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Global muscular dystrophy research: A 25-year bibliometric perspective

Shri Ram

Abstract:

Muscular dystrophy is a genetic disorder leading to progressive weakness of muscles caused due to dysfunction in or lack of protein in muscle cells. The prevalence of muscular dystrophy has been observed globally and is becoming a critical area of study for better health services. The purpose of the study is to analyze the research strength of muscular dystrophy using bibliographic literature. A quantitative literature analysis was carried out on muscular dystrophy from 1991 to 2015 for assessing the global research trends. This literature-based study was conducted using the documents retrieved from the Science Citation Index using the keywords: Duchenne Muscular Dystrophy (DMD), Becker Muscular Dystrophy (BMD), Congenital Muscular Dystrophy (CMD), Myotonic Dystrophy, Emery-Dreifuss Muscular Dystrophy, Facioscapulohumeral Muscular Dystrophy, Oculopharyngeal Muscular Dystrophy, and Limb-Girdle Muscular Dystrophy. Analysis was done for annual productivity of publication, authorship, collaboration, country performance, citation frequency, characteristics of most cited document, journal productivity, etc.

Key Words:

Bibliometric analysis, muscular dystrophy, research impact, research output

Key Message:

The study of publication research pattern for muscular dystrophy over the last 25 years revealed that the articles related to muscular dystrophy have grown at a rate of 3.92% per year. Through this article, the progress of research in muscular dystrophy has been investigated using bibliometric methods. The results of this article might be useful for collaborative research between institutions and authors.

Muscular dystrophy is an X-linked disease caused by dystrophin gene mutations. It is a progressive muscle disorder without a central or peripheral nerve abnormality.[1,2] It has been reported that 1 in every 3500 male births is affected by Duchenne muscular dystrophy.[3] Disease progression is characterized by impairment of motor function and loss of ambulation in a patient aged between 9 and 14 years.[4,5] Different methodologies have been adopted to assess the progression of research in a given field of study. Bibliometrics is one of the methods used for quantitative analysis of published literature. Assessment of current research trend in a given field can be assessed based on publication output, and it reflects the trend in the field, whether the focus is on present, previous, or future research.[6] There is no significant study, neither a bibliometric analysis nor a literature analysis based scientometric study, on muscular dystrophy. Some bibliometric studies have been reported on pluripotent stem cell research,[7] stem cell research output in general,[8-11] globalization of stem cell research,[12] and stem cell research for specific geographic regions.[13,14] Other studies reporting on stem cells were associated with citation analysis.[15,16] Furthermore, bibliometric studies associated with neurological disorders such as Guillain–Barre syndrome[17] and amyotrophic lateral sclerosis[18] have also been reported, which reflect diseases associated with locomotion and neural disorders. Few literature reviews based on Web of Science data have been reported for Duchenne muscular dystrophy.[19,20] The purpose of the study was to study the research trend of muscular dystrophy using bibliometric methods.

Materials and Methods

The bibliographic data on muscular dystrophy was retrieved from the Science Citation Index Expanded (SCIE) Database from 1991 to 2015. SCI [established by the Institute for Scientific Information (ISI)] is one of the most reliable sources of biographic indexing and abstracting database used globally for literature analysis.

Central Library, Thapar University, Patiala, Punjab, India

Address for correspondence:
Dr. Shri Ram, Central Library, Thapar University, Patiala - 147 004, Punjab, India.
E-mail: shriram@thapar.edu

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Muscular dystrophy encompasses a range of disorders. These disorders are Duchenne muscular dystrophy (DMD), Becker muscular dystrophy (BMD), congenital muscular dystrophy (CMD), myotonic dystrophy, Emery–Dreifuss muscular dystrophy, facioscapulohumeral muscular dystrophy, oculopharyngeal muscular dystrophy, and limb-girdle muscular dystrophy.[21] These keywords form the basis of bibliographic data retrieval from the SCIE database. These keywords appear as Medical Subject Headings (MeSH) terms of the SCI database and have been used for data retrieval.

