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Review Article

Y-Chromosomal and Mitochondrial SNP Haplogroup Distribution in Indian Populations and its Significance in Disaster Victim Identification (DVI) - A Review Based Molecular Approach

Sinha M[1]*, Rao IA[1] and Mitra M[2]

[1]Department of Forensic Science, Guru Ghasidas University, India

[2]School of Studies in Anthropology, Pt. Ravishankar Shukla University, India

***Corresponding author:** Sinha M, Department of Forensic Science, Guru Ghasidas University, India

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Abstract

Disaster Victim Identification is an important aspect in mass disaster cases. In India, the scenario of disaster victim identification is very challenging unlike any other developing countries due to lack of any organized government firm who can make these challenging aspects an easier way to deal with. The objective of this article is to bring spotlight on the potential and utility of uniparental DNA haplogroup databases in Disaster Victim Identification. Therefore, in this article we reviewed and presented the molecular studies on mitochondrial and Y-chromosomal DNA haplogroup distribution in various ethnic populations from all over India that can be useful in framing a uniparental DNA haplogroup database on Indian population for Disaster Victim Identification (DVI).

Keywords: Disaster Victim identification; Uniparental DNA; Haplogroup database; India

Introduction

Disaster Victim Identification (DVI) is the recognized practice whereby numerous individuals who have died as a result of a particular event have their identity established through the use of scientifically established procedures and methods [1]. Deceased identification is crucial in mass disaster cases not only on humanitarian ground but also on legal grounds. A huge figure of peoples as victims of disaster remains unrevealed in every case of mass disasters as the bodies of victims are mostly ruined afar from identification. In India, the scenario of disaster victim identification is very challenging unlike any other developing countries. For dealing with mass fatalities in India, there is lack of any organized theoretical and practical outlook. Conventional identification methods are available but these methods failed in gathering information from highly degraded remains. Advancement in technical aspects of DNA based methods makes forensic DNA profiling a method of choice. In mass disasters, for Disaster Victim Identifications (DVIs) comparison were made of victims (deceased) sample to the DNA available from victim's body claimant for DNA profiling. Those bodies are identified and victim's charters were given but problem arises where bodies were not identified due to non-availability informative reference samples. Environmental conditions of places where disaster has occurred results in disintegration, decaying and intermixing of deceased remains. In such situations, simply doing a DNA Profiling is not sufficient. In the way of determining the individual identity of deceased additional information on geographical origin of such mutilated bodies will became the gold standard for disaster victim identification.

Genetic markers used in DVI

In DVI, the choice of genetic markers should be consistent with the necessity mentioned above which can reveal the fact that the human genome variation is not uniform. This inconsequential assertion put forward characteristics of a number of markers ranging from its distribution in the genome, their power of discrimination and population restriction, to the sturdiness nature of markers to the process of degradation and their willingness for multiplex and automated analysis. The characteristics of different markers and the technical approaches presently used in personal genetic identification were discussed further.

Short tandem repeats (STR) markers

STR profiling is the most frequently applied approach for personal genetic identification. Usually, 5 to 20 common alleles of forensically relevant STR loci are considered [2]. These STR loci are characterized by their high power of individual discrimination and Polymorphic Informativity Content (PIC) [3]. One of the great advantages of STRs is their multiallelic nature which can aid in analyzing mixtures of alleles from multiple contributors and their nonoverlapping size helps to distinguished different alleles. They can be analyzed in a multiplex manner, with amplification of as many as 16 loci which can be typed simultaneously, therefore, reducing the sum of material analyzed [4,5]. However being the most routinely and commonly applied genetic markers in forensics, STRs have some limitations, which are restraining their utility in Disaster Victim Identification. STRs provides specifically useful on well-preserved bone and soft tissue samples. The amplicon size required for STR analysis is too long (150–450 bp) for allowing useful amplification of degraded DNA templates [6]. Although the development of mini-STRs having length 60–80 bp, obtained by primers designed to closely locate the tandem repeat sequence, largely resolve this problem [7-9] at the same time sustaining consistency with the existing core loci. But, the template

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Table 1: Geographical, Social, Ethnic and Linguistic and Haplogroup description of population included in the study for Y haplogroup.

Population	Region	Sample Size	Ethnicity	Language Affiliation	Haplogroup	Reference
Northern India						
Harijan	Uttar-Pradesh	20	Caste	Indo-European	H1	[45]
Mushar UP	Uttar-Pradesh	50	Caste	Indo-European	O2a	[45]
Tharu	Uttar-Pradesh	6	Tribe	Indo-European	O3e	[46]
Hindu ND	New Delhi	49	Caste	Indo-European	H1a1	[47]
Punjab	Punjab	59	Caste	Indo-European	R1	[48]
Chamar	Uttar-Pradesh	18	Caste	Indo-European	H1	[49]
Muslim	Uttar-Pradesh	19	Religious Group	Indo-European	R1a1	[49]
Rajput	Uttar-Pradesh	28	Caste	Indo-European	R1a1	[49]
UP Brahmin	Uttar-Pradesh	14	Caste	Indo-European	R1a1	[49]
HP Rajput	Himachal Pradesh	15	Caste	Indo-European	R1a1	[50]
Kanyakubj Brahmin	Uttar-Pradesh	11	Caste	Indo-European	R1a1	[50]
UP Jat	Uttar-Pradesh	10	Caste	Indo-European	R1a1	[50]
UP Thakur	Uttar-Pradesh	8	Caste	Indo-European	R1a1	[50]
Khatri	Uttar-Pradesh	7	Caste	Indo-European	R1a1	[50]
Bhoksha	Uttar-Pradesh	10	Caste	Indo-European	O2a, R1a1	[50]
UP Kurmi	Uttar-Pradesh	11	Caste	Indo-European	R2, R1a1	[50]
Jaunsari	Uttar-Pradesh	6	Caste	Indo-European	O2a, R1a1	[50]
Bahelia	Uttar-Pradesh	53	Caste	Indo-European	H	[51]
Brahmin	Uttar-Pradesh	86	Caste	Indo-European	R	[51]
Kshathriya	Uttar-Pradesh	37	Caste	Indo-European	R	[51]
Manghi	Uttar-Pradesh	59	Caste	Indo-European	H	[51]
Western India						
Dhodia	Gujarat	63	Tribe	Indo-European	H1	[52]
Dubla	Gujarat	42	Tribe	Indo-European	H1	[52]
Konkana	Gujarat	24	Tribe	Indo-European	R1	[52]
Vasava	Gujarat	24	Tribe	Indo-European	H1	[52]
Gamit	Gujarat	18	Tribe	Indo-European	H1	[52]
Valvi Chaudhari	Gujarat	32	Tribe	Indo-European	J2	[52]
Nana Chaudhari	Gujarat	25	Tribe	Indo-European	H2	[52]
Mota Chaudhari	Gujarat	27	Tribe	Indo-European	H1	[52]
Pavagadhi Chaudhari	Gujarat	29	Tribe	Indo-European	R1	[52]
Madia Gond	Maharashtra	14	Tribe	Dravidian	H1	[52]
Katkari	Maharashtra	19	Tribe	Indo-European	H1	[52]
MahadeoKoli	Maharashtra	11	Tribe	Indo-European	H1,R1	[52]
Pawara	Maharashtra	16	Tribe	Indo-European	H1	[52]
Thakur	Maharashtra	48	Tribe	Indo-European	R1	[52]
Desasth Brahmin	Maharashtra	16	Caste	Indo-European	Q	[52]
Maratha	Maharashtra	16	Caste	Indo-European	G	[52]
Dhangar	Maharashtra	16	Caste	Indo-European	G	[52]
Chitpavan Brahmin	Maharashtra	15	Caste	Indo-European	R1	[52]
Gujarati Patel	Gujarat	9	Caste	Indo-European	G	[52]
Desasth Brahmin	Maharashtra	16	Caste	Indo-European	H1	[51]
Katakari	Maharashtra	19	Tribe	Indo-European	H1	[51]

