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# A Bibliometric Analysis on "Fertility Rate" Research Trends

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## A BIBLIOMETRIC ANALYSIS ON “FERTILITY RATE” RESEARCH TRENDS

### ABSTRACT

The systematic literature search on the fertility rate was performed on articles from the Web of Science compiled by the Institute of Scientific Information (ISI) to provide major publication characteristics. All articles related to Fertility from year 1980 to 2011 were analyzed with the bibliometric approach using non-parametrics techniques. Total Citation, Citation per year and Cited References were significantly different between the 80's, 90's and 2000's, with more than a 100% increase in the number of publication. The association between number of authors and citation per year were significantly weak. Number of publication in a journal posed a poor negative association with the citation per year. Similarity between Authors Keyword and KeyWords Plus® do not promote the increase in citation per year. The author's affiliation and country of publication would be an interesting exploration for future fertility research. The bibliometric analyses on Fertility is rather new and vital, as the key finding will provide researchers guidance in the literature search and future publication.

**Keywords:** Fertility; Bibliometric; Publication Trend; Author keyword; KeyWords Plus®

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## Introduction

Fertility conditions are an imperative study in the macro and micro level. At the micro level, the fertility among young adults are at a concerning stage causing the medical and health research on improving fertility to rapidly grow (Malizia, Hacker, & Penzias, 2009). Also, the demand on consumable good have boost the research on fertility of animals and plants (Royal et al., 2000). On a macro level, research on fertility sheds a light on the economic growth, development of sectors, labour need and many more especially with the rapid fertility transition over the decades (Bongaarts & Watkins, 1996; Myrskylae, Kohler, & Billari, 2009) . The term fertility rate generally refers to the average number of offspring’s to be reproduced over a lifetime of the reproducing species.

The growing research interest on fertility creates the need to systematically gather data on past literature and its publication characteristics. To capture the trends and characteristics of these publications, the bibliometric analyses is suitable and a widely used research tool in many areas of study. (Ale Ebrahim, 2013b; Anduckia, Gomez, & Gomez, 2000; Cronin, 2001; Eshraghi, Osman, Gholizadeh, Ali, & Shadgan, 2013; Tian, Wen, & Hong, 2008). The Institute of Scientific Information (ISI) Web of Science database will be used to extract needed data as it is reliable and is a popular source for reviewing literature. (Aghaei Chadegani et al., 2013; Kostoff, 2000; Tian et al., 2008).

There are many direction in the bibliometric analyses which includes the conventional method of a quantitative approach to the number of publication based on countries, research fields, or journals (Dannenberg, 1985; Davis & Gonzalez, 2003; Fu, Long, & Ho, 2014; Fu, Wang, & Ho, 2013; Ho, 2012; Rahman, Haque, & Fukui, 2005). Despite the valuable insight this conventional method has provided, there is a wave of interest these days on the orientation of a research field in terms of the publication content (Tian et al., 2008). The content analysis involves finding trends (Huffman et al., 2013; Menendez-Manjon, Moldenhauer, Wagener, & Barcikowski, 2011; Sooryamoorthy, 2010), correlation and relationship in the author keyword (Chiu & Ho, 2007; Mao, Wang, & Ho, 2010), KeyWords Plus® indexed by ISI (Garfield & Sher, 1993; Tan, Fu, & Ho, 2014; Wang, Wang, Zhang, Cai, & Sun, 2013), source titles (Li, Ding, Feng, Wang, & Ho, 2009; Yin, 2013), collaborations with international authors (Jacso, 2012; Zyoud, Al-Jabi, Sweileh, & Awang, 2014), citation analyses (Ho, 2014), language (Diekhoff, Schlattmann, & Dewey, 2013), and many more. Author Keyword are words or phrases provided by the author to justly provide gist of the article while KeyWords Plus® are words or phrases that frequently appear in the titles of an article's references, but do not necessarily appear in the title of the article itself. KeyWords Plus®, retrieved from the Thomson Reuters auto indexion system, may be present for articles that have no author keywords, or may include important terms not listed among the title, abstract, or author keywords (Ale Ebrahim, 2013a). The Web of Sciences Core Collection is a leading database with high quality and multidisciplinary research information, by the subscribed from the Institute of Scientific Information (ISI), also known as Thomson Reuters.