Data analysis included all document types, including an article, editorial, letter, meeting abstract, note, and review. Research impact of publications was assessed in terms of the number of citations accumulated by the articles; authors, countries, and institutions were compared. Further, individual authors and institutions were also assessed based on the Hirsch index.[22] The journal impact factors were taken into consideration for Journal Citation Report (JCR) 2015 edition. Citations per paper was calculated by dividing the total number of citations till 15th October 2016 by the total number of papers during the period.

Results and Discussion

A total of 21,505 documents published during the 25-year study period were categorized into ten document types, comprising 69.36% articles, followed by meeting abstracts (12.06%), reviews (10.59%), conference proceedings (2.58%), editorials (2.52%), letters (2.15%), notes (0.83%), book chapters (0.41%), news items (0.28%), and corrections (0.21%). Apart from the journal articles, major contributions came from meeting abstracts and review articles. Meeting abstracts and review articles reflected recent research development. Journal articles represented the majority of peer-reviewed document types in muscular dystrophy research, where 15,194 articles were used for further analysis in this study.

Publication output

From 1991 to 2015, the annual number of articles published on muscular dystrophy increased about three-fold, and the number of articles increased from 478 in 1991 to 1475 in 2015. Literature has grown linearly at a rate of 3.92% per annum. The reason for the growth of literature and research activities can be visualized as increased research funding opportunities available through different funding agencies. During 1991 and 2005, no articles were published through funding sources. During 2006 and 2015, 5156 articles were sponsored by 463 funding agencies globally; whereas, during 2011 and 2015, 6627 articles were funded by 1446 funding agencies. National Institute of Health emerged as one of the major funding agencies, and funded 5.19% of 21,505 articles published on muscular dystrophy, followed by Muscular Dystrophy Association (2.19% of 21,505 articles) and Association Francaise Contre Les Myopathies (1.13% of 21,505 articles). There were about 1821 agencies associated during the period of study [Table 1].

The number of authors also increased from 1991 to 2015. The average number of authors per paper ranged from a minimum of 3.50 authors per paper in 1991, continually increasing to

Table 1: Characteristics of muscular dystrophy publications

Year	NP	% of NP	AU	AU/P	Citation	ACPP	Self-citations	% of self-citations
1991	478	2.22	1674	3.50	15754	32.96	144	0.91
1992	471	2.19	1674	3.55	20243	42.98	199	0.98
1993	543	2.53	1933	3.56	20285	37.36	189	0.93
1994	517	2.40	1878	3.63	20163	39.00	175	0.87
1995	539	2.51	1923	3.57	20539	38.11	175	0.85
1996	556	2.59	2149	3.87	21504	38.68	163	0.76
1997	599	2.79	2312	3.86	23270	38.85	148	0.64
1998	613	2.85	2391	3.90	25911	42.27	170	0.66
1999	691	3.21	2641	3.82	30360	43.94	245	0.81
2000	672	3.13	2746	4.09	30757	45.77	309	1.00
2001	767	3.57	3055	3.98	34303	44.72	240	0.70
2002	805	3.74	3223	4.00	35375	43.94	261	0.74
2003	727	3.38	3190	4.39	29378	40.41	229	0.78
2004	835	3.88	3510	4.20	35170	42.12	313	0.89
2005	889	4.13	4005	4.51	28229	31.75	243	0.86
2006	936	4.35	3898	4.16	26362	28.16	245	0.93
2007	931	4.33	4380	4.70	29386	31.56	280	0.95
2008	1042	4.85	4898	4.70	27710	26.59	285	1.03
2009	1060	4.93	4915	4.64	25442	24.00	341	1.34
2010	1207	5.61	5565	4.61	22654	18.77	317	1.40
2011	1192	5.54	5724	4.80	19504	16.36	373	1.91
2012	1264	5.88	6243	4.94	16952	13.41	384	2.27
2013	1290	6.00	6205	4.81	12896	10.00	388	3.01
2014	1406	6.54	7065	5.02	8653	6.15	364	4.21
2015	1475	6.86	7472	5.07	3507	2.38	549	15.65
Total	21,505		94669	4.40	584307	27.17	6729	0.12

NP = Number of publications; Au = Number of authors; Au/P = Number of authors per publication; ACPP = Annual citations per publication

5.07 in 2015. The average number of authors per paper was 4.40 authors. The research impact in terms of the citation count has been taken as the number of citations scored by each article published in that year, as was the status in October 2015. The average citation per paper was 27.17. Figure 1 shows the trend of publication growth and average citation per paper for the articles published in that year. The highest number of citations per paper (45.77) was in the year 2000.

