Age, Gender and Research Productivity: A Study of Speech and Hearing Faculty in India

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ABSTRACT

Introduction: Productivity as a function of demographic variables is a management conundrum. While previous studies have covered the sciences and humanities, the field of allied health sciences remains uninvestigated. **Aims:** The aims of this study included (a) investigation of publication productivity trend across age groups, (b) finding out the age at which the publication productivity peaks, and (c) to study the variance in publication productivity across age groups, gender-wise. **Method:** Following a cross-sectional longitudinal study, the data set covered 1174 Research Productive Units (RPU) from 1995-96 to 2014-15 relating to scientific publications involving 114 teaching faculty in speech and hearing institutions. **Findings:**The findings of this study revealed that research performance score for scientific publications showed two peaks, in the age group >55 yrs and another in the age group of < 30 yrs, the former being the higher of the peaks. Other findings include: The male teaching faculty (N=520, Mean score=12.47, Median =12.00 SD=4.671) fared better than the female teaching faculty (N=654, Mean score=11.70, Median = 9.00 , SD=4.784). **Conclusion:**The study can contribute to formulation of appropriate HRD strategies and policies in areas like determination of age for retirement, fixing of differential teaching workload for different age groups based on the "research productive" yrs.
Keywords: Research Productivity, Age Cohorts, Gender, Research Policy, Speech and Hearing, Demographic Variables.

INTRODUCTION

Productivity as a function of demographic variables, especially, age: how much and at what point of time in the life cycle of academicians and researchers is not only a management conundrum to be understood and solved for proper planning and design of appropriate policies for research management in scientific and academic institutions, but also a matter of great interest to sociologists, philosophers and science policy makers.

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As Jones[1] observed: "The intersection of age and great achievements sheds light on a rich landscape, where creativity, knowledge, scientific progress, economic growth, demographics and science institutions all intersect. As studies continue to reveal the forces at work in the age-creativity relationship, this broader landscape will continue to come into sharper focus". In studies relating to scientific performance and research productivity, gaining a fair level of understanding into the demographic and various individual-level variables is vital. Among the demographics, there exists substantive literature exploring the association between age, gender and research productivity, albeit with conflicting and inconclusive results.

While conducting a critical review on Publication Productivity among Scientists, Fox,[2] cites the following studies: Lehman[3] published evidence that scientists' major contributions occur in their late 30s or early 40s, and thereafter decline. In subsequent documentation, Lehman,[4] verified his observations, and showed further that the age peak occurred earlier in abstract disciplines (such as mathematics and theoretical physics) and later in more empirically based fields (such as geology and biology). Moreover, he observed that the age peak is sharper for major contributions and achievements, and flatter for minor scientific accomplishments.

Following Lehman[4], Pelz and Andrews[5], found a productivity peak in scientists' late 30s and early 40s; but they also observed a second peak ten to fifteen yrs later at age 50. Thus, in contrast to the continuing decline of Lehman's observations[4], Pelz and Andrews[5] found a two-peaked curve of age and productivity. The disparity in the two sets of investigations is attributable in part to differences in the studies' dependent variables: Lehman[4] found the sharp decline with age only for major contributions. Pelz and Andrews[5] performance measures, on the other hand, included a wide range of achievements in paper, patents, reports and manuscripts, and for this range of contributions, the age peak is less dramatic.

Cole S.[6] on the other hand, reports a slightly curvilinear relationship between age and quantity of publications for a cross-section of academics in six scientific fields. Across fields, he finds that publication rates rise gradually with age, peak in the late 30s or early 40s, and then drop off. Additional longitudinal data on mathematics, which allow him to disentangle age and cohort effects, show the same pattern as his cross-sectional data: the relationship between age and productivity is slightly curvilinear, but productivity does not differ significantly with age.

Hammel's[7] longitudinal study of chemists in the University of California system challenges findings that productivity declines with age. In his study, Hammel[11] reports that 'productivity increases strongly with age and decreases weakly with the square of age, so that the pattern is one of gradually decelerating increase'. In contrast to previous studies, Hammel[7] infers that scientific productivity increases with age, with some evidence of flattening, but not necessarily decline, with age. Moreover, he reports that increases in productivity are more marked for more recent cohorts, and that the declines apparent in any mean across persons are 'attributable largely to the "shooting stars" – the high producers who climb to a peak and then decline'.