The aim of this study is to analysis the Web of Sciences literature on Fertility from year 1980 to 12<sup>th</sup> of June, 2014. by using the quantitative approach. This assumes investigations on the publication output, citation analyses, author keyword, KeyWords Plus®, authors and journals. This bibliometric analyses will facilitate researchers by providing guidance in the literature search and future publication.

## Methods and Materials

The data collected were from the Web of Science (WoS) Core Collection subscribed from the Institute of Scientific Information. The indexes include SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, and BKCI-SSH. As the study intends to review the bibliometric of articles related to fertility rate, the following keywords were used, as shown in Table 1.

**Table 1 Keywords used in Web of Science**

Keyword in the Title	Frequency
<b>Fertility rates, Fertility rate</b>	495
<b>Fertility level, Fertility Levels</b>	232
<b>Endogenous Fertility</b>	66
<b>Fertility reduced, Fertility reduction, Fertility reducing</b>	30
<b>Birth rate</b>	756
<b>Fertility declining, Fertility decline, Fertility declined</b>	409
<b>Decreasing fertility, decreased fertility</b>	121
<b>Below replacement fertility</b>	42
<b>Fertility transition, Fertility transitions</b>	217

A total of 2333 articles were extracted from a time span from 1980 to 2014. The data is valid as of the 12<sup>th</sup> of June, 2014. The search was refined up to 2011 as previous bibliometric studies have indicated that citation statistics of the articles which are shorter than 3 years may have stability insufficiency (Adams, 2005; UZUN, 2006). The articles were then ranked in accordance to the citation per year instead of total citation, to eradicate the biasness where some articles were found to be cited more often due to the leverage of time since published (Eshraghi et al., 2013; Loonen, Hage, & Kon, 2008). Analyses includes descriptive and inferential techniques to infer significance among categories. The core objectives discussed are:

- Characteristics of publication output and citation analyses
- Investigation on the Journals and Authors
- Analysis of Author Keyword and KeyWords Plus®

The range of techniques that were used to analyze these retrieved information were descriptive analyses, the inferential analyses that were carried out include the independent sample Mann Whitney, Spearman Correlation, and Kruskal Wallis.

## Results and Discussion

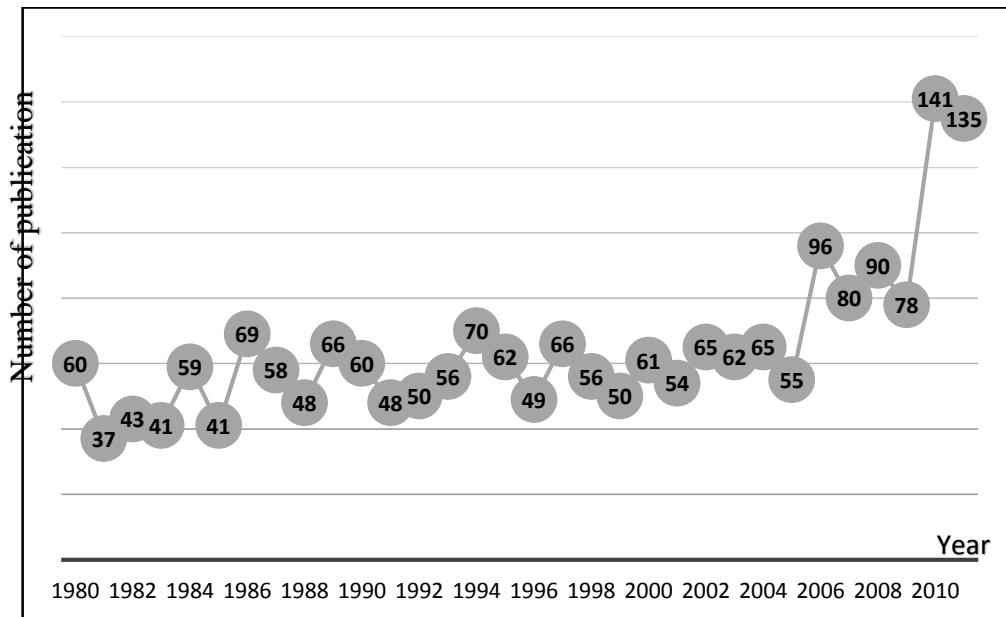
### *Characteristics of publication output*

Over the period of 1980 to 2011, there has been an increase in the number of published paper related to fertility, despite the fluctuations seen in Figure 1. In 1980, the number of publications were 60 and by the end of year 2011 the number of publication has risen up to 135.