The self-citation trend was found to be occurring in an increasing order. From 2008 to 2014, the percentage of the self-citations per year were 1% or more; whereas in 2015, the percentage of the self-citation had increased to 15.65% [Table 1] with the overall self-citations being 0.12% per year. Self-citation is a common and fundamental attribute of scientific articles.[23] There is a strong correlation between self-citation and Mean Expected Citation Rate in biology, biosciences, and biomedical research, which is true in this case too.[24,25] Indian publications on muscular dystrophy started appearing since 1993 with the number of publications reaching the figure of 31 (12.6%) in 2015. About 69.2% publications appeared during the last ten years from 2003 to 2015.

Country of publication

The authors' countries relating to muscular dystrophy publications were analyzed based on the affiliation of at least one author. Table 2 presents the data from the top seven countries ranked by the number of publications. Among the 21,505 publications with author information, 1132 countries published articles on various aspects of muscular dystrophy. Seven countries listed in Table 2 contributed 89.46% of the global publications. USA tops the rank on indicators such as total publications (35.50%), with total citations (301,885 citations), average citations per paper of 38.87, and the highest h-index value of 215. Japan ranked first in terms of single country publication (58.01%), whereas USA ranked second (51.97%) and Canada ranked third (23.84%). In muscular dystrophy research, international collaboration was most prominent in the case of France (97.47%), followed by Germany (97.33%) and UK (92.95%). Regarding the citation impact based on h-Index (Hirsch 2005) values, USA had the highest value of 215, followed by UK (127), and France (110). The publication growth for these seven most productive countries is illustrated in Figure 2. During the study period, USA dominated over rest of the countries. On an average, 200 papers were published annually until 2009. Thereafter, every year, an incremental trend could be observed.

India published 365 articles during the study period, which was 1.7% of the global output. In terms of total publications, India ranked 15th among the most productive countries engaged in muscular dystrophy research.

Productivity of institutes associated with muscular dystrophy research

The contribution of different institutions was considered based on the author affiliation, that is, the member of the institution having authored at least one paper with the same affiliation. The publication on muscular dystrophy came from 2821 institutes. There were 647 papers with no author affiliation. Among the top 10 institutions [Table 3], three each were from USA, France, and UK and one from Japan. Leading institutions in muscular dystrophy research were the Institut National de La Sante et de La Recherche Medicale Inserm, France with a global share of 4.94% publications, the University of London, UK with 5.03% of the global share, and Assistance Publique

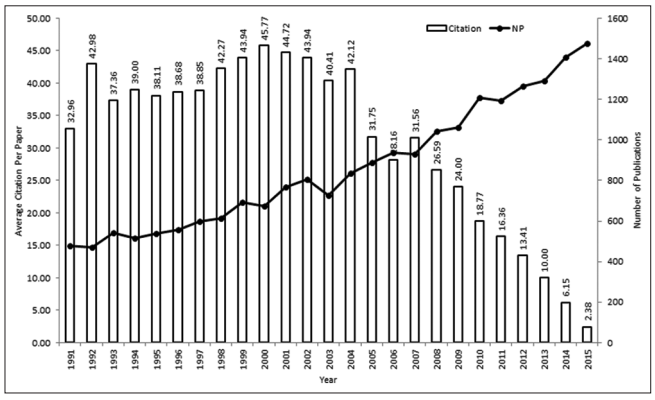

Figure 1: Publication growth and citation trends of muscular dystrophy research (1991-2015)

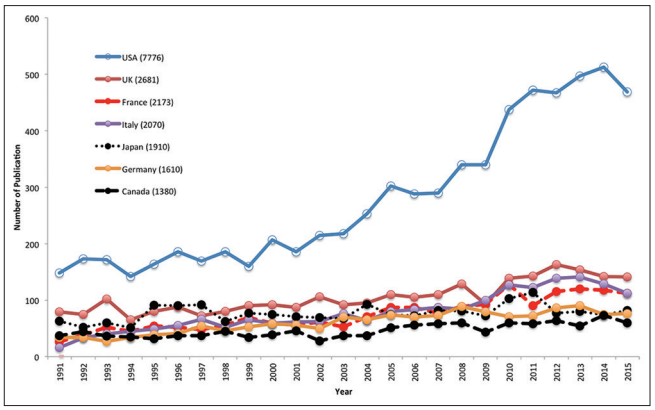

Figure 2: Most productive countries and their publication growth (1991-2015)