Kyvik[8] summarizes the findings from previous studies as follows: (a) the relationship between age and the number of publication is curvilinear where productivity expands with increasing age and reaches a peak when the scientists are in the late thirties and early forties after which it declines; (b) those scientists who are more productive at a younger age will continue to be productive as they grow older; (c) in some cases two peaks are observed, the first and highest in their late thirties and early forties and another around 60; (d) there are vast differences between various disciplines with regard to the relationship between age and scientific publishing.

Kotrlik *et al*.[9] in a study using a random sample of 228 college and university agricultural education faculty members in the United States concluded that age did not significantly affect research productivity. Williams *et al*.[10] and Ramsden[11] also observed that similar results and found that there was no association between age and research productivity.

As Creswell J[12] observed, the precise relationship between age and research productivity is difficult to determine because of complex measurement and other methodological problems. The studies also report cross-sectional rather than longitudinal data, thereby possibly entangling the effects of age with the effects of cohorts. (Cole S.[6]; Reskin,[13]) Cohorts may differ in research performance not simply because of age differences but also because the pressures to publish vary from one historical period to another.

Acknowledging this entangling effect, authors have turned to other data collection procedures, such as longitudinal designs (in which a cohort group is followed over several decades) or a combination of cross-sectional and longitudinal designs, called a cross-sequential approach. Over,[14] But even these designs are subject to sample attrition problems.

A further difficulty is identifying the true 'age curve' between age and research productivity. One model holds that the 'age curve' is curvilinear, (Lehman[3]) who found that scholarly achievement peaks in the late thirties and early forties and declines thereafter. Another model suggests that the relationship is bimodal or "saddle-shaped".[5] Pelz and Andrews[5] found that publication productivity peaks during the ages of 35 to 44 and 50 to 54. Bayer and Dutton[15] also confirmed this relationship; a "spurt-obsolescence curve" best fitted five of seven disciplines they studied.

The best "age curve" is probably a function of the sample being studied. (Bayer and Dutton)[15] and the criterion measures of age and productivity used (Reskin[13]). These qualifications aside, various monotonic functions (e.g., "obsolescence," "spurt", and "spurt-obsolescence") or a bimodal curve, represented by a peak in performance about 10 yrs after the doctorate and a second peak toward the end of a faculty career, best describe the relationship between age and research (Reskin[13]).

Studies investigating demographic variables have also dealt with gender in their study. While some researchers found no differences in research productivity due to gender; (Xie Y. and K.A Shauman[16] Teodorescu D),[17] many studies have also shown significant differences in the research productivity among genders, Aksnes D.W *et al* [18], Kyvik & Teigen,[19] which indicated that male researchers publish more than the female researchers. Further, studies by Cole and Zuckerman[20] revealed a narrowing gap in the publication productivity of both the genders.

While most of the above studies are in the field of science, none of them cover the allied health sciences. In this context, the present study investigated age, gender as a function of research productivity in one of the allied health sciences i.e., speech and hearing sciences. Specifically, the objectives of the study included (a) investigation of the productivity trend in scientific publications across age groups, (b) to find out the age at which the research productivity peaks, and (c) to study the variance in research productivity across age groups in terms of gender for the teaching faculty working in speech and hearing institutions in India with respect to scientific publications.

METHOD

Research Design

The research design used is a descriptive study of the ex-post facto type and follows a cross-sectional-longitudinal study. Cross sectional in terms of coverage, i.e, covering teaching faculty in seven speech and hearing institutions and longitudinal in terms of the period covered i.e. 20 yrs.

Research Productive Unit (RPU)

While reckoning the research productivity for this purpose, a research productive unit was taken to mean the researcher's contribution in their capacity as first author / last author, any other author bye-line position in scientific publications.

Corpus

At present, there are nine institutions which are offering doctoral programmes in speech and hearing in India and on the basis of information gathered from the institutional website, the annual reports of the institutions, questionnaires sent to these institutions followed by field visits, information on scientific publications and the demographic data was collected from these speech and hearing institutions. In all, the data set covered 1174 Research Productive Units (RPU)s, relating to scientific publications involving 114 teaching faculty, from seven institutions.