The highest number of publication is at 2010, followed by a minimal reduction in the year 2011. In a wider perspective, the jump in the number of publication begin at 2006, where it leaped 75% from year 2005 and in 2010 a leap of 81%. The characteristics of these published papers were investigated by decades, as shown in Table 2.

Total number of articles published in the year 1980-1989, 1990-1999 and 2000-2011 were respectively 522, 567 and 1244. This shows that there is a huge increase, a little more than double, in the output of the last decade as compared to the two previous. In comparison to the total citation, the highest average is within year 1990-1999. This could be the advantage of having more years for citation, which brings about the measure of citation per year to evade the mentioned bias. Based on the citation per year, 2000-2011 has the highest citation per year at 0.9. The increase in the citation per year is linear on average, moving from 0.3 to 0.6 and ending at 0.9. However, there is a decline in the cited reference in these three decades, from 26.5 to 17.2. In order to justify the increase and decrease, the Kruskal Wallis test was carried out with the Post Hoc Dunnett’s T3 test as the assumption for homogeneity of variance was not met while the skewness of the data were in the similar direction.

**Figure 1 Publication per year since 1980**



All the three investigated characteristics the Total Citation (TC), Citation per year (CPY) and citation reference (CR) had at least one pair significantly different than the other. The Post Hoc test further suggest that the Total Citation in the 90’s is indeed significantly higher than the 2000’s, while the citation per year in the year 2000-2011 was significantly higher than the other range of years. Although we see a huge increase in the publication per year, the total citation per article has dropped in the field of fertility but the citation per year has increased steadily. Recent articles on fertility have been cited more often indicating a growing interest in the change of the current fertility development. Cited references on the other hand dropped drastically from 24.5 to 17.2 in the year 2000 – 2011. This reduction highlightes that the number of literature reviewed is far less important than reviewing the absolutely relevant articles. With globalization taking place, the search for literature of quality is made accessible with databases like Web of Science, Ebsco Host an many more.

**Table 2 Characteristics of Publication Output**

Year	Statistics	TC*	CPY*	CR*
<b>1980-1989</b>	Mean	9.7	0.3	26.5
	Skewness	6.1	6.3	1.4
<b>1990-1999</b>	Mean	11.9	0.6	24.0
	Skewness	5.0	5.4	1.7
<b>2000-2011</b>	Mean	7.3	0.9	17.2
	Skewness	7.1	7.3	2.1
<b>Significance</b>		p<0.0001	p<0.0001	p<0.0001

\*TC: Total Citation ; CPY: Citation per Year; CR: Cited Reference

More than 50% of the articles in the fertility research field were published under the Demographics, Obstetrics Gynaecology and Reproductive Biology category. The other categories ranges from a percentage of 3% - 9% as depicted in Table 3. Other categories with lesser than 3% include Family Studies, Social Sciences Biomedical, Anthropology, Public Environmental Occupational Health Ssci, Genetics Heredity, History Of Social Sciences, Multidisciplinary Sciences, Public Environmental Occupational Health Sci, Pediatrics, Zoology and Planning Development.

**Table 3 Web of Science Categories**

Categories	Frequency	Percentage (%)
<b>Demography</b>	517	22.1
<b>Obstetrics Gynecology</b>	377	16.2
<b>Reproductive Biology</b>	316	13.5
<b>Sociology</b>	204	8.7
<b>Economics</b>	183	7.8
<b>Public Environmental Occupational Health</b>	150	6.4
<b>Agronomy</b>	133	5.7
<b>Veterinary Sciences</b>	99	4.2
<b>Agriculture Dairy Animal Science</b>	98	4.2
<b>Agriculture Multidisciplinary</b>	82	3.5
<b>History</b>	78	3.3
<b>Medicine General Internal</b>	77	3.3

*Journal and Authors on Citation per year*

The journal in which an article is published and the number of authors are investigated to determine the impact on the citation per year. Table 4 below is a list of the top 10 highly cited articles in the fertility research. The highest cited article is by (Royal et al., 2000) with 21.4 citation per year under the category of Agriculture, Dairy & Animal Science, followed by (Malizia et al., 2009) under the category of Medicine, General & Internal.