Pawara	Maharashtra	16	Tribe	Indo-European	H1	[51]
Eastern India						
Cheek-Baraik	Jharkhand	20	Tribe	Indo-European	H1	[45]
Dusadh	Bihar	22	Caste	Indo-European	H1	[45]
Lohra	Bihar	16	Tribe	Indo-European	H1	[45]
Munda	Jharkhand	42	Tribe	Austro-asiatic	O2a	[45]
Asur	Jharkhand	88	Tribe	Austro-asiatic	O2a	[45]
Ho	Bihar	45	Tribe	Austro-asiatic	O2a	[45]
Mawasi_JHK	Jharkhand	27	Tribe	Austro-asiatic	O2a	[45]
Santhal	Jharkhand	20	Tribe	Austro-asiatic	O2a	[45]
Baiga_ORISSA	Orissa	42	Tribe	Austro-asiatic	O2a	[45]
Bonda	Orissa	42	Tribe	Austro-asiatic	O2a	[45]
Gadaba	Orissa	27	Tribe	Austro-asiatic	O2a	[45]
Juang	Orissa	54	Tribe	Austro-asiatic	O2a	[45]
Kharia	Orissa	37	Tribe	Austro-asiatic	O2a	[45]
Savara	Orissa	21	Tribe	Austro-asiatic	O2a	[45]
Mushar_BIH	Bihar	46	Tribe	Indo-European	O2a	[45]
Mushar_JHK	Jharkhand	39	Tribe	Indo-European	O2a	[45]
Santhal	West-Bengal	110	Tribe	Austro-asiatic	O	[53]
Mahali	Jharkhand	25	Tribe	Austro-asiatic	H	[53]
Asur	Jharkhand	55	Tribe	Austro-asiatic	O	[53]
Birjia	Orissa	24	Tribe	Austro-asiatic	O	[53]
Birhor	West-Bengal	38	Tribe	Austro-asiatic	O	[53]
Munda	Orissa	53	Tribe	Austro-asiatic	O	[53]
Ho	Jharkhand	79	Tribe	Austro-asiatic	O	[53]
Kharia	Jharkhand	36	Tribe	Austro-asiatic	O	[53]
Savar	Orissa	47	Tribe	Austro-asiatic	H, R	[53]
Lodha	West-Bengal	47	Caste	Austro-asiatic	R	[53]
Mahali	Jharkhand	32	Tribe	Austro-asiatic	R	[53]
Mahishya	West-Bengal	13	Caste	Indo-European	H1	[53]
Santal	West-Bengal	14	Tribe	Austro-asiatic	O2a	[49]
Tanti	West-Bengal	7	Tribe	Indo-European	H1	[49]
WB Brahmins	West-Bengal	18	Caste	Indo-European	R1a1	[49]
Bihar Brahmin	Bihar	18	Caste	Indo-European	R1a1,O2a	[50]
Bhumihar	Bihar	20	Caste	Indo-European	R1a1,O2a	[50]
Rajput	Bihar	12	Caste	Indo-European	R1a1,O2a	[50]
Kayastha	Bihar	14	Caste	Indo-European	R1a1,O2a	[50]
Yadav	Bihar	8	Caste	Indo-European	R2,O2a	[50]
Kurmi	Bihar	13	Caste	Indo-European	R2,O2a	[50]
Baniya	Bihar	11	Tribe	Indo-European	R2,O2a	[50]
Ho	Jharkhand	12	Tribe	Austro-asiatic	O2a	[50]
Bhumij	Jharkhand	15	Tribe	Austro-asiatic	O2a	[50]
Kharia	Jharkhand	10	Tribe	Austro-asiatic	O2a	[50]
Munda	Jharkhand	14	Tribe	Austro-asiatic	O2a	[50]
Birhor	Jharkhand	15	Tribe	Austro-asiatic	O2a	[50]
Santhal	Jharkhand	15	Tribe	Austro-asiatic	O2a	[50]

Oriya Brahmin	Orissa	24	Caste	Indo-European	R1a1,O2a	[50]
Karan	Orissa	18	Caste	Indo-European	R1a1,O2a	[50]
Khandayat	Orissa	13	Caste	Indo-European	R1a1,O2a	[50]
Gope	Orissa	16	Caste	Indo-European	R2,O2a	[50]
Paroja	Orissa	15	Tribe	Dravidian	O2a	[50]
Juang	Orissa	20	Tribe	Austro-asiatic	O2a	[50]
Saora	Orissa	19	Tribe	Austro-asiatic	O2a	[50]
Mahishiya	West-Bengal	20	Caste	Indo-European	R1a1,O2a	[50]
NamaSudra	West-Bengal	20	Caste	Indo-European	R2,O2a	[50]
Bauri	West-Bengal	20	Caste	Indo-European	R2,O2a	[50]
Maheli	West-Bengal	20	Tribe	Austro-asiatic	O2a	[50]
Karmali	West-Bengal	19	Tribe	Austro-asiatic	O2a	[50]
Lodha	West-Bengal	20	Tribe	Austro-asiatic	O2a	[50]
Southern India						
Vokkaliga	Karnataka	102	Caste	Dravidian	L	[54]
Bettakurumba	Tamilnadu	5	Tribe	Dravidian	H	[55]
Jenukurumba	Tamilnadu	3	Caste	Dravidian	F	[55]
Kattunaiken	Tamilnadu	4	Tribe	Dravidian	F	[55]
Kuruchian	Tamilnadu	14	Tribe	Dravidian	R	[55]
Mullukurumba	Tamilnadu	9	Tribe	Dravidian	F	[55]
Mullukurunan	Tamilnadu	15	Tribe	Dravidian	F	[55]
Panyia	Kerala	7	Tribe	Dravidian	C,F	[55]
Yerava	Kerala	41	Tribe	Dravidian	F	[55]
South Indians	Andhra-Pradesh	24	Caste	Dravidian	R	[55]
Tribals Andhra Pradesh	Andhra Pradesh	29	Tribe	Dravidian	H1a1, R1a1	[47]
Chenchu	Andhra-Pradesh	40	Tribe	Dravidian	H	[56]
Koya	Andhra-Pradesh	42	Tribe	Dravidian	H	[56]
Lambadi	Andhra-Pradesh	36	Caste	Dravidian	R*	[56]
Baggata	Andhra Pradesh	23	Tribe	Dravidian	O	[57]
Poroja	Andhra Pradesh	20	Tribe	Dravidian	O	[57]
Valmiki	Andhra Pradesh	24	Tribe	Dravidian	O	[57]
Ambalakarer	Kerala	29	Caste	Dravidian	J2b2,L1	[49]
Irula	Kerala	30	Tribe	Dravidian	H1	[49]
Iyengar	Kerala	30	Caste	Dravidian	R1a1	[49]
Iyer	Kerala	29	Caste	Dravidian	R1a1	[49]
Kota	Tamilnadu	16	Tribe	Dravidian	H1	[49]
Kurumba	Tamilnadu	19	Tribe	Dravidian	H1	[49]
Pallan	Tamilnadu	29	Caste	Dravidian	R1a1	[49]
Toda	Tamilnadu	8	Tribe	Dravidian	H1	[49]
Vanniyar	Tamilnadu	25	Caste	Dravidian	J2b2,L1	[49]
Vellala	Tamilnadu	31	Caste	Dravidian	J2b2,L1	[49]
Siddis	Migrant from Ethiopia (African Ancestry) currently from Andhra Pradesh	125	Tribe		E1b1a	[58]
Naikpod	Andhra-Pradesh	68	Tribe	Dravidian	H1	[51]
Andh	Andhra-Pradesh	54	Tribe	Dravidian	J2	[51]
Pardhan	Andhra-Pradesh	128	Tribe	Dravidian	H1	[51]

