Tuberculosis Control Program, National Leprosy Control Program etc. collect and compile the data about relevant indicators. National Health Mission focuses on Reproductive and Child Health services. But there is no system of merger of data generated from different programs. Latest reports of periodic national surveys National Family Health Survey (NFHS 4) (26) and District Level Household Survey (DLHS 4) (27) disseminate huge data pertaining to districts. These surveys do not compile and compare district wise information. That is left to researchers from the country. None of these sources excepting NRHM provides sub district information. The State and District have block wise and Primary Health Center wise information collected under Health Management Information System (HMIS) but that is not frequently used, excepting monthly review meetings. The reliability and validity is uncertain as they are generated from service department and mostly from rural areas. Secondly the data has restricted access. It is difficult for a health administrator to review a plethora of indicators. For avoiding confusion and obtaining separate information of many indicators, composite index is an acceptable and desirable solution. We have tried to enlist important indicators in four groups giving differential weightage. There were many contestant indicators like malnutrition in children, proportion of fully immunized children, water contamination rates etc. whose inclusion was discussed. Many indicators like low birth weight babies, fully immunized children and Infant Mortality Rate are interrelated;

hence only one of them was included in the final list. Indicators like Life expectancy, Total Fertility Rate, prevalence of hypertension or diabetes, tobacco consumption etc. are certainly better indicators but block level information is not available.

Disability Adjusted Life Years (DALY) is an excellent attempt to merge mortality and morbidity data. Based on DALYs including effect of risk factors 'epidemiological transition level' among Indian states was measured and trend was also documented. (28) Varied procedures have been used to develop system to measure health status at district level.(5,6,7) Development composite index from socio economic and nutrition perspectives are also documented. (29, 30) World Health Organization has given separate guidelines for calculation of Urban Health Index.(31) In the guide lines as well in calculation urban health index substantial weightage is given to socio economic factors. (32) The urbanization in Yavatmal district is about 20% only; hence much attention was not paid to the urban section.

The highest composite index of Yavatmal block was expected. It has a medical college hospital consequently there are more doctors, nurses and beds. Being a city it is having many private hospitals. Establishing system for scores, ranking and comparison of geographical areas is a commonly adopted procedure. Uniformly in the Indian attempts of developing composite health index including developed in this article, lack inclusion of behavioral and environmental factors. There is paucity of data about these factors hence we did not include. Others also must have not included these factors for the same reason.

The indicators have some correlation among each other. The principal component analysis has reduced 10 indicators to four components. First component included doctor population ratio, bed population ratio and social determinants of health – Latrine and unsafe fuel. Nurse population ratio as sub constituent of health system was expected in this component, as all three indicators are ought to be inter-related. All indicators in this group probably reflect facet of urbanization/population density. Second component brings IMR and Fluoride affected villages in one group which is difficult to explain. This is definitely a concern and need to be further studied and intervened at policy level. Third component includes API, nurse-population ratio and institutional deliveries. Combination of these indicators reflects service delivery aspect and hence looks rational, realistic and valid. The fourth component is Crude Birth Rate which is independent of all other parameters.

Cost of scientific research is criticized many times and words like 'most wasteful' science projects are also utilized by critics. It is opined that ultimately the scientific studies must directly or indirectly contribute to betterment of human life.(33) The principle of value for money is applicable everywhere. Here we have developed a concept with almost without any financial resources and we believe that its application may help in bringing equity in health. Such exercise may be undertaken in all the districts. The results may be published and discussed by administrators and elected people representatives. The community will certainly accept such practice. This was recommended at the launch of then, National rural Health Mission.

Conclusion

The selected categories and weightage to various indicators for evolving composite health index are comparable to most of the international references. We have minimized the number of indicators to only ten and scores are given to individual blocks using very simple method. Block wise comparison seems to be realistic and hence may be adopted to review community status and progress in it, by health administrators. We have suggested this simple procedure for comparison of composite health index among blocks but may be used for districts also or any small geographical areas. The number and indicators may be changed depending upon availability of data. These statistics can guide decision makers about need of better supervision and allocation of resources in differential manner.

Recommendations

All the data collected and compiled through Health Management System including vertical programs may be made available on website. Doctor/population ratio, nurse/population ratio and bed/population ratio, reflecting health system may updated, made integral part of HMIS and updated regularly. Such index may be calculated yearly or at least once in two years and published for public information.

Limitation of the study

The validity and reliability of the secondary data used here is believed to be reasonable. There can be different opinions about selection of indicators. The risk factors are not considered for lack of data. The composite index is basically developed for understanding comparative status of blocks within the district.