Table 2: Most productive countries in muscular dystrophy research

Country	TP	% Share	Single Country	%	ICP	%	TC	ACPP	h-Index
USA	7776	35.50	4041	51.97	3735	48.03	301885	38.87	215
UK	2681	12.24	189	7.05	2492	92.95	88103	32.86	127
France	2173	9.92	55	2.53	2118	97.47	61608	28.35	110
Italy	2070	9.45	382	18.45	1688	81.55	58325	28.18	103
Japan	1910	8.72	1108	58.01	802	41.99	45191	23.66	93
Germany	1610	7.35	43	2.67	1567	97.33	51810	32.18	105
Canada	1380	6.30	329	23.84	1051	76.16	43663	31.64	91

TC = Total publications; TC = Total citations; ACPP = Annual citations per publication; h-index = Hirsch index; ICP = International collaborated papers

Table 3: Most productive institution associated with muscular dystrophy research

Affiliation	TP	Share	TC	ACPP	h-Index
Institut National De La Sante Et De La Recherche Medicale Inserm, France	1082	5.03	35994	33.27	90
Assistance Publique Hopitaux Paris, France	902	4.19	27383	30.36	80
University of London, UK	883	4.10	25451	28.82	75
University of California System, USA	810	3.76	32205	39.76	89
Centre National De La Recherche, Scientifique, France	755	3.51	24241	32.11	76
Harvard University, USA	615	2.86	35263	57.34	98
University College London, UK	566	2.63	14562	25.73	60
Imperial College London, UK	544	2.53	25480	46.84	75
National Center for Neurology Psychiatry Japan, Japan	541	2.51	18481	34.16	70
Howard Hughes Medical Institute, USA	503	2.33	46795	93.03	114

TC = Total publications; TC = Total citations; ACPP = Annual citations per publication; h-index = Hirsch index

Hopitaux Paris, France with 4.19% of the global share. Howard Hughes Medical Institute, USA exhibited its predominance in the most number of citations (46,795) and the highest h-index value of 114, followed by Institut National De La Sante Et De La Recherche Medicale Inserm, France with 35,994 citations and h-index of 90 and Harvard University, USA with 35263 citations and the h-index value of 98. The publication trends of Institut National De La Sante Et De La Recherche Medicale Inserm, France showed an increasing trend every year, but the citation trends were uniform with an average citation per paper of 33.27; although the Howard Hughes Medical Institute USA published less papers, the average citation per paper was very high (93.03 citations per paper) [Figure 3].

The highly popular work from "Institut National De La Sante Et De La Recherche Medicale Inserm, France" was cited 770 times with an average citation of 40.53 citations per year.[26]

Among the Indian Institutions, the All India Institute of Medical Sciences contributed the highest number of articles (42 articles) followed by the National Institute of Mental Health and Neuro Science (32 articles) and Sanjay Gandhi Postgraduate Institute of Medical Science, Lucknow (30 articles). There were 160 institutions from India that contributed articles related to this field.

Authorship patterns and productivity

The authors' contribution in muscular dystrophy research was analyzed based on the total number of publications, their percent share, the total number of citations, the average citation per paper, and the h-index for the study period. The 107,279 authors either singly or in a collaboration produced 21,505 articles on muscular dystrophy during the study period. Table 4 presents the ten most productive authors engaged in muscular dystrophy research. Muntoni published the most number of articles (416; 1.93% share) followed by Bushby (234; 1.09% share), and Campbell (233; 1.08% share). There were 8525 articles from 5443 corresponding authors who were from 2499 institutes and 88 countries. A total of 3973 (73%) authors only had one article as a corresponding author. Considering the research impact of individual authors based upon the average number of citations accumulated until October 2016, Campbell scored 22,306 citations for 233 articles. The average citation per paper was 95.63 citations, which was the highest among all the authors. Muntoni scored 14,216 citations for 416 articles with an annual citations per publication (ACPP) of 34.18 followed by Kunkel with 1008 citations for 150 articles. Kunkel