AP Brahmin	Andhra-Pradesh	19	Caste	Dravidian	R1a1, H1	[50]
Chenchu	Andhra-Pradesh	20	Tribe	Dravidian	O2a, H1	[50]
Kamma Chaudhary	Andhra-Pradesh	19	Caste	Dravidian	R2, H1	[50]
Kappu Naidu	Andhra-Pradesh	20	Caste	Dravidian	R2, H1	[50]
Komati	Andhra-Pradesh	20	Caste	Dravidian	R2, H1	[50]
Naikpod Gond	Andhra-Pradesh	20	Tribe	Dravidian	O2a, H1	[50]
Raju	Andhra-Pradesh	19	Caste	Dravidian	R1a1, H1	[50]
Reddy	Andhra-Pradesh	14	Caste	Dravidian	R1a1, H1	[50]
Yerukala	Andhra-Pradesh	20	Tribe	Dravidian	O2a, H1	[50]
Lingayat	Karnataka	12	Caste	Dravidian	R1a1, H1	[50]
Gowda	Karnataka	7	Caste	Dravidian	R2, H1	[50]
Bhovi	Karnataka	15	Caste	Dravidian	R2, H1	[50]
Christian	Karnataka	13	Caste	Dravidian	R2, H1	[50]
Muslim	Karnataka	4	Religious Group	Dravidian	R2, H1	[50]
Kuruva	Karnataka	13	Tribe	Dravidian	O2a, H1	[50]
Chakkliar	Tamilnadu	14	Caste	Dravidian	R2, H1	[50]
Kallar	Tamilnadu	12	Caste	Dravidian	R1a1, H1	[50]
Vanniyar	Tamilnadu	13	Caste	Dravidian	R1a1, H1	[50]
Pallar	Tamilnadu	16	Caste	Dravidian	R2, H1	[50]
Gounder	Tamilnadu	18	Caste	Dravidian	R1a1, H1	[50]
Irular	Tamilnadu	12	Tribe	Dravidian	O2a, H1	[50]
Ezhava Hindu	Kerala	9	Caste	Dravidian	R2, H1	[50]
Nair	Kerala	4	Caste	Dravidian	R1a1, H1	[50]
Kallar	Tamilnadu	84	Caste	Dravidian	J2	[59]
Sourashtran	Tamilnadu	46	Caste	Dravidian	R1a1	[59]
Yadhava	Tamilnadu	129	Caste	Dravidian	L	[59]
North-East India						
Khasi	Meghalaya	91	Tribe	Austro-asiatic	O-M95	[53]
Garo	Meghalaya	33	Tribe	Tibeto-Burman	O-M122	[53]
Khasi	Meghalaya	353	Tribe	Austro-asiatic	O2a	[60]
Mizo	Mizoram	27	Tribe	Tibeto-Burman	O3e	[49]
Tripperah	Tripura	21	Tribe	Tibeto-Burman	O3e	[49]
Bhutia	Sikkim	4	Tribe	Tibeto-Burman	O2a	[51]
Adi Pasi	Arunanchal-Pradesh	10	Tribe	Tibeto-Burman	O2a	[50]
Mara	Mizoram	15	Tribe	Tibeto-Burman	O2a	[50]
Hmar	Mizoram	20	Tribe	Tibeto-Burman	O2a	[50]
Lai	Mizoram	12	Tribe	Tibeto-Burman	O2a	[50]
Lusei	Mizoram	19	Tribe	Tibeto-Burman	O2a	[50]
Kuki	Mizoram	12	Tribe	Tibeto-Burman	O2a	[50]
Manipuri Muslim	Mizoram	9	Caste	Tibeto-Burman	O2a	[50]
Central India						
Kanwar	Madhya-Pradesh	19	Tribe	Indo-European	H1, O2a	[45]
Kharia	Madhya-Pradesh	21	Tribe	Austro-asiatic	O2a	[45]
Mawasi-Jharkhand	Madhya-Pradesh	24	Tribe	Austro-asiatic	O2a	[45]
Mushar-MP	Madhya-Pradesh	46	Tribe	Indo-European	O2a	[45]
Mawasi-MP	Chhattisgarh	12	Tribe	Austro-asiatic	O2a	[46]

Birhor-CG	Chhattisgarh	27	Tribe	Austro-asiatic	O2a	[46]
Baiga-MP	Madhya-Pradesh	23	Tribe	Austro-asiatic	O2a	[46]
Pando	Chhattisgarh	23	Tribe	Indo-European	O2a	[53]
Oraon	Chhattisgarh	91	Tribe	Dravidian	H	[53]
Nagesia	Chhattisgarh	14	Tribe	Dravidian	O	[53]
Korwa	Chhattisgarh	42	Tribe	Austro-asiatic	O	[53]
Halba	Madhya-Pradesh	21	Tribe	Indo-European	O2a	[49]
Muria	Madhya-Pradesh	20	Tribe	Dravidian	H1	[49]
Kamar	Madhya-Pradesh	30	Tribe	Dravidian	H1	[49]
Bharia	Madhya-Pradesh	50	Tribe	Dravidian	O2a	[61]
Saharia	Madhya-Pradesh	73	Tribe	Indo-European	R1a	[61]
Bhil	Madhya-Pradesh	30	Tribe	Indo-European	H1	[61]
Bhaina	Chhattisgarh	25	Tribe	Indo-European	O2a	[62]
Kol	Madhya-Pradesh	25	Tribe	Austro-asiatic	O2a	[62]
Gond	Chhattisgarh	25	Tribe	Dravidian	O2a	[62]
Kanwar	Chhattisgarh	25	Tribe	Indo-European	H1	[62]

size required for the analysis including mini-STRs might be too long to successfully analyze heavily degraded samples. Another limitation of using STRs is that where the analysis is not fully automated reliable discrimination is not possible for the set of 13–15 core loci, which, in some cases, is necessary. The presence of null alleles, triallelic patterns, alleles with size not matching the standardized allelic ladder are some of the other potential technical problems might occur in STR analysis. STR loci (10–3–10–5) are having high mutation rate, which depicting them very informative, while also makes them less stable [10,11]. The use of STRs in lineage or ethnicity analysis is compromised because of the resulting problem of its ability to distinguish the alleles identical by the state from those identical by descent [12]. Finally, STRs do not provide phenotypic hints regarding the analyzed samples [13].

