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Short Communication

Examining Population Structure of Rajasthan with Implications for Public Health Planning and rate Standardization to support Eye and Vision Care Public Health Programming

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Abstract

Introduction: Scientific thinking and methods are necessary in order to make valid comparisons of the distribution of health outcomes within and across populations. To date, no prior report has been identified as examining the population structure of Rajasthan and its implication for public health planning applied to eye health and vision care service utilization. In this report, the population structure of Rajasthan was examined based on official projections. A brief discussion was offered for the use of population structure data in public health planning, specifically to support eye health and vision care public health programming in Rajasthan.

Methods: Using an ecological design, secondary data were used to examine the projected population structures of Rajasthan and India from 2016 to 2026. The data were abstracted from publically-available reports and organized by age group and sex for 2016, 2021, and 2026. Population pyramids were constructed for the data from each of the three aforementioned years for both the population of Rajasthan and the corresponding data for the population of India.

Results: The projected population of Rajasthan is expected to rise from 2016 to 2026. During this ten-year time span, the proportion of individuals in the younger age groups (birth to 34 years) will represent a sizable number of individuals compared to those in the older age groups. A comparison of the projected population structures, by age-group strata and sex, showed differences in population pyramids.

Discussion: These findings suggest that, when making public health planning decisions for Rajasthan, public health planners concerned with eye conditions and vision care service utilization might consider the distribution of population by age grouping. Furthermore, it might be appropriate to establish a “standard reference population” for Rajasthan in order to compare age-standardized rates of eye conditions and vision care utilization through 2026.

Keywords: Population structure, Managerial epidemiology, Public health planning, Eye health and vision care service utilization

Introduction

The comparison of eye morbidity and vision care service rates across populations is a fundamental activity of managerial epidemiology [1]. Scientific thinking and analytic methods are required in order to make valid comparisons of the distribution of eye conditions or vision care service utilization within and across populations. From a practical perspective, incidence and prevalence rates of many eye conditions (e.g., diabetic retinopathy, childhood blindness) and the utilization rates of vision care services (e.g., refractive error correction) in a population require

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the comparison of these rates over time. Rates are easy to calculate and understand, so there is a temptation to compare rates across populations in order to make health planning decisions. However, the comparison of crude rates without taking into account population structure from which the rates are calculated could lead to problematic comparisons that, in turn, lead to the unwise allocation of scarce public health resources in a geographic area [1-3].

Not unlike its impact on health in a broad sense [3,4], the structure of age in a population may have impact on the eye health needs of a community along with resource utilization planning efforts for eye and vision care services. The proportions of individuals in the various age strata in a population may suggest the presence of different eye conditions in each stratum. In fact, some eye conditions are predicted by age--e.g., age-related macular degeneration (ARMD)--while other conditions, such as color blindness, are predicted by sex [5]. It is reasonable to surmise that the interplay of the various age groups in a population along with the proportion of males and females in the same population might, over-time, influence availability and use of vision care services in a health care system. The consideration of population structure (especially in terms of age group and sex) might impact the vision care needs of Rajasthan for the next several years.

Improving eye health and vision care service utilization in Rajasthan will likely require sustained governmental, civil society/NGO, and public health action. Also essential is comparison of prevalence and incidence rates for selected eye conditions and vision care services which will both inform public health planning decisions and be used as a tool for monitoring population vision health status. The comparison of rates in Rajasthan for eye conditions such as glaucoma and childhood blindness, as well as the utilization of low-vision services and correcting refraction errors, are examples of some eye and vision health outcomes that could be used as measures and monitored at a state-level. To date, no prior report has been identified that examines the population structure of Rajasthan and its implications for public health planning pertaining to eye health and vision care service utilization. In this brief report, we examine the population structure of Rajasthan based on official projections and discuss population structure for use in public health planning to support eye health and vision care public health programming in Rajasthan.

Methods

Using an ecological design, secondary data were used to examine the population structure of Rajasthan and India from 2016 to 2026. In this secondary data analysis project, the examination of population structure relied upon publically-available, population projections from the Office of the Registrar General and Census Commissioner, Government of India [6]. The data were abstracted from public reports and organized by age group (AgeGrp) and sex (Male and Female) for 2016, 2021, and 2026.