Procedure

While collecting the data, the scientific publications of teaching faculty in the core departments of speech, language and hearing alone were reckoned and the publications by the researchers in the allied departments were excluded, unless in combination/ collaboration with a speech and hearing professional. Publications in Symposium / Conference proceedings have been included. The data collected covered a period of 20 yrs from 1995-96 to 2014-15.

Measuring research productivity

With a view to accord differential weightages and to arrive at research performance score as a metric, the guidelines adopted by the University Grants Commission (UGC)[21] for the Academic Performance Indicators (APIs) were largely kept in mind. However, apposite modifications have been made.

Taking into account the venue of publications: viz., national or international and based on the authorship bye-line position, a productivity index was arrived at as follows: A score of 15 and 30 was given for single authorship in national journal publications and international journal publications respectively.

The score for joint publications have been calculated in the following manner: of the total score for the relevant category of publication, viz., national or international, the first/Principal author and the corresponding author, assigned 60% of the total points and 40% assigned to the other bye-line positions. Accordingly, the first and the last author, were assigned a score 9 and a score of 6 assigned for authors in other bye-line positions in respect of national journals. Similarly, the first and the last author, were assigned a score 18 and a score of 12 assigned for authors in other bye-line positions in respect of international journals.

Age cohort groups

Based on their chronological age, the researchers were classified under seven age intervals as follows: ≤30, 31-35, 36-40, 41-45, 46-50, 51-55 and >55. The age group of ≤ 30 included teaching staff from 23-30 yrs and the age group of >55 included teaching staff from 56-63.

Data analysis

Statistical analysis was done using the software Statistical Package for Social Sciences (SPSS), version 20.0. Descriptive statistics was done to compute the mean, and standard deviation (SD), median. Test for normality was negative and therefore, the following non-parametric tests were performed using the SPSS software.

Kruskal-Wallis test was done to compare the research productivity score across age groups and gender.

Mann-Whitney test was done to compare the research productivity score across age groups and for each of the 2 independent samples.

RESULTS

Age and Research Productivity

Table 1 shows the mean, median and standard deviation (SD) of mean publication scores across the seven age groups. Figure 1 shows the trend in mean publication

Table 1: Mean, Median and SD of publication scores across age-groups

Age-Groups / Mean publication scores	< =30	31-35	36-40	41-45	46-50	51-55	>55	Total
Mean	13.33	12.81	10.18	11.15	11.12	12.10	13.43	
Median	12.00	12.00	9.00	9.00	9.00	9.00	12.00	
SD	4.900	4.469	4.532	4.218	4.361	4.623	5.500	
N	239	186	147	124	212	182	84	1174

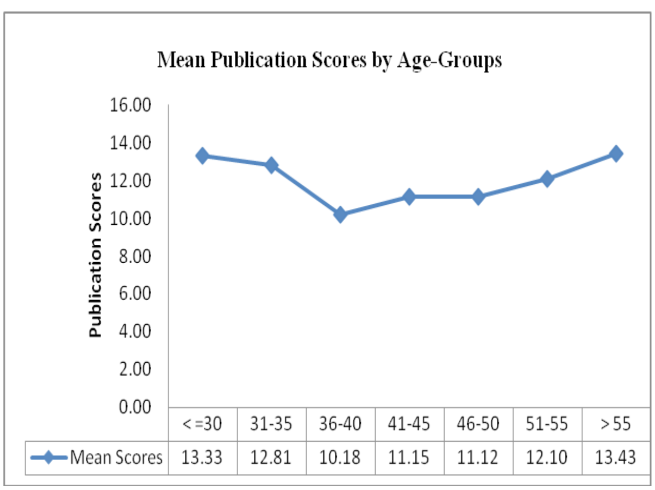

Figure 1: Trend in Mean publication scores by age-groups.