Single-nucleotide polymorphism (SNP) markers

To a routine STR-based DNA profiling, SNP markers suggest a useful and gradually more important augmentation. Unlimited source of human genome diversity for analysis is provided by SNPs (Cooper, et al. 1985; Wang, et al. 1998). SNP profiling as an application for DNA identification put forward some of the advantages over the use of STR markers, but at the same time experiences some limitations. An imperative, widespread advantage of using SNPs with aim of DVI rises from the scope of analyzing heavily degraded fragments and unpreserved tissue samples. DNA templates of less than 60 bp in length can be amplified using SNPs (approximately the length of two flanking primers). SNP typing eases the identification due to their biallelic nature but makes them not very revealing on a per-locus basis for identity testing. Their utility for identity testing can be increased by exploring many unlinked SNPs, but in order to accomplish the level of discrimination large group of SNPs (50–100) and characteristic 13 core STR loci (i.e. 10–15–10–16) is essential to be genotyped [14-16]. Conveniently, the multiple SNP profiling nowadays becomes cost-effective and standardizable because of large multiplex assays enabled through complete automation of the process. Although SNP markers have some disadvantages, these markers are difficult in explanation the situations which involve mixtures of samples, since the individual profiles are difficult to prepare and are not reliable from mixed sample of unknown source [2]. Autosomal SNPs exhibits an important feature of considerable variability in their heterozygosity levels across the genome. On the order of 10–8/site/generation, which is a low mutation rate of SNPs [17,18], this makes SNPs stable genetic markers, that can provide identity by descent reflected by the state of their alleles. This creates differences in frequency and distribution of SNPs among diverse populations with different ethnic background and which attributes their distinct evolutionary and demographic histories [19,20]. Most investigations of autosomal X-and Y-chromosome, and mtDNA markers indicate more elevated amounts of hereditary variety in African contrasted with non-African populaces, mirroring the antiquated history of the beginning of current people [19-21]. Different contrasts in SNP markers dissemination reflect later statistic histories, for example, movements, populace bottlenecks, detachment, admixture and so forth. [22], and might be utilized for surmising the geographic or ethnic source of a person. The likelihood of utilizing SNPs for the surmising of ethnic starting point of the examined test, which can help in anticipating the geographic root or certain physical attributes of a benefactor, can be a vital resource in DVI endeavors, when no match is found between the casualty's remaining parts and any living individual or accessible database records. Y-Chromosomal and Mitochondrial SNP haplotypes have a place with mainland particular haplogroup and can be utilized to show the patrilineal and matrilineal root of the examined test, however their informativity is restricted but can provide some indications inferring paternal and maternal biogeographic ancestry [23,24]. SNP markers for DVI have now been applied in a variety of instances, following the terrorist attacks of 11 September 2001 on the World Trade Center in New York City [25]. Finally, SNPs, for their 100,000-times lower mutation rate in contrast to STRs, are superior for kinship testing [26] and may replace STRs for such a purpose once commercial kits become available.

Y-chromosomal DNA and mitochondrial SNP markers

Y-chromosomal DNA and mitochondrial SNP markers has

Table 2: Geographical, Social, Ethnic, Linguistic and Haplogroup description of populations included in the study for Mitochondrial DNA haplogroup.

Populations	Geographical Region	Sample Size	Ethnicity	Language Family	Frequent Haplogroup	References
Northern India						
Yadava	Uttar Pradesh	37	Caste	Indo European	A,B,F,HV,TJ,N1,X, I1, R1,R6,R7,R30, U, U4, U7, U2i	[64]
Rajput	Uttar-Pradesh	51	Caste	Indo-European	M, M5	[63]
Jat Sikh	Punjab	48	Caste	Indo European	B,F, H,HV, N1,N, R*,U*,U1,U2i, U7	[63]
Scheduled Caste	Punjab	48	Caste	Indo European	B,F, H,HV, N1,N, R*,U*,U1,U2i, U7	[63]
Punjab Brahmins	Punjab	48	Caste	Indo European	B,F, H,HV, N1,N, R*,U*,U1,U2i, U7	[63]
UP Brahmins	Uttar Pradesh	27	Caste	Indo European	A,B,F,HV,TJ,N1,X, I1, R1,R6,R7,R30, U, U4, U7, U2i	[63]
Khatris	Uttar Pradesh	48	Caste	Indo European	A,B,F,HV,TJ,N1,X, I1, R1,R6,R7,R30, U, U4, U7, U2i	[63]
Tharu	Uttar Pradesh	12	Tribe	Indo European	A,B,F,HV,TJ,N1,X, I1, R1,R6,R7,R30, U, U4, U7, U2i	[55]
Buksa	Uttar Pradesh	18	Tribe	Indo European	A,B,F,HV,TJ,N1,X, I1, R1,R6,R7,R30, U, U4, U7, U2i	[55]
Mixed Caste	Jammu &Kashmir	NF	Caste	Indo-European	F,R,R*R6,J,W,H, HV,U*,U2a,U2b, U2i	[56]
Lobanas	Punjab	62	Caste	Indo European	U B,F, H,HV, N1,N, R*,U*,U1,U2i, U7	[56]
Mixed Caste	Punjab	109	Caste	Indo European	U B,F, H,HV, N1,N, R*,U*,U1,U2i, U7	[56]
Bokas	Uttar Pradesh	18	Tribe	Indo European	A,B,F,HV,TJ,N1,X, I1, R1,R6,R7,R30, U, U4, U7, U2i	[56]
Mixed Caste	Uttar Pradesh	NF	Caste	Indo European	A,B,F,HV,TJ,N1,X, I1, R1,R6,R7,R30, U, U4, U7, U2i	[56]
Kanet	Himachal Pradesh	37	Tribe	Tibeto-Burman	R, R9, W,U,U2,U2b,U7	[65]
Chamar	Uttar Pradesh	NF	Caste	Indo European	A,B,F,HV,TJ,N1,X, I1, R1,R6,R7,R30, U, U4, U7, U2i	[66]
Muslims	Uttar Pradesh	28	Caste	Religious group	A,B,F,HV,TJ,N1,X, I1, R1,R6,R7,R30, U, U4, U7, U2i	[66]
Chamar	West-Bengal	25	Caste	Indo-European	A,HV,TJ,N1,X,R*	[66]
Bhargava	Uttar Pradesh	172	Caste	Indo European	A,B,F,HV,TJ,N1,X, I1, R1,R6,R7,R30, U, U4, U7, U2i	[67]
Chatruvedi	Uttar Pradesh	172	Caste	Indo European	A,B,F,HV,TJ,N1,X, I1, R1,R6,R7,R30, U, U4, U7, U2i	[67]
Rohidas	Uttar Pradesh		Caste	Indo European	A,B,F,HV,TJ,N1,X, I1, R1,R6,R7,R30, U, U4, U7, U2i	[68]
Southern India						
Turpu Kapu	Andhra-Pradesh	42	Caste	Dravidian	N1,N,N5,R*, R5, TJ, X,J101, T1a, T2a, U1a, U2a, U2b, U7, K1a1, K	[69]
Yadhava	Andhra-Pradesh	47	Caste	Dravidian	N1,N,N5,R*, R5, TJ, X,J101, T1a, T2a, U1a, U2a, U2b, U7, K1a1, K	[69]
Relli	Andhra-Pradesh	20	Caste	Dravidian	N1,N,N5,R*, R5, TJ, X,J101, T1a, T2a, U1a, U2a, U2b, U7, K1a1, K	[69]
Madiga	Andhra-Pradesh	26	Caste	Dravidian	N1,N,N5,R*, R5, TJ, X,J101, T1a, T2a, U1a, U2a, U2b, U7, K1a1, K	[69]
Mala	Andhra-Pradesh	24	Caste	Dravidian	N1,N,N5,R*, R5, TJ, X,J101, T1a, T2a, U1a, U2a, U2b, U7, K1a1, K	[69]
Niyogi Brahmins	Andhra-Pradesh	20	Caste	Dravidian	N1,N,N5,R*, R5, TJ, X,J101, T1a, T2a, U1a, U2a, U2b, U7, K1a1, K	[60]
Vydiki Brahmins	Andhra-Pradesh	20	Caste	Dravidian	N1,N,N5,R*, R5, TJ, X,J101, T1a, T2a, U1a, U2a, U2b, U7, K1a1, K	[60]
Kshtriya	Andhra-Pradesh	20	Caste	Dravidian	N1,N,N5,R*, R5, TJ, X,J101, T1a, T2a, U1a, U2a, U2b, U7, K1a1, K	[60]
Vyaya	Andhra-Pradesh	20	Caste	Dravidian	N1,N,N5,R*, R5, TJ, X,J101, T1a, T2a, U1a, U2a, U2b, U7, K1a1, K	[60]
Teliga	Andhra-Pradesh	37	Caste	Dravidian	N1,N,N5,R*, R5, TJ, X,J101, T1a, T2a, U1a, U2a, U2b, U7, K1a1, K	[60]
Toda	Kerala	50	Tribe	Dravidian	U*, U2i, U7	[63]
Pallan	Tamilnadu	30	Caste	Dravidian	A, N, R, U	[63]
Vellala	Tamilnadu	43	Caste	Dravidian	A, N, R, U	[63]
Jenu Kuruba	Karnataka	114	Tribe	Dravidian	R*	[70]
Betta Kuruba	Karnataka	115	Tribe	Dravidian	R*	[70]
Kuruchian	Kerala	46	Tribe	Dravidian	U*, U2i, U7	[55]
Mullukurunan	Kerala	44	Tribe	Dravidian	U*, U2i, U7	[55]
Soliga	Karnataka	14	Tribe	Dravidian	R*	[55]
Koraga	Karnataka	33	Tribe	Dravidian	R*	[55]