The Government of India report entitled "Population Projections for India and States 2001-2026" contains the official population projections that relied upon the Component Method for projections pertaining to India and twenty-one selected states, including Rajasthan [6]. This method for making population projections is related to the Cohort-Component Method. This method has the advantage of maintaining the knowledge of the underlying distribution of age in the population over time. The simplest form of this method for population projections is given by the following [7]:

$P_t = P_{t-1} + B_{t-1,t} - D_{t-1,t} + \text{Net Migration}_{t-1,t}$ (eq 1)

where the Indian population from 2001 thru 2026 was projected as follows:

- P_t, start with the base population at time, t
- P_{t-1}, population at time, t-1
- $B_{t-1,t}$, births in the time interval
- Net Migration $_{t-1,t}$, net migration in the time interval

The projections that follow this simplest form (eq 1) are applied to the Indian population and twenty-one selected states. Another method, the Mathematical Method, simply relies on past population growth and is applied to the State of Goa and six Union territories [6].

We described the percentage of males and females for each age group in the general populations of Rajasthan and India. A line graph was constructed to show the pattern of population growth for both populations from 2016 to 2026. Population pyramids were constructed for each year of the population of Rajasthan and India (without the duplicate contribution of Rajasthan) included in this exercise. The datasets were analyzed for differences that might be present in the data for which the population pyramids were constructed. The appropriate χ^2-statistic and associations (Cramer's V) were calculated [8]. MS-Excel (2013) with the "Statistician Add-In" (Bollen, 2016) was the software package used in statistical data analysis.

The primary limitation of this exercise is that we did not independently verify the projections based on population data collected from Rajasthan.

Results

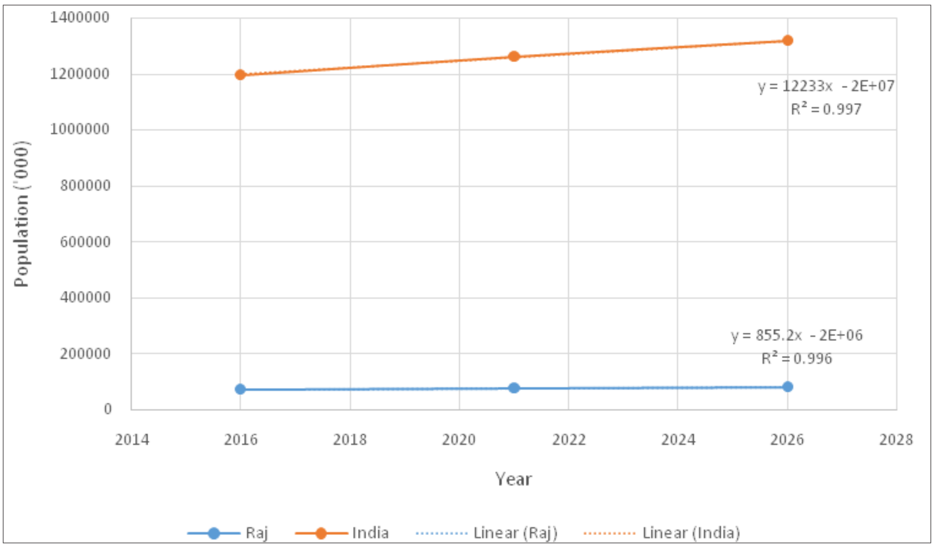
We examined the projected structure of the population of Rajasthan from 2016 to 2026 by age group and sex (see Table 1 on next page). The population of India was examined in the same way (not shown). In the table, the population projections are presented for a ten-year time period assuming that no geopolitical or climatic change will impact the structure of the population projections.

Table 1.Population Structure of Rajasthan (%), 2016, 2021, and 2026 (000')

	2016 (N=72,948)		2021 (N=77,676)		2026 (N=81,501)	
Age Grp (yrs)	M	F	M	F	M	F
0-4	9.97	9.46	9.13	8.68	7.84	7.46
5-9	10.13	9.56	9.22	8.71	8.58	8.12
10-14	10.07	9.50	9.46	8.93	8.73	8.25
15-19	10.47	10.42	9.37	8.84	8.94	8.43
20-24	10.34	10.12	9.71	9.64	8.82	8.28
25-29	9.51	9.11	9.58	9.41	9.14	9.09
30-34	7.77	7.39	8.81	8.48	9.02	8.89
35-39	6.33	6.35	7.19	6.88	8.29	8.01
40-44	5.41	5.80	5.84	5.91	6.74	6.49
45-49	4.80	5.25	4.96	5.38	5.45	5.57
50-54	4.24	4.50	4.37	4.85	4.59	5.05
55-59	3.46	3.59	3.77	4.10	3.96	4.49
60-64	2.65	2.77	3.01	3.23	3.35	3.75
65-69	1.90	2.08	2.23	2.43	2.59	2.89
70-74	1.31	1.62	1.52	1.75	1.83	2.10
75-79	0.91	1.28	0.97	1.30	1.15	1.44
80+	0.72	1.21	0.85	1.48	0.97	1.69
Total	100.00	100.00	100.00	100.00	100.00	100.00