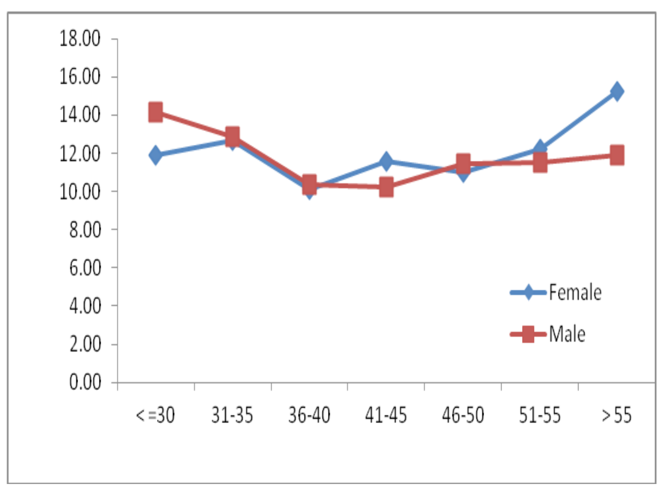

Figure 2: Mean scores across age groups between the genders.

The trend shows an interesting pattern: Two peaks at the extremes, both in the age groups : ≤ 30 yrs as well as at >55 yrs, with the highest peak at above 55 yrs which is marginally high over the 25-30 yrs age group. A decline during 31-35 yrs which becomes steeper during 36-40, only to increase steadily during 41-45. The performance remains more or less flat during 46-50, but, steadily increases through 51-55 to attain the highest peak during 56-60 yrs. The age groups ≤30 yrs and that beginning from 51 yrs onwards form the most productive period in respect of scientific publications.

Peak research productivity

It was observed that the research performance score for scientific publications shows two peaks, the highest being in the age group >55 and another in the age group of ≤ 30 yrs.

Statistical Analysis

Non-parametric Kruskal-Wallis test revealed significant difference between the age groups and the research productivity mean score: $\chi^2(6) = 76.264$, $p<0.005$. This was followed up by Mann-Whitney test for each of the pairs of independent samples which is shown in Table 2.

The results on Mann-Whitney test for scientific publications across age groups revealed significant difference ($p<0.05$) between the age groups : ≤30 yrs and 36-40, 41-45, 46-50, 51-55 yrs; 31-35 yrs and 36-40, 41-45 and 46-50 yrs; 36-40 yrs and 41-45, 46-50, 51-55 and >55 yrs; 41-45 yrs and 51-55, >55 yrs; 46-50 yrs and 51-55 and >55 yrs.

Gender and Research Productivity

The male teaching faculty (N=520, Mean score=12.47, Median =12.00 SD=4.671) fared better than the female teaching faculty (N=654, Mean score=11.70, Median = 9.00, SD=4.784). Table 3 shows the mean, median and

Table 2: Mann Whitney Test Results - Mean Publication Scores and Age Group P (2-tailed),* = significant at 0.05 level

Age Group	31-35	36-40	41-45	46-50	51-55	>55
<30	U =21148	U =10669	U =10754	U =18681	U =18832	U = 9928
	z =0.904	z =6.762	z =4.505	z =5.133	z =2.490	z =0.158
	p =0.366	p =0.000*	p =0.000	p =0.000	p =0.013*	p =0.874
31-35		U =8765	U =8868	U =15218	U =15351	U =7552
		z =5.831	z =3.592	z =4.167	z =1.616	z =0.460
		p =0.000*	p =0.000*	p =0.000*	p =0.106	p =0.645
31-35			U =7646	U =13050	U =9814	U =3860
			z =2.428	z =2.842	z =4.360	z =4.988
			p =0.015*	p =0.004*	p =0.000*	p =0.000*
41-45				U =13110	U =9812	U =3881
				z =0.044	z =2.047	z =3.321
				p =0.965	p =0.041*	p =0.001*
46-50					U =16889	U =6778
					z =2.300	z =3.511
					p =0.021*	p =0.000*
51-55						U =6748
						z =1.630
						p =0.103

Table 3: Mean, Median and SD of publication scores across age groups by Gender (F=Female; M=Male)

Age / Mean Scores	<= 30		31-35		36-40		41-45		46-50		51-55		> 55	
	F	M	F	M	F	M	F	M	F	M	F	M	F	M
Mean	11.90	14.14	12.64	12.86	10.08	10.38	11.60	10.24	11.00	11.46	12.24	11.49	15.24	11.93
Median	9.00	18.00	12.00	12.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	18.00	9.00
SD	4.858	4.752	4.636	4.427	4.978	3.545	4.185	4.188	4.178	4.858	4.598	4.743	6.253	4.312
N	86	153	47	139	97	50	83	41	156	56	147	35	38	46

Figure 3: Mean scores across age groups for both genders alongside individual genders.