Yerava	Karnataka	53	Tribe	Dravidian	R*	[55]
Kattunaikan	Tamilnadu	16	Tribe	Dravidian	A, R*, U, U*, U2i, U7	[55]
Mullukurumba	Tamilnadu	17	Tribe	Dravidian	A, R*, U, U*, U2i, U7	[55]
Kadar	Kerala	32	Tribe	Dravidian	U*, U2i, U7	[71]
Kadar	Tamilnadu	40	Tribe	Dravidian	A, R*, U, U*, U2i, U7	[71]
Paniyan	Tamilnadu	30	Tribe	Dravidian	M3, A, R*, U, U*, U2i, U7	[71]
Chenchu	Andhra-Pradesh	90	Tribe	Dravidian	R, R*, R5, R6,R7, R30, HV, N1, J2, U*, U2, U2a, U5, U7	[56]
Koya	Andhra-Pradesh	90	Tribe	Dravidian	R, R*, R5, R6,R7, R30, HV, N1, J2, U*, U2, U2a, U5, U7	[56]
Lambadi	Andhra-Pradesh	86	Caste	Indo-European	N1,N,N5,R*, R5, TJ, X,J101, T1a, T2a, U1a, U2a, U2b, U7, K1a1, K	[56]
Thoti	Andhra-Pradesh	48	Tribe	Dravidian	R, R*, R5, R6,R7, R30, HV, N1, J2, U*, U2, U2a, U5, U7	[71]
AP Brahmins	Andhra-Pradesh	44	Caste	Indo-European	N1,N,N5,R*, R5, TJ, X,J101, T1a, T2a, U1a, U2a, U2b, U7, K1a1, K	[72]
Kolam	Andhra-Pradesh	36	Tribe	Dravidian	R, R*, R5, R6,R7, R30, HV, N1, J2, U*, U2, U2a, U5, U7	[72]
Mixed Caste	Kerala	55	Caste	Indo European	R,U	[65]
Cochin Jews	Kerala	45	Caste	Indo European	R,U	[65]
Havik	Karnataka	48	Caste	Indo European	R, R*, U*, U2i, U7,U1a, U20	[73]
Mukri	Karnataka	43	Caste	Indo European	R, R*, U*, U2i, U7,U1a, U20	[73]
KarnatakaBrahmins	Karnataka	47	Caste	Dravidian	R, R*, U*, U2i, U7,U1a, U20	[73]
Pallar	Tamilnadu	30	Caste	Dravidian	U and its sub haplogroup	[66]
Irula	Tamilnadu	30	Tribe	Dravidian	A, R*, U, U*, U2i, U7	[66]
Kota	Tamilnadu	30	Tribe	Dravidian	A, R*, U, U*, U2i, U7	[66]
Kurumba	Tamilnadu	30	Tribe	Dravidian	A, R*, U, U*, U2i, U7	[66]
Ambalakarer	Tamilnadu	30	Caste	Dravidian	A, N, R, U	[66]
Iyer	Tamilnadu	30	Caste	Dravidian	A, N, R, U	[65]
Iyengar	Tamilnadu	30	Caste	Dravidian	A, N, R, U	[66]
Vanniyar	Tamilnadu	30	Caste	Dravidian	A, N, R, U	[66]
Reddy	Andhra-Pradesh	NF	Caste	Indo-European	N1,N,N5,R*, R5, TJ, X,J101, T1a, T2a, U1a, U2a, U2b, U7, K1a1, K	[74]
Thogataveera	Andhra-Pradesh	NF	Caste	Indo-European	M4, M4b, N1,N,N5,R*, R5, TJ, X,J101, T1a, T2a, U1a, U2a, U2b, U7, K1a1, K	[74]
Andh	AndhraPradesh	66	Tribe	Dravidian	R, R*, R5, R6,R7, R30, HV, N1, J2, U*, U2, U2a, U5, U7	[51]
Pardhan	Andhra-Pradesh	193	Tribe	Dravidian	R, R*, R5, R6,R7, R30, HV, N1, J2, U*, U2, U2a, U5, U7	[51]
Naikpod	Andhra-Pradesh	88	Tribe	Dravidian	R, R*, R5, R6,R7, R30, HV, N1, J2, U*, U2, U2a, U5, U7	[51]
Porja	Andhra-Pradesh	110	Tribe	Dravidian	N	[75]
Saora	Andhra-Pradesh	110	Tribe	Austro-Asiatic	N, N22	[75]
Eastern India						
Munda	Jharkhand	7	Tribe	Austro-Asiatic	R*	[63]
Gaud	West-Bengal	13	Caste	Indo-European	A, HV,TJ,N1,X, R*	[63]
Toto	West Bengal	30	Tribe	Tibeto-Burman	R*	[63]
Ho	Jharkhand	54	Tribe	Austro-Asiatic	M2	[63]
Munda	Bihar	102	Tribe	Austro-Asiatic	R*	[70]
Malpaharia	West Bengal	114	Tribe	Indo-European	M59	[70]
Pauri Bhuiya	Orisaa	120	Tribe	Indo-European	M59, M61a	[70]
Oraons	West Bengal	38	Tribe	Dravidian	M,N	[72]
Mixed Caste	West Bengal	50	Caste	Indo-European	A, HV,TJ,N1,X, R*	[65]
Kurmi	West Bengal	55	Caste	Indo-European	A, HV,TJ,N1,X, R*	[65]
Lodha	West-Bengal	56	Tribe	Austro-Asiatic	R*	[65]
Lodha	West Bengal	32	Tribe	Austro-Asiatic	R*	[66]