Data Source: "Table 18-Projected Population by Age and Sex as on 1 March: 2001-2026, Rajasthan," Report of the Technical Group on Population Projections Constituted by the National Commission on Population, May 2006.

The line graph on the next page shows the trends in the projected population counts for Rajasthan and India (see Figure 1). The trend line for each set of population data is similar. Not surprisingly, the populations of India and Rajasthan showed a wide gap with a more pronounced increase in the population of India expected by 2026 compared to that of Rajasthan.



Data Source: "Table 18-Projected Population by Age and Sex as on 1 March: 2001-2026, Rajasthan," Report of the Technical Group on Population Projections Constituted by the National Commission on Population, May 2006.

Figure 1.Population Projections: India and Rajasthan, 2016, 2021, 2026

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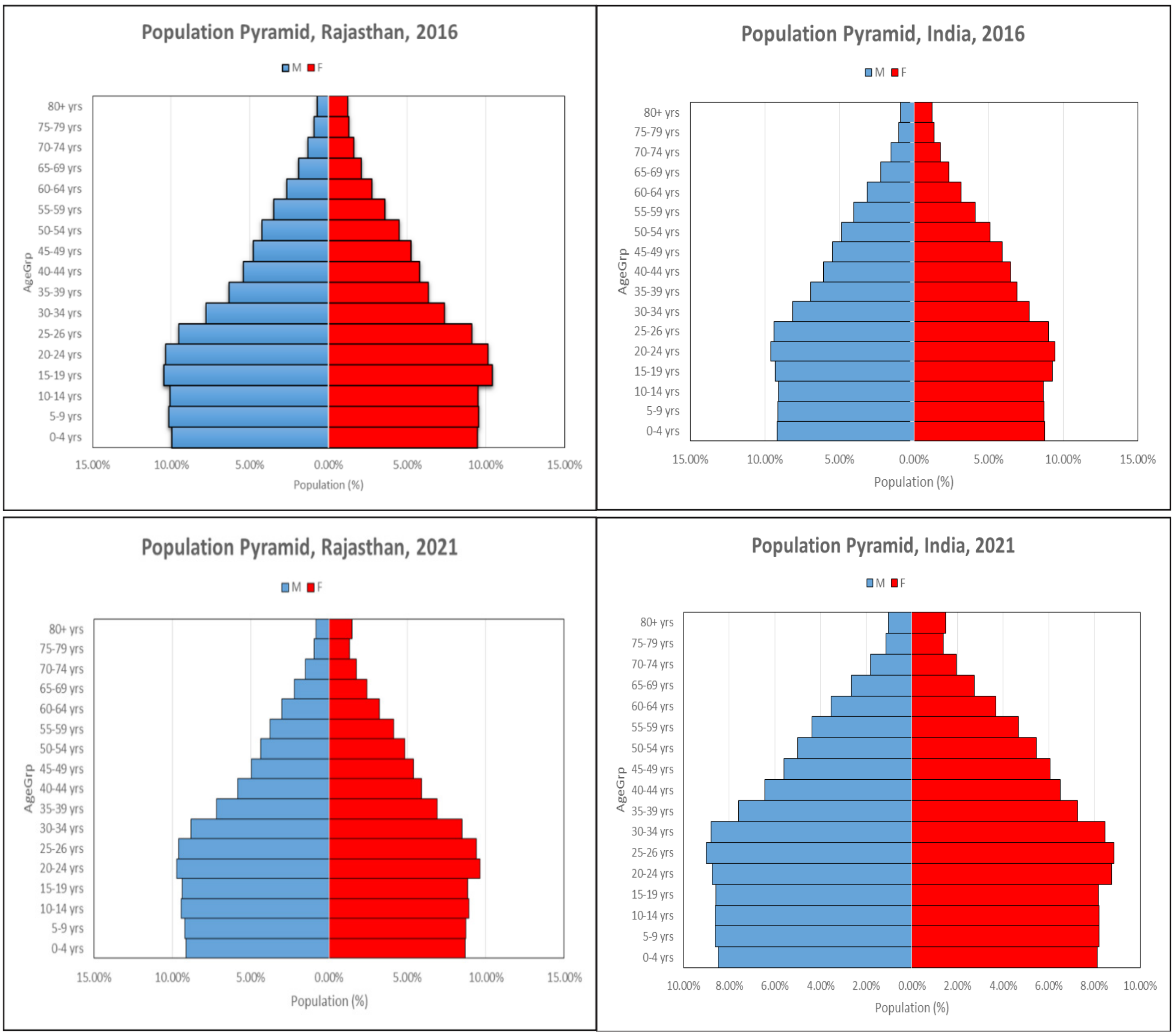
There are projected to be differences in the proportion of males and females in each population over time (see Table 2).