SD of publication scores across the seven age groups by gender.

Gender, Age-Groups and Research productivity

Figure 2 compares the pattern of mean publication scores across age-groups between the genders. Figure 3 shows the variance in pattern of mean publication scores across age-groups for both genders taken together alongside individual genders.

In Figure 2, the trend observed in the mean publication scores show a contrasting pattern between the genders. While the peak productivity was observed for the female teaching faculty at >55 yrs, the peak productivity for the male teaching faculty was observed at ≤30 yrs.

The pattern of female teaching faculty shows a remarked undulating pattern. A rise during 31-35 yrs which declines during 36-40, picking up during 41-45 yrs, dropping slightly during 46-50, only to increase steadily during 51-55 and > 55 yrs. The age groups up to 35 yrs and that beginning from 51 yrs onwards form the most productive period in respect of scientific publications.

The pattern of male teaching faculty shows an inverted U curve. A decline during 31-35 yrs which becomes steeper during 36-40 and 41-45 yrs, only to increase steadily during 46-50 , 51-55 and > 55 yrs. The age groups ≤30 yrs and that beginning from 46 yrs onwards form the most productive period in respect of scientific publications.

The peaks of both genders curve and that of the female teaching faculty are similar occurring at > 55 yrs, whereas the male teaching faculty presents a different pattern as far as the peak productivity is concerned as presented in Figure 3. The least productivity age interval seems to be almost uniform between 36-40 yrs.

DISCUSSION

While there is no previous literature in the field of speech and hearing on this subject, to correlate the findings, nevertheless, the findings of the study could be discussed with the available literature on the subject of age, gender and research productivity, albeit, in other disciplines.

The pattern and association revealed in this study does not bear resemblance or similarity with the results of the studies reported in the literature review dealt in this article. Indeed, as noted by Kyvik,[8] there are vast differences between various disciplines with regard to the relationship between age and scientific publishing. As pointed out by Bayer and Dutton,[15] the best "age curve" is probably a function of the sample being studied and the criterion measures of age and productivity used (Reskin[13]).

The general trend of research productivity could also be due to increasing expectations and the bench marks/quality standards articulated by the UGC, RCI and NAAC, the increase in the retirement age to 65 yrs in university setups, the shift in the hiring and promotion policies placing emphasis and accentuation on research productivity in the recent yrs, not attributable to age alone but the interplay of a combination of factors at any point of time.

Contrary to the findings of numerous studies exploring the relationship between age and research productivity in the past as well as in recent times, which reported a decline as age increases, especially, after the chronological age of 40 yrs, (Lehman,[4] Cole S,[6] Kyvik,[8], Ebadi A, and Schiffauerova A),[22] the finding of this study reveals that the best productivity yrs in so far as the research productivity is concerned, in fact, occurs in the later yrs in the age beyond 50 yrs in the intervals of 51-55 and 56-60 yrs.

The finding of this study revealed that the research performance score for scientific publications showed two peaks, in the age interval >55 and another in the age interval of 25-30, the former being the higher of the peaks. The occurrence of two peaks as observed by Pelz and Andrews[5], had a time difference of 10-15 yrs, whereas the time difference in this case is of 25 yrs.

The occurrence of such a phenomenon with two peaks happening at the extremes could be related, in a way to the ideas of Galenson, D.W.[23] in his book "Old Masters and Young Geniuses: The Two Life Cycles of Artistic Creativity". Galenson, D.W.[23] demonstrates that there are two fundamentally different approaches to innovation, and that each is associated with a distinct pattern of discovery over a lifetime. Experimental innovators work by trial and error, and arrive at their major contributions gradually, late in life. In contrast, conceptual innovators make sudden breakthroughs by formulating new ideas, usually at an early age. The applicability of the above in the instant sample, however, needs a deeper investigation.

The occurrence of peak at > 55 yrs could be attributed to the enhanced level of networking and collaboration happening between senior researchers and junior researchers within the department / institution, researchers outside the institution, joint authorship with post graduate and doctoral students being supervised.