Santal	West Bengal	20	Tribe	Austro-Asiatic	R*	[66]
Bagdi	West Bengal	31	Caste	Indo-European	A, HV,TJ,N1,X, R*	[66]
WB Brahmins	West Bengal	22	Caste	Indo-European	A, HV,TJ,N1,X, R*	[66]
Mahiashya	West Bengal	33	Caste	Indo-European	A, HV,TJ,N1,X, R*	[66]
Agharia	Orissa	24	Caste	Indo-European	H,R*,R5,R7,T,U,U2a,U2b,U7, U2i,U7a	[66]
Gaud	Orissa	13	Caste	Indo-European	H,R*,R5,R7,T,U,U2a,U2b,U7, U2i,U7a	[66]
Tanti	Orissa	16	Caste	Indo-European	H,R*,R5,R7,T,U,U2a,U2b,U7, U2i,U7a	[66]
Juang	Orissa	20	Tribe	Austro-Asiatic	HV,pHV,R*,R6,U2i	[76]
Saora	Orissa	19	Tribe	Austro-Asiatic	HV,pHV,R*,R6,U2i	[76]
Paroja	Orissa	21	Tribe	Dravidian	M4a, HV,pHV,R*,R6,U2i	[76]
Gope	Orissa	16	Caste	Indo-European	H,R*,R5,R7,T,U,U2a,U2b,U7, U2i,U7a	[76]
Karan	Orissa	17	Caste	Indo-European	H,R*,R5,R7,T,U,U2a,U2b,U7, U2i,U7a	[76]
Khandayat	Orissa	16	Caste	Indo-European	M3, H,R*,R5,R7,T,U,U2a,U2b,U7, U2i,U7a	[76]
Orissa Brahmins	Orissa	20	Caste	Indo-European	H,R*,R5,R7,T,U,U2a,U2b,U7, U2i,U7a	[76]
Rajbhansi	West Bengal	172	Caste	Indo-European	A, HV,TJ,N1,X, R*	[74]
Western India						
Navbudha	Maharashtra	10	Caste	Indo-European	M*, U(K)	[77]
Madia Gond	Maharashtra	15	Tribe	Dravidian	M,M2,M2a,M3,M4,U2,R	[77]
Kolam	Maharashtra	12	Tribe	Dravidian	M,U2,R	[77]
Korku	Maharashtra	12	Tribe	Austro-Asiatic	M,M4,M6,W,R	[77]
Bohra	Maharashtra	10	Caste	Indo-European	M,R,U3,U7	[77]
Irani	Maharashtra	8	Caste	Indo-European	M,Ma,M18,R,U,T1,M	[77]
Maratha	Maharashtra	10	Caste	Indo-European	M,M2,M5,R	[77]
Naba Baudh	Maharashtra	40	Caste	Indo-European	M,M2a,M4, M26,U2,U7,	[77]
Maratha	Maharashtra	41	Caste	Indo-European	M2, M4, M30, M55	[63]
Kathodi	Gujarat	120	Caste	Indo-European	M3, M30, M35	[70]
Mathakur	Maharashtra	116	Tribe	Indo-European	M2, M4, M30e	[70]
Kathakur	Maharashtra	120	Tribe	Indo-European	M2, M4, M30e, M38	[70]
Katkari	Maharashtra	46	Tribe	Indo-European	M3a2	[70]
Andh	Maharashtra	115	Tribe	Dravidian	M2, M25, M35, M39	[70]
Hill Kolam	Maharashtra	123	Tribe	Dravidian	M35a	[70]
Dongri Bhil	Gujarat	118	Tribe	Indo-European	M3a2, M35a, M30, M33	[70]
Desasth Brahmins	Maharashtra	19	Caste	Indo-European	M18, M25	[78]
Chitpavan Brahmins	Maharashtra	20	Caste	Indo-European	M4	[78]
Dhangar	Maharashtra	19	Tribe	Dravidian	M4, M6a	[78]
ValviChaudhari	Gujarat	50	Tribe	Indo-European	M*, U(K), R0(H), D, N*(A,W), R(B,J,T,F)	[52]
NanaChaudhari	Gujarat	52	Tribe	Indo-European	M*, U(K), N*(A,W), R(B,J,T,F)	[52]
MotaChaudhari	Gujarat	50	Tribe	Indo-European	M*, U(K), N*(A,W), R(B,J,T,F)	[52]
Pavagadhi Chaudhari	Gujarat	41	Tribe	Indo-European	M*, U(K), N*(A,W), R(B,J,T,F)	[52]
Gamit	Gujarat	34	Tribe	Indo-European	M*, U(K), D, N*(A,W), R(B,J,T,F)	[52]
Konkana	Gujarat	37	Tribe	Indo-European	M*, R(B,J,T,F)	[52]
Vasava	Gujarat	47	Tribe	Indo-European	M*, U(K), R0(H), D, R(B,J,T,F)	[52]
Dubla	Gujarat	74	Tribe	Indo-European	M*, U(K), R0(H), D, N*(A,W), R(B,J,T,F)	[52]
Dhodia	Gujarat	64	Tribe	Indo-European	M*, U(K), R0(H), D, N*(A,W), R(B,J,T,F)	[52]
Gujarati	Gujarat	53	Caste	Indo-European	M, M30e,	[48]
Konkanastha Brahmins	Maharashtra	58	Caste	Indo-European	M3, HV, TJ,	[48]