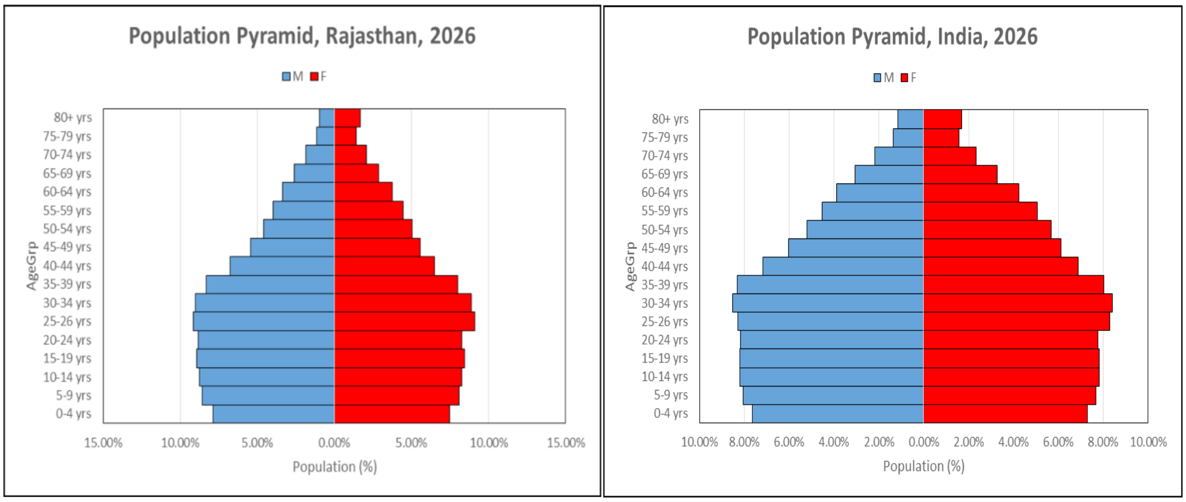
Table 2.Population structure by sex in each location, 2016, 2021, 2026

	2016		2021		2026	
	M	F	M	F	M	F
Rajasthan	38,091	34,858	40,570	37,104	42,551	38,950
India*	619,076	576,934	653,513	608,557	682,624	635,714
p-values	χ^2 (5.68) = 0.0172; Cramer's V =0.002		χ^2 (5.94) = 0.0148; Cramer's V =0.002		χ^2 (5.69)= 0.0171; Cramer's V = 0.002	

Data Source: "Table 18-Projected Population by Age and Sex as on 1 March: 2001-2026, Rajasthan," Report of the Technical Group on Population Projections Constituted by the National Commission on Population, May 2006.

Figure 2 uses the same underlying data found in Table 1. Population pyramids are the most common way of comparing the structure of a population from managerial epidemiological and demographic perspectives. The comparison of population pyramids for both Rajasthan and India show a projected difference in the sex and age strata from 2016 to 2026 (see Figure 2).





Results: 2016 | χ^2 (733.731) p < 0.001; 2021 | χ^2 (682.917) p < 0.0001; 2026 | χ^2 (594.667) p < 0.0001

Figure 2.Comparison of Population Structure, Rajasthan and India, 2016, 2021, 2026

Discussion

As public health planning efforts are undertaken in the future to promote enhanced eye health and vision care services in Rajasthan, a close inspection of population projections may be warranted. The consideration of population demographic data is essential to public health planning [1,9]. The result of this managerial epidemiological exercise was that, while the projected population of Rajasthan is expected to rise from 2016 to 2026, the proportion of individuals in the younger age groups (birth to 34 years) will represent a sizable number of the ten-year time span compared to individuals in the older age groups (see Table 1). In that decade, we expect the projected population increases in Rajasthan to be generally parallel with the population increases in India; there will also be differences in the male/female composition of these two populations (see Figure 1 and Table 2). A comparison of the projected population structure by age-group strata and sex showed differences in population pyramids (see Figure 2). Considering the shape of the upper and lower parts of the population pyramids, the Indian population might show characteristics of a demographic transition by 2026 [10,11,12].