Relevance of the study

Simple and valid system of calculating composite health index may be developed on the lines described in the article. Ranking of blocks may be useful tool for differential supervision and resource allocation.

Authors Contribution

PPD designed and conducted the study; has written the script. MN helped in collecting the data and finalization of script. AD carried out statistical analysis and helped in finalization of script.

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Tables

TABLE 1 BLOCK WISE STATUS OF IMPORTANT HEALTH INDICATORS IN YAVATMAL DISTRICT

Block	IMR	Birth rate	API	% Fluoride affected villages	Doctor populn. Ratio*	Nurse populn. Ratio*	Bed populn. Ratio*	% Latrine use	% Unsafe fuel	% Institut. deliveries
Arni	21.0	18.0	4.3	10.8	1.4	2.4	4.1	28.0	88.9	99.0
Babhulgaon	5.0	14.0	0.1	2.1	0.3	3.7	5.4	32.9	86.2	97.6
Darwha	18.0	20.0	0.1	13.1	0.6	2.2	5.4	33.0	86.9	99.9
Digras	28.0	15.0	0.3	0.0	4.0	1.4	8.4	37.0	83.2	98.9
Ghatanji	31.0	18.0	0.2	25.0	1.0	3.3	3.9	22.8	86.4	98.5
Kalamb	27.0	18.0	0.5	17.5	0.3	3.5	4.7	28.2	87.1	96.3
Kelapur	15.0	13.0	5.2	15.7	1.5	2.7	8.2	30.2	79.0	97.8
Mahagaon	10.0	20.0	0.0	11.2	0.2	3.3	2.8	17.1	91.7	98.0
Maregaon	12.0	18.0	1.2	6.1	0.1	2.7	5.3	22.2	84.9	95.8
Ner	8.0	16.0	0.4	1.7	0.8	2.4	4.0	37.1	89.2	98.8
Pusad	11.0	15.0	1.3	5.9	3.8	1.4	13.0	28.6	81.9	99.7
Ralegaon	48.0	16.0	0.6	54.1	0.2	3.8	5.3	24.7	86.4	99.4
Umarkhed	26.0	15.0	0.0	14.6	2.1	1.9	4.2	33.0	85.2	99.9
Wani	33.0	14.0	0.1	5.6	2.5	1.4	11.4	43.3	54.4	99.5
Yavatmal	12.0	17.0	6.1	2.1	10.8	6.0	41.9	59.9	50.0	100.0
Zari-Jamani	20.0	15.0	0.2	17.2	0.3	4.6	6.0	13.5	87.3	88.0
District	19.0	16.0	1.7	12.8	2.9	2.9	11.7	33.9	78.3	99.5

*IMR= number of infant deaths per 1,000 live births, Birth rate=number of births per 1,000 population, API=Number of positive slides per 1,000 population per year, * per 10,000 population*

TABLE 2 BLOCK WISE MARKS OUT OF 100, FOR IMPORTANT HEALTH INDICATORS IN YAVATMAL DISTRICT

Block	IMR	Birth rate	API	% fluoride affected villages	Doctor populn. ratio	Nurse populn. ratio	Bed populn. ratio	% Latrine use	% Unsafe fuel	% Institut. deliveries	Composite index
Arni	**24**	**72**	**0**	**16**	**13**	**39**	**10**	**47**	52	**99**	**0.372**
Babhulgaon	**100**	**93**	**20**	**81**	**3**	**62**	**13**	**55**	53	**98**	**0.578**
Darwha	**28**	**65**	**29**	**13**	**6**	**36**	**13**	**55**	53	**100**	**0.398**
Digras	**18**	**87**	**6**	**100**	**37**	**24**	**20**	**62**	55	**99**	**0.508**
Ghatanji	**16**	**72**	**10**	**7**	**9**	**55**	**9**	**38**	53	**99**	**0.369**
Kalamb	**19**	**72**	**4**	**10**	**3**	**58**	**11**	**47**	53	**96**	**0.373**
Kelapur	**33**	**100**	**0**	**11**	**14**	**45**	**19**	**50**	58	**98**	**0.430**
Mahagaon	**50**	**65**	**50**	**15**	**1**	**55**	**7**	**28**	50	**98**	**0.420**
Maregaon	**42**	**72**	**2**	**28**	**1**	**44**	**13**	**37**	54	**96**	**0.389**
Ner	**63**	**81**	**5**	**100**	**8**	**40**	**10**	**62**	52	**99**	**0.519**
Pusad	**45**	**87**	**2**	**29**	**35**	**23**	**31**	**48**	56	**100**	**0.455**
Ralegaon	**10**	**81**	**4**	**3**	**2**	**64**	**13**	**41**	53	**99**	**0.370**
Umarkhed	**19**	**87**	**100**	**12**	**20**	**31**	**10**	**55**	54	**100**	**0.487**
Wani	**15**	**93**	**15**	**31**	**24**	**23**	**27**	**72**	84	**100**	**0.483**
Yavatmal	**42**	**76**	**0**	**83**	**100**	**100**	**100**	**100**	92	**100**	**0.794**
Zari-Jamani	**25**	**87**	**13**	**10**	**2**	**77**	**14**	**23**	53	**88**	**0.391**
District	26	81	1	13	27	48	28	57	59	100	0.440