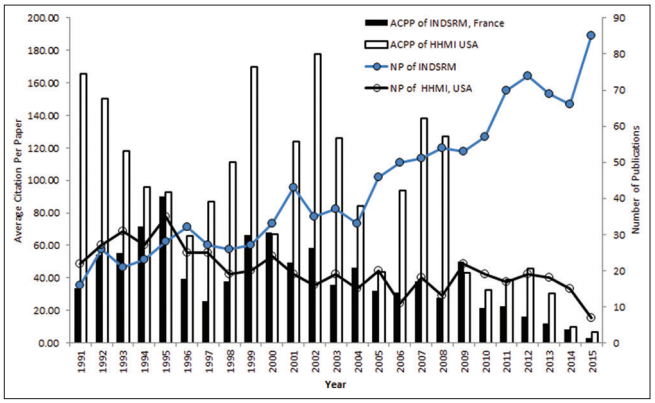

Figure 3: The most productive institutions engaged in muscular dystrophy research (1991-2015)

was ranked second in terms of annual citations per publication (ACPP; 67.19 citations per paper). On the parameter of Hirsch value (h-index), Kunkel had the highest value (83) among these most productive authors, followed by Campbell (h-Index: 60) and Angelinic (h-index: 55). With respect to the Indian authors, the highest number of papers were published by Khalidkar from Sir Jamsetjee Jijebhoy Hospital Mumbai (20 articles) with 81 citations (h-index: 6).

Distribution of author keywords and research hotspot

The title of an article always includes information which the author would most like to express to their readers. Based on keywords available in the title of the article, the research hotspot in muscular dystrophy was analyzed. The most used word in titles was "Muscular Dystrophy" which appeared in 8600 articles, followed by "Duchenne Muscular Dystrophy" (8283), "Muscular Dystrophies" (5593), "Dystrophin" (5394), "Muscle, Skeleton" (4244), "Muscular Dystrophy, Duchenne" (3674), "Skeletal Muscle" (3444), "Gene Mutation" (3382), "Unclassified Drug" (2945), and "Genetics" (2622). The medical subject heading and keywords in the titles used by the authors reflect the subject through the article content. A total of 21,505 articles with records of author keywords from 1991 to 2015 in SCI were further analyzed to study the trends of the keyword used. The keywords frequently used related to muscular dystrophy were "phenotype" (2515), "muscular biopsy" (2233), "immunohistochemistry" (2006), "limb-girdle muscular dystrophy" (1852), Becker muscular dystrophy" (1835), "muscle weakness" (1678), "metabolism" ((1592), "muscle

cell" (1511), "myopathy" (1501), neuromuscular disease" (1432), "muscle atrophy" (1359), "facioscapulohumeral muscular dystrophy" (1097), and "myotonic dystrophy" (1083). These author keywords reflect the research hotspots in muscular dystrophy, which are related to muscular weakness.

The keywords that were frequently used to denote the association of proteins in muscular dystrophy were "protein expression" (2347), "creatine kinase" (1560), "membrane protein" 2105), "protein function" (965), "protein localization" (827), "cytoskeleton protein" (756), and "creatine kinase blood level" (728). It is a fact that imbalances in protein function are one of the major causes of muscular dystrophy.[27,28] These keywords reflect the protein association in muscular dystrophy research.

Muscular dystrophy is a genetic disorder caused by mutation. Mutations cause changes in the genetic composition of "dystrophin" protein located primarily in the skeleton and cardiac muscles leading to the disorder.[29] The major keywords used to depict the mutational and genetic aspects of muscular dystrophy were "gene mutation" (3382), "genetics" (2622), "mutation" (2173), "gene expression" (1842)", "gene deletion" (1541), "gene therapy" (1416), "gene" (1010), "genetic analysis" (914), "genetic disorder" (821), "gene expression regulation" (780), "genotype" (730), and "genetic screening" (677). As far as the clinical terminologies are concerned, the authors have used "nuclear magnetic resonance imaging" (1018), "signal transduction" (990), and "histopathology" (868) in the title of the article. The genetic links can be assessed through these keywords and thus reflect the hotspot associated with genetics.