Gujarat	Gujarat	NF	Caste	Indo-European	M*, U(K), R0(H), R(B,J,T,F)	[79]
Other Maharashtrian Brahmins	Maharashtra	58	Caste	Indo-European	M, R, WE	[65]
Parsi	Maharashtra	55	Caste	Indo-European	M3a, N, R	[65]
Rajput	Rajasthan	35	Caste	Indo-European	M3a, N,R	[65]
Agharia	Gujarat		Tribe	Indo-European	M*	[66]
Central India						
Gond	Chhattisgarh	51	Tribe	Dravidian	M,N,U	[63
Nihal	Madhya Pradesh	112	Tribe	Indo-European	M2, M4, M5, M18, M30, M37, M40, M53,	[70]
Korku	Madhya Pradesh	111	Tribe	Austro-Asiatic	M2, M3, M33, M37, M38, M55, M57	[70]
Kamar	Chhattisgarh	111	Tribe	Dravidian	M2, M3, M5, M36, M39, M40, M41, M49	[70]
Muria	Chhattisgarh	49	Tribe	Dravidian	M,U	[66]
Bharia	Madhya Pradesh	65	Tribe	Dravidian	M3, M6, M33, M36, M45, M46	[61]
Kol	Madhya Pradesh	175	Tribe	Austro-Asiatic	M,N	[62]
Kanwar	Chhattisgarh	32	Tribe	Indo-European	M,N	[62]
Halba	Chhattisgarh	47	Tribe	Indo-European	M, N, R8	[80]
Andaman & Nicobar						
Jarwa	Andaman & Nicobar	10	Tribe	Andamanese	M31a1, M31a1b	[70]
Onge	Andaman & Nicobar	23	Tribe	Andamanese	M31a1	[81]
Great Andamanese	Andaman & Nicobar	20	Tribe	Andamanese	M31a2	[81]
Nicobarese	Andaman & Nicobar	14	Tribe	Nicobarese	E5a, E5a1, F1a1a1, F, Fa1a1, R	[81]
Shompen.	Andaman & Nicobar	29	Tribe	Nicobarese	E5a, E5a1, F1a1a1, F, Fa1a1, R	[50]
North-East India						
Mizo	Mizoram	29	Tribe	Tibeto-Burman	U	[63]
Tipperah	Tripura	51	Tribe	Tibeto-Burman	A,F,U	[63]
Chakma	Tripura	10	Tribe	Tibeto-Burman	A,F,U	[63]
Jamatia	Tripura	55	Tribe	Tibeto-Burman	A,F,U	[63]
Mog	Tripura	25	Tribe	Tibeto-Burman	A,F,U	[63]
Riang	Tripura	51	Tribe	Tibeto-Burman	A,F,U	[63]
Adi	Arunanchal Pradesh	45	Tribe	Tibeto-Burman	M, R, A, F	[55]
Apatani	Arunanchal Pradesh	52	Tribe	Tibeto-Burman	M, R, A, F	[55]
Nishi	Arunanchal Pradesh	52	Tribe	Tibeto-Burman	M, R, A, F	[55]
Naga	Assam	43	Tribe	Tibeto-Burman	A,F,U	[55]
Dirang Monpa	Arunanchal Pradesh	100	Tribe	Tibeto-Burman	M5, M9, M49, M62	[70]
Shertukpan	Arunanchal Pradesh	103	Tribe	Tibeto-Burman	M4, M5, D, M43, M61	[70]
Sonowal kachari	Arunanchal Pradesh	112	Tribe	Tibeto-Burman	M6, M9, D, M18, M59, M60	[70]
Wanchoo	Arunanchal Pradesh	125	Tribe	Tibeto-Burman	M4, M8, M9, D, M49, M58	[70]
Gallong	Arunanchal Pradesh	107	Tribe	Tibeto-Burman	M6, M8, M11, M40, M60	[70]
Lepcha	Sikkim	109	Tribe	Tibeto-Burman	M8, M9, D, M18, M33	[70]
Khasi	Meghalaya	NF	Tribe	Austro-Asiatics	M48, M49	[82]
Garo	Meghalaya	NF	Tribe	Austro-Asiatics	M49	[82]
Paite	Manipur	41	Tribe	Tibeto-Burman	M, N, A	[72]
Thadou	Manipur	42	Tribe	Tibeto-Burman	M, C, D, N, A	[72]
Koms	Manipur	37	Tribe	Tibeto-Burman	M, N, A	[72]
Rongmei	Manipur	40	Tribe	Tibeto-Burman	M, C, D, N, A, B	[72]
Aimol	Manipur	50	Tribe	Tibeto-Burman	M, D, N,A,B	[72]

Meitei	Manipur	43	Non-Tribe	Tibeto-Burman	M, C,D,N,A,B	[72]
Tripuri	Tripura	45	Tribe	Tibeto-Burman	M,D,A,U	[66]

NF= Not Found

Table 3: Frequencies of Y haplogroups among four language families and two major ethnic groups of India reported in various studies.

References	Austro-asiatic	Dravidians	Indo-European	Tibeto-Burman	Caste	Tribe
	Haplogroup	Haplogroup	Haplogroup	Haplogroup	Haplogroup	Haplogroup
[48-54,59,62,63]	O2a	H1	O2a	O3e	R1a1, H1	O2a
			H1a			
	O2a					
	O2a	O2a	O2a			
				O3a3c		
	K	BR*	BR*	K		
	O2a	H1, R1a	H1, R1a	O2a		
	J2b	J2a	J2a	J2a and b	J2a,b and J1	J2a
	O2a	H1	R1a1	O2a	R1a1, R2	O2a
					R	H
					R,H	O

Table 4: Frequencies of Mitochondrial DNA haplogroups among four language families and two major ethnic groups of India reported in various studies.

References	Austro-Asiatic	Dravidians	Indo-European	Tibeto-Burman	Caste	Tribe
	Haplogroup	Haplogroup	Haplogroup	Haplogroup	Haplogroup	Haplogroup
[48,50, 52,61,62,63,65,66, 70, 72,76-79,81, 74]	M,M2, M3, M33, M37, M38, M55, M57, M4,M6,M48, M49, HV,pHV,R*,R6,U2i	R, R*, R5, R6,R7, R30, HV, N1, J2, U*, U2, U2a, U5, U7,N1,N,N5,R*, R5, TJ, X,J101, T1a, T2a, U1a, U2b, K1a1, K	M, M5, F,R,R*,R6,J,W,H, HV,U*U2a,U2b, U2i, B,F, H,HV, N1,N, R*,U*,U1,U2i, U7	M, M6, M9, D, M18, M59, M60, R*,R9, W,U,U2,U2b,U7, M, C, D, N, A, B, F	M*, M3,U(K), R(B,J,T,F), A, U, U2a, U2b, U2i, U7	R*, HV, pHV, R*,R6,U2i, H,R*,R5,R7,T,U,U2a,U2b,U7, U2i,U7a

Table 5: Number of populations studied, for Y-chromosomal polymorphisms, in different geographical regions of India.

Geographic Region	No. of populations studied	References
North India	**21**	[45-52]
South India	**57**	[47,50,51,49, 55-59]
Central India	**21**	[45,46,53,49,61-62]
East India	**57**	[45,50,53,49]
West India	**22**	[51-52]
North-East India	**13**	[50,51,53,49,60]

Table 6: Number of populations studied for Mitochondrial DNA polymorphisms, in different geographical regions of India.