Bold italic represents normal distribution (Kolmogorov-Smirnov Normality Test; P>0.05)

Underlined values are outliers

TABLE 3 CORRELATION MATRIX AMONG VARIOUS INDICTORS, YAVATMAL DISTRICT

	IMR	CBR	API	% Fluoride affected villages	Doctor populn. ratio	Nurse populn. ratio	Bed populn. ratio	% Latrine use	% Unsafe fuel	% Institut. deliveries
IMR	1.00	0.13	-0.02	0.54*	-0.04	0.18	0.05	0.09	-0.09	0.01
CBR	0.13	1.00	-0.04	0.22	0.11	-0.19	0.06	0.20	0.20	-0.06
API	-0.02	-0.04	1.00	-0.20	-0.16	-0.19	-0.26	-0.12	-0.18	0.11
% Fluoride affected villages	0.54*	0.22	-0.20	1.00	0.45	0.04	0.37	0.59*	0.28	0.20
Doctor Population ratio	-0.04	0.11	-0.16	0.45	1.00	0.29	0.95**	0.82**	0.79**	0.36
Nurse Population ratio	0.18	-0.19	-0.19	0.04	0.29	1.00	0.50*	0.09	0.28	-0.40
Bed population ratio	0.05	0.06	-0.26	0.37	0.95**	0.50*	1.00	0.77**	0.85**	0.23
% Latrine use	0.09	0.20	-0.12	0.59*	0.82**	0.09	0.77**	1.00	0.80**	0.57*
% Unsafe fuel	-0.09	0.20	-0.18	0.28	0.79**	0.28	0.85**	0.80**	1.00	0.26
% Institutional deliveries	0.01	-0.06	0.11	0.20	0.36	-0.40	0.23	0.57*	0.26	1.00

TABLE 4 ROTATED COMPONENT MATRIX

Indicator	Component			
	1	2	3	4
IMR	-0.10	0.93	-0.09	-0.02
CBR	0.08	0.11	-0.05	0.92
API	-0.21	-0.05	0.50	-0.23
% Fluoride affected villages	0.39	0.79	0.05	0.21

Doctor population ratio	0.95	0.08	-0.04	0.00
Nurse population ratio	0.29	0.12	-0.77	-0.42
Bed population ratio	0.94	0.10	-0.25	-0.08
% Latrine use	0.90	0.25	0.22	0.13
% Unsafe fuel	0.91	-0.07	-0.11	0.14
% Institutional deliveries	0.45	0.10	0.79	-0.08

TABLE 5 CATEGORIES AND NUMBER OF INDICATORS ADVOCATED BY VARIOUS ORGANIZATIONS

WHO (100)	European Commission (88)	CDC (Matrix of 42)	University of Wisconsin (35)	NITI Aayog (28)	HMIS (16)	Present study (10)
Health status,	Demographic and socio-economic situation	Mortality	Health outcome: Length of life	Key health outcomes	Pre-pregnancy/ Reproductive age	Health outcome
Risk factors	Health Status	Morbidity	Health outcome: Quality of life	Intermediate health outcomes	Pregnancy care	Health system
Service coverage	Determinants of health	Health care: access and quality	Health behaviours	Health monitoring data integrity	Child birth / delivery	Other determinants
Health systems	Health interventions: health services	Health behaviours	Clinical care	Governance	Post natal, maternal and new born care	Utilization of services
	Health interventions: health promotion	Demographic and social environment	Social and Economic factors	Health system/ service delivery		
		Physical environment	Physical environment			

Number of indicators are in parenthesis

Figures

FIGURE 1 THE BOX PLOT OF BLOCK WISE COMPOSITE INDEX