Productive journals publishing muscular dystrophy research

Articles on muscular dystrophy were published in 1450 journals. Of these, the ten journals with the most muscular dystrophy related articles are listed in Table 5, which have published more than 200 (1% of 21505) articles. Neuromuscular Disorders published the highest number of articles with 2042 articles, followed by Muscle Nerve (698 articles) and Neurology (563 articles), whereas the American Journal of Human Genetics Virology had the highest impact factor (IF) in 2015 of 10.794, followed by Annals of Neurology with an IF and impact factor in 2015 of 9.638 (230 articles).

Neurology India (IF 2015 = 1.41), published from India, has published 68 articles (0.29% global share) and is ranked 49th in the list of most productive journals.

Table 4: Characteristics of most productive authors and their research impact

Authors	NP	% of 21,505	Citations	ACPP	h-index
F. Muntoni	416	1 (1.93)	14217	2 (34.18)	9 (40)
K. Bushby	234	1 (1.09)	6643	7 (28.39)	8 (41)
K.P. Campbell	233	3 (1.09)	22306	1 (95.73)	2 (60)
E.P. Hoffman	198	4 (0.92)	7559	5 (38.18)	10 (40)
V. Straub	193	5 (0.90)	7261	6 (37.62)	6 (42)
T. Voit	175	6 (0.81)	6023	9 (34.42)	7 (42)
I. Nonaka	171	7 (0.80)	6135	8 (35.88)	14 (35)
J.R. Mendell	167	8 (0.78)	5601	10 (33.54)	12 (39)
M. Zatz	167	9 (0.78)	4817	13 (28.84)	15 (32)
C. Angelini	164	10 (0.76)	5245	11 (31.98)	3 (55)
J.S. Chamberlain	161	11 (0.74)	9158	4 (56.88)	5 (48)
H. Lochmuller	157	12 (0.73)	3175	15 (20.22)	4 (52)
S. Takeda	157	13 (0.73)	4140	14 (26.37)	13 (39)
J.P. Tremblay	152	14 (0.71)	5227	12 (34.39)	11 (40)
L.M. Kunkel	150	15 (0.70)	10078	3 (67.19)	1 (83)

ACCP = Annual citations per publication; NP = number of publications; h-index = Hirsch index; NP = number of publications

Most frequently cited articles

The most cited articles relating to muscular dystrophy research were analyzed based on the total citations accumulated till 2015 (TC2015). The citation data obtained from SCI is the total number of times a particular article was cited. The number of citation count is considered to be a quality indicator of research value (which is not necessarily always true), that measures the impact and visibility in a particular field of research.[38] The most-frequently cited articles (900 times or more) during 1991–2015 were retrieved. The most-frequently cited article was "Molecular-basis of myotonic-dystrophy - expansion of a trinucleotide (CTG) repeat at the 3′ end of a transcript encoding a protein-kinase family member" published in 1992 by Brook *et al*., which was cited 1655 times, followed by "Dystrophin expression in the MDX mouse restored by stem cell transplantation" by Gussoni *et al*., published in 1999 (1305 citations). Of these, nine most-frequently cited articles, "Cellular and molecular regulation of muscle regeneration" published in 2004 by Charge and Rudnicki had the highest average citation per year (ACPY) of 90.23 citations per year for its 1173 citations. Figure 4 shows the progression of citations scored by these highly cited articles on muscular dystrophy [Table 6].

The research impact in terms of citation count has always been a debatable issue, though it is increasingly being used in research evaluation, benchmarking, and funding allocations.[30] Many scholars have used different terminologies to depict the citation lifecycle considering its value for assessment of research impact – "citation windows,"[31,32] "ageing,"[33] and "durability."[34] Two articles on muscular dystrophy by Brook *et al*., (total count [TC] = 1655; 320 citations in the first 3 years) and Gussoni *et al*. (TC = 1305; 180 citations in the first 3 years) received quick citations. At the same time, the article by Gussoni *et al*., (TC = 1305) showed an early decline in citation pattern. Aversa (1985) reported similar trends of the early rise-rapid decline of citations.[35] Of these most cited papers, six showed a late rise and a late decline. The article