The discipline of speech and hearing sciences is a non-traditional discipline and highly clinical and rehabilitation oriented, requiring considerable yrs of professional experience to acquire sufficient expertise to result in research productivity. Therefore, we witness this uncommon phenomenon and the reversal of trend in comparison to the majority findings which predict decline in research productivity with age increase.

Further, the discipline is still at its nascent stage in the country and the researchers face constraints in the availability of funding and other resources for conducting high quality research work such as conducting well-designed, randomized controlled trials as that taken up in clinical medicine. Moreover, there was a dearth of doctorates, until even as late as a decade to 5 yrs ago, and therefore, the research in this field, especially, conducting of research projects was only limited to the senior researchers.

The occurrence of the second peak at ≤30 yrs could be attributed to the desire for contribution to science and recognition in the scientific community by young scientists with fresh ideas and increased potential for creativity, while young, to come out with research productivity of considerable impact. (Falagas M.E *et al*)[24] Further, the notion that science is a young man's game "where the best work is done at a comparatively young age" is articulated by Zuckerman, H. & Merton, R.K[25] and according to Skirbekk, V;[26] the numerical and reasoning abilities of individuals are at their best in their 20s and early 30s.

The second peak at ≤ 30 yrs also finds support from Kyvik S. & Aksnes D. W,[27] wherein, partial explanations for increase in publication productivity from a generational perspective is attributed to better qualified new generations of academic staff, the increase in research collaboration, improved funding and research conditions, and the introduction of incentive systems.

Further, as observed by Over[14] cohorts may differ in research performance not simply because of age differences but also because the pressures to publish vary from one historical period to another, which explains the equally promising research performance in terms of research productive scores for scientific publications by teaching faculty in the age group ≤ 30 yrs. This trend is very encouraging and needs to be nurtured for higher research productivity in future.

Not with standing, caution needs to be exercised in interpreting the statistical results in cohort studies, especially, in measuring productivity as a function of age, as there could always be a few star performers in any of the age groups who catapult the mean score.

The other interesting findings of this study

There are no differences in research productivity due to gender which supports the "narrowing gap theory" between genders as put forth by Cole and Zuckerman.[3] The discipline of speech and hearing sciences has traditionally been female dominated as can be seen from the N, nevertheless, many men have taken to this discipline, in recent past and the overall research performance of male teaching faculty has been better than their female counterparts in scientific publications and only marginally lower than the female teaching faculty in certain age groups.

CONCLUSION

This is the first study to look at the association between age, gender and research productivity in the discipline of speech, language and hearing sciences. Further, the study adopts a different approach in exploring the relationship between age and research productivity by analysing the variations in the scientific publications across age groups, taking into account both cross-sectional as well as longitudinal data. The study is restricted to the research productivity by the teaching faculty in the core departments. But it needs to be appreciated that besides, the core-faculty, this discipline being essentially, inter-disciplinary, active collaboration occurs with the faculty from the allied departments and the clinical staff.

It is also pertinent to mention that there are methodological issues in getting a reliable and updated information on the scientific publications in this discipline in India and it is time to give a deep thought towards maintaining a publication database such as Current Research Information System in Norway (Cristin)[28] (http://www.cristin.no / english/) and organisations like Indian Speech and Hearing Association (ISHA) could take an initiative in this regard.

A future study on the life-cycle productivity pattern of star researchers in this discipline can shed better light on the findings of this study. An understanding of the dynamics of the life-cycle of a researcher, the role of doctoral / post graduate students, the role of networking and collaboration can help plan the right Human Resources Development (HRD) policies and strategies to tap their optimum productivity potential by motivating and incentivising the researchers, by creating a conducive research environment for enhancing the overall research productivity in this discipline. From the point of view of science administrators and policy makers, the study is expected to contribute formulation of appropriate manpower management strategies and policies in areas like determination of age for retirement, fixing of differential teaching workload for different age groups based on the "research productive" yrs.

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CONFLICT OF INTEREST

None

ABBREVIATION USED

APIs: Academic Performance Indicators; HRD: Human Resource Development; ISHA: Indian Speech and Hearing Association; NAAC: National Assessment and Accreditation Council; RCI: Rehabilitation Council of India; RPU: Research Productive Unit; SD: Standard Deviation; SPSS: Statistical Package for Social Sciences; UGC: University Grants Commission.

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