Implications: Public Health Planning

These findings suggest that, when making eye and vison health planning decisions for Rajasthan, public health planners concerned with health planning for the needs of the population in terms of eye conditions and utilization of vision services might consider the structure of population mainly by age grouping. Optometrists (along with other health care professionals) in India who are involved in primary eye care and public health planning are knowledgeable of how eye and vision conditions impact a population by age and sex. It may be that age-related eye and vision conditions in and around Rajasthan follow a pattern related to the population structure of Rajasthan by age and sex. If so, then this information may be useful to public health planners—including governmental public health planners, optometrists, other health care professionals, and civil society/NGO partners for eye and vision care services in Rajasthan. Managerial epidemiologists and public health planners can convert the data of a population pyramid into estimates for health services [9].

Comparing the rate of a health condition (or other health outcome) or the use of health services, in a population relies upon the quantitative methods of managerial epidemiology [1]. The proper comparison and interpretation of health rates in a population is very important for health planners who are allocating scarce resources to meet the health needs of a population. However, the comparison of crude rates by health planners can be misleading if the age and sex composition of the population is not taken into account [3,9].

The effect of age in a population is an essential component to understanding its health status and its utilization of health services. If populations are different in terms of age and sex, then it is very appropriate to compare health outcome rates between populations where these rates have been standardized [1,9,13,14]. Rather than comparing crude rates of ARMD, childhood blindness, or uncorrected errors of refraction, for example, the population projections presented in this report suggest that age-standardized rate comparison might be useful.

Implications: Age-Standardization

Age-standardization of rates over time is necessary because it takes into account the influence of age on a health outcome [1,3,9,13,14] and, tacitly, acknowledges the cohort approach to understanding population health [4]. Age-standardized rates of uncorrected errors of refraction in and

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around Rajasthan might permit public health planners to align eye and vision care resources in an efficient manner. The goal would be to improve eye and vision status in Rajasthan while simultaneously helping India to meet the objectives of "VISION 2020: The Right to Sight." This plan has been described by its authors as "a global initiative for the elimination of avoidable blindness, a joint program of the World Health Organization (WHO) and the International Agency for the Prevention of Blindness (IAPB)."

When the WHO established the "standard reference population" for international comparisons of incidence, prevalence, and mortality, they reminded the international, public health community of three important points [3]. First, while there are several techniques for adjusting age-specific rates, direct standardization of rates has become the most common method used in demography and epidemiology. Second, there is no conceptual justification for choosing one standard reference population (and the associated weights) over another, thus the eventual choice is arbitrary. And, third, the selection of a standard population should be chosen to reflect the age-structure of the population over a long time period, and not "to match" future age-specific rates with a current or older population.

Given that the work of the WHO informed this report, it might be appropriate to establish a "standard reference population" for Rajasthan in order to calculate age-standardized rates of eye conditions and vision care utilization and, then, compare these rates through 2026. Practically, a registry of selected eye conditions in Rajasthan could contain data that would be used to monitor eye health status in the state and age-standardized rates could be reported and used in public health planning [15]. A "standard reference population" for Rajasthan could be established, say, from the information in Table 1 for 2026. And, then, the reporting of rates pertaining to selected eye conditions and vision care service utilization (or rates of other health outcomes) by managerial epidemiologists and public health planners could use the projections for Rajasthan in 2026 as the "standard reference population" for direct standardization of rates. Such an approach would utilize the already existing data and projections from the Government of India.

Summary

Epidemiology is considered to be a population health science [12]. In this report, the population structure of Rajasthan was examined based on projection data from the Government of India. A short discussion of the importance of age-standardized rates was presented in the context of eye conditions and vision care service utilization for public health planning in Rajasthan. Finally, a proposal was offered to establish a "standard reference population" for Rajasthan based on 2026 projections. If accepted, then it would be possible to make age-adjusted rate comparisons for eye conditions and vision care service utilization in public health planning efforts to enhance the eye and vision health status of Rajasthan.

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Conflict of Interest: None

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