Geographic Region	No. of populations studied	References
North India	21	[63,55,56,65-68]
South India	51	[51,53,64,66,69, 71,74]
East India	28	[63,65,66,70,76]
West India	35	[48,52,63,65,66,70,76,77,78 ,79,74]
North-East India	25	[50,63,55,66,70,72,82]
Central India	11	[61-63,70,80]
Andaman & Nicobar	5	[70,81,50]

already proven its utility in identifying cases, but a very little emphasis has been given to these uniparental SNP haplogroups having the potential of elucidating the geographical ancestry. "Haplogroup is a genetic population group of people who share a common ancestor on the (y-chromosomal DNA) patrilineal or (mt DNA) matrilineal line. They are assigned letters of alphabets and numbers" (International Society of Genetic Genealogy) or it can be defined as a group of haplotype that share a common ancestor. Haplotypes are further described as group of genes inherited collectively from a single parent. Both Y-chromosomal and mitochondrial DNA haplogroups are identified by single nucleotide polymorphisms (SNPs) on DNA locations where one nucleotide has mutated or switched to a different nucleotide. Individuals, put into a particular haplogroup by detecting the presence of a particular SNP at these uniparental DNA locations. Haplogroups of uniparental DNA are having potential for tracing the geographical ancestry. A large number of molecular studies have been performed from past 20th century and verified the utility of haplogroups in tracing the origin and ethnic association for various populations of the world. Haplogroup frequencies vary from population to population and even continent [27] this is because of the diverse nature of human populations at the genetic level. Examination of Y chromosome haplogroups and mitochondrial haplogroups can give data on biogeographic family line of a person. Y chromosome haplogroups have differential recurrence conveyances around the globe. For example haplogroups A and B are about only found among sub-Saharan Africans; H is solely found on the Indian sub-continent (and among Roma); and M is only found in Oceania. Other Y haplogroups, for example, R

and N are seen crosswise over endless ranges of Eurasia. Similarly late advance in entire mtDNA(Mitochondrial DNA) sequencing has given expanded comprehension about the mtDNA phylogeny and uncovered a substantial number of various mtDNA haplogroups. Numerous mtDNA haplogroups demonstrate confined mainland disseminations, for example, haplogroup l to Africa, V to Europe and the Middle East, or P and Q to Oceania and haplogroup M except M1 and U to India [28-31].

Across the globe human genetic diversity and its distribution is not uniform (Cavalli-Sforza, Menozzi, and Piazza 1994), this differences in diversity distribution accompanied the significance of realizing the distribution of these differences to satisfy the questions associated to ethnic diversity, migrations, founder populations and fondness to studies of complex disorders or Pharmacogenomics and geographical origin determination in cases of disaster victim identification in large diverse population. Geographical differentiation in diversity patterns in terms of geography are seen on many spots and exists of continental differences lie in populations of African continent the heterozygosity level is higher which is supported by their larger effective size of populations and their extensive time of occupation [32], on the other hand sudden changes and genetic margins generated due to social hierarchy also created differences [33] whereas for differences at gene frequency level signifies the reliable fact of natural selection and the majority of variations at DNA is considered to be neutral or nearly so.

The differing qualities at haploid Y-chromosome have huge relationship with topography which makes it an essentially proficient examination of both arrangement and populace augmentations [34,35]. The acceptably fathomable all inclusive plan of the Y-chromosome phylogeny and its extension starts the examination and examinations on composite Y-chromosome twofold haplogroup assorted qualities [36-41]. Intensive reviews on association and elements of human mitochondrial genome have been comprehensively utilized as a part of populace hereditary qualities and developmental reviews. It's maternal transmission, lack of recombination aides in recognizing the mutual family. Coordinating to particular haplogroup or its sub clades served to connected people to a typical geographic starting point [42]. The overall circulation of mitochondrial DNA (mtDNA) variations, connecting particular clades of the mtDNA phylogeny with certain geographic zones. In any case, a multiplex genotyping framework for the recognition of the mtDNA haplogroups of major mainland conveyance that would be attractive for effective DNA-based biogeographic parentage testing in different applications [43]. Although, mitochondrial DNA suffers low power of discrimination due to lack of recombination and uniparental inheritance but several typing methods are used nowadays to improve its power of discrimination [44].

Indian Scenario y-chromosomal and mitochondrial DNA SNP haplogroup distributions in India

The exclusive assets of uniparental DNA markers like inheritance (paternal and maternal), small effective population size, polymorphic nature and absence of recombination has allowed the examination of this revealing markers by investigators worldwide for determining the genetic structure and the geographical maternal and paternal history of human populations. In current years, researcher's are concerned to major issues relevant to haplogroup determination in peopling and origin of various population of India by conducting hierarchical typing of the Y-chromosome binary polymorphisms and mitochondrial DNA hyper variable region sequencing. Studies on these markers presented a scenario to understand the association of ethnicity and geography with particular haplogroup frequency.

In this context, we present a systematic review of the studies conducted on Indian populations using different set of Y-chromosomal and mitochondrial DNA markers for determining haplogroup distributions. The details of the populations studied by various authors, their geographical affiliation and haplogroup distributions are summarized in Table 1 and Table 2 for Y-chromosomal and mitochondrial DNA. The number of population studied for Y-chromosomal and mitochondrial DNA polymorphisms in different geographical regions of India are depicted in Table 3 and Table 4. The number of populations studied in each geographical region of India for Y-chromosomal and Mitochondrial DNA is depicted in Table 5 and Table 6. Frequencies of Y-chromosomal in four language families and two major ethnic groups of India are summarized in Table 3. The dialect family can be characterized as a gathering of dialects related through plunge from a typical progenitor, called the proto-dialect of that family. The expression "family" mirrors the tree model of dialect start in chronicled phonetics, which makes utilization of an allegory contrasting dialects with individuals in an organic family tree, or in an ensuing alteration, to species groups in a phylogenetic tree of transformative scientific classification. (https://www.ethnologue.com/) [29]. Populaces of India talk's dialect of a specific dialect family had a dialect connection for any of the dialect family. In India, there are four dialect families Dravidian, Indo-European, Tibeto-Burman and Austro-Asiatic.

Conclusion

SNPs at mitochondrial and Y-chromosomal DNA in populations designate the individuals of populations into Haplogroup. Haplogroup database from populations of world are available for comparison in research purposes. No such government approved haplogroup databases are available on Indian populations for comparison. The numbers of populations covered in India in each molecular study are sufficiently enough to create a database but no steps has been taken in India to fulfill these gaps. The available haplogroup databases are from the various researches are only accessible for research finding comparisons and validation of the findings. Such studies have recommended remarkable upshots into the genetic history of paternal and maternal lineages in India while there have been prevalence of some confines from restricted geographical sampling, deficient molecular affirmations, grouping of ethnically ill-defined populations and inappropriate statistical tools. On the basis of the above review we recommend that India is intensely lying at the path of disasters followed by fatal outcome at mass level. For the proper identification of victims the Government of India should setup a database for comparative DNA analysis by means of haplogroup identification specifically for those bodies in which reference samples for comparisons are not available. India is emerging as a nation with digitalization in every department of government institution. Therefore, India should take the step further by framing DNA haplogroup databases, which will help to elucidate the identification practice with enhanced approach. Keeping these problems in mind

we can conclude that still there is lot to do in response to effective Disaster Victim Identification (DVI). In conclusion, this review suggests option for disaster victim identification through genetic identification by using the Y- chromosomal and mitochondrial DNA SNP haplogroup when there is highly degraded DNA or no hint for probable geographical origin of the samples. Consequently, this review will be useful for analysis in Disaster Victim Identification.

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