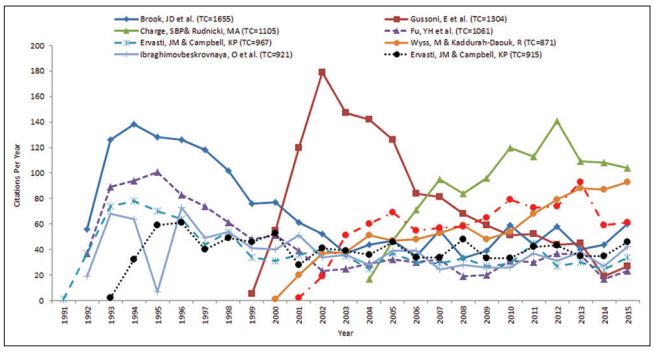

Figure 4: Characteristics of highly cited papers in muscular dystrophy

by Charge and Rudnicki (TC = 1105) showed an early rise and slow decline in citation pattern. The early citation rise[36] and slow decline in citation turn out to be more valuable and impactful [Figure 4].[37,38]

Distribution of subject categories

The articles related to muscular dystrophy were distributed in 139 of 176 subject categories. These subject categories are as per the SCI distribution of journals, as of 2016. Table 7 presents the top ten Web of Science categories with at least 500 articles. The subject categories which occupied top ranks are Clinical Neurology with 5953 articles (27.68% of 21505 articles), followed by Neurosciences with 4840 (22.50%) articles, Genetic Heredity with 3412 (15.86%) articles, Biochemistry and Molecular Biology with 3014 (14.01%) articles, Cell Biology with 2569 (11.94%) articles, Medicine Research Experimental with 1313 (7.5%) articles, and Biotechnology Applied Microbiology with 1060 (4.92%) articles. Other seven subject categories had less than 1000 articles.

The top seven subject categories for muscular dystrophy showed a similar growth pattern for each category. The nature of Clinical Neurology research was similar to the Neuroscience research, that is obvious from Figure 5; both the fields have shown similar growth pattern. The number of publications in the fields of clinical neurology and neurosciences have remained first and second ranked, respectively, throughout the study period. There has been a steep growth of literature during 2000 to 2001 for both the categories. Epidemiological studies on muscular dystrophy provide some of the evidence for such changes in the field.[39]

The growth of literature in genetics and heredity has been constant with minor growth at a later stage throughout the

Table 5: Most productive journals in muscular dystrophy research

Source titles	NP	% of 21,505	IF2015
Neuromuscular Disorders	2042	9.495	3.107
Muscle Nerve	698	3.246	2.713
Neurology	563	2.618	8.166
Human Molecular Genetics	531	2.469	5.985
American Journal of Human Genetics	390	1.814	10.794
Plos One	373	1.734	3.057
Journal of Biological Chemistry	301	1.4	4.258
Molecular Therapy	270	1.256	6.938
Journal of the Neurological Sciences	252	1.172	2.126
Annals of Neurology	230	1.07	9.638

NP = Total number of publications; IF = Impact factor

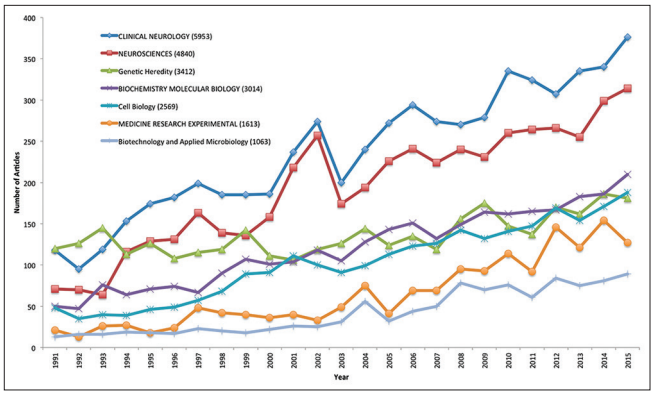

Figure 5: Subject coverage of muscular dystrophy research

Table 6: Most frequently cited papers on muscular dystrophy

Author	Title	Total citations (TC=2015)	ACPY
Brook, JD *et al.*	Molecular-basis of myotonic-dystrophy - expansion of a trinucleotide (CTG) repeat at the 3' end of a transcript encoding a protein-kinase family member, *Cell* 1992:68:799-808	1655	67.36
Gussoni, E *et al.*	Dystrophin expression in the MDX mouse restored by stem cell transplantation *Nature*1999;401:390-4	1305	72.89
Charge SBP and Rudnicki MA	Cellular and molecular regulation of muscle regeneration *Physiological Reviews* 2004;84:209-38	1105	90.23
Fu YH *et al.*	An unstable triplet repeat in a gene related to myotonic muscular-dystrophy *Science* 1992;255:1256-8	1081	43.24
Ervasti JM and Campbell KP	Membrane organization of the dystrophin-glycoprotein complex *Cell 1991;66:1121-31*	985	37.88
Wyss M and Kaddurah-Daouk R	Creatine and creatinine metabolism *Physiological Reviews* 2000;80:1107-213	941	55.35
Ibraghimovbeskrovnaya O *et al.*	Primary structure of dystrophin-associated glycoproteins linking dystrophin to the extracellular-matrix *Nature* 1992;355:696-702	939	37.56
Ervasti JM and Campbell KP	A role for the dystrophin-glycoprotein complex as a transmembrane linker between laminin and actin *Journal of Cell Biology* 1993:122:809-23	931	38.79
Hawke TJ and Garry DJ	Myogenic satellite cells: Physiology to molecular biology *Journal of Applied Physiology* 2001;91:534-51	910	56.88

ACPY: Average citation per year

Table 7: Distribution of publications in different subject categories

Web of science categories	Number of articles	Share of publication
Clinical neurology	5953	27.68
Neurosciences	4840	22.50
Genetics, heredity	3412	15.86
Biochemistry, molecular biology	3014	14.01
Cell biology	2569	11.94
Medicine research, experimental	1613	7.50
Biotechnology, applied microbiology	1060	4.92
Pediatrics	962	4.47
Cardiac, cardiovascular systems	883	4.10
Multidisciplinary sciences	752	3.49
Physiology	633	2.94
Biophysics	533	2.47
Medicine, general, internal	533	2.47

study period, whereas all the other subject categories have shown an increasing trend [Figure 5]. The literature growth in clinical neurology and neurosciences is more as compared to that observed in other fields.

Conclusions

The study of publication research pattern over 25 years for muscular dystrophy was carried out. The results contained a considerable amount of information related to muscular dystrophy and its allied area of research since 1991. Literature growth accessed through bibliometric analysis of muscular dystrophy research shows that the articles have grown at a rate of 3.92% per year. Most of the research has taken place in the last ten years due to an active participation of various funding agencies, for example, the National Institute of Health funded 5.19% of research on muscular dystrophy followed by Muscular Dystrophy Association (2.19%), and Association Francaise Contre Les Myopathies (91.13%). There were seven most productive countries that contributed 89.46% of the total publications, in which the USA was the most contributing country with a share of 35.50% of the global output. The trends of self-citation in muscular dystrophy have been found to be increasing. In 2008, there were less than 1% self-cited articles, whereas in 2015, this increased to 15.65%. India has been ranked 15th in terms of total publications on muscular dystrophy. The Institut National De La Sante Et De La was the most productive institute with 5.03% of the global share. Regarding individual research impact in terms of citations and the h-index, the Howard Hughes Medical Institute has scored the highest citation count (46,795 citations) and the h-index value of 114. In terms of the authorship pattern, Muntoni published the most number of papers (416 papers), but in terms of individual research impact on the parameter of citation and h-index, Kunkel scored the most number of citations for 150 papers with an h-index of 83. All the key terms and the various names of muscular dystrophy occupied the top rank in terms of the terminology used by the author in the title. There were nine most frequently cited articles on muscular dystrophy, which have scored more than 900 citations until 2015. Two articles showed a very early rise in the citation count and had the most impactful contribution, whereas one article showed an early rise but a delayed decline in citation scoring. Through this research, the progress of research in muscular dystrophy has been investigated. The results of this research might be useful to the stakeholders engaged in collaborative research with potential institutions and authors.

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Conflicts of interest
There are no conflicts of interest.

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