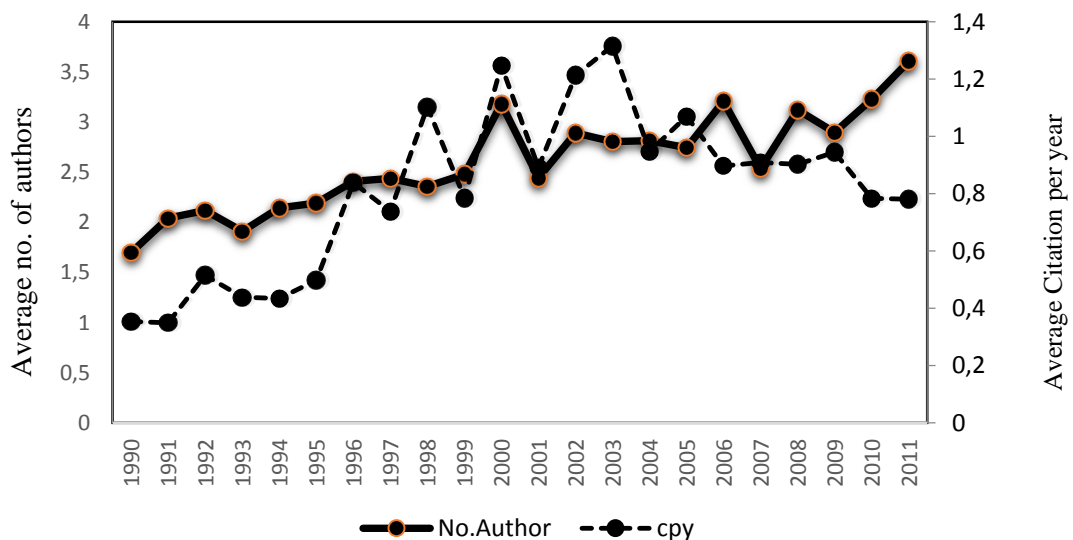
**Table 4 List of top 10 articles with highest citation**

<b>Authors</b>	<b>Title</b>	<b>CPY</b>
<b>Royal, MD; Darwash, AO; Flint, APE; Webb, R; Woolliams, JA; Lamming, GE</b>	Declining fertility in dairy cattle: changes in traditional and endocrine parameters of fertility	21.40
<b>Malizia, BA; Hacker, MR; Penzias, AS</b>	Cumulative Live-Birth Rates after In Vitro Fertilization	15.33
<b>Tang, SY; Chen, LS</b>	Density-dependent birth rate, birth pulses and their population dynamic consequences	14.15
<b>Bongaarts, J; Watkins, SC</b>	Social interactions and contemporary fertility transitions	13.21
<b>Grifo, JA; Noyes, N</b>	Delivery rate using cryopreserved oocytes is comparable to conventional in vitro fertilization using fresh oocytes: potential fertility preservation for female cancer patients	12.80
<b>Lopez-Gatius, F</b>	Is fertility declining in dairy cattle? A retrospective study in northeastern Spain	12.25
<b>Joseph, KS; Kramer, MS; Marcoux, S; Ohlsson, A; Wen, SW; Allen, A; Platt, R</b>	Determinants of preterm birth rates in Canada from 1981 through 1983 and from 1992 through 1994	12.06
<b>Myrskylä, M; Kohler, HP; Billari, FC</b>	Advances in development reverse fertility declines	11.67
<b>Papanikolaou, EG; Kolibianakis, EM; Tournaye, H; Venetis, CA; Fatemi, H; Tarlatzis, B; Devroey, P</b>	Live birth rates after transfer of equal number of blastocysts or cleavage-stage embryos in IVF. A systematic review and meta-analysis	11.29
<b>McDonald, P</b>	Gender equity in theories of fertility transition	10.87

The citation per year has a cyclic movement, as seen in Figure 2, where the highest citation per year were between 1998 and 2005. On the other hand, average number of authors per year for one article have shown an overall increase. A bivariate non-parametric Spearman correlation analysis, regardless of year, showed that there is a significant yet weak relationship between number of authors and citation per year ( $r=0.215$ ,  $p<0.001$ ). A further analyses was done by computing the correlation before year 2000 and after revealed the similar results. There was a weak correlation between number of authors and citation per year before 2000(0.389,  $p<0.001$ ) and after (0.115,  $p<0.001$ ). This suggests that in the research pertaining to fertility, more authors may not convene an increase in the citation per year and this is evident in the 90's and 2000's.

The top 15 highest published journal and the 15 highest cited journal in the fertility field were analyzed as depicted in Table 5. The highest journal publishing the fertility study is the Fertility and Sterility Journal with 144 publication from year 1980 – 2011, and a citation per year of 0.95. Among the top 15 journals, 5 of them were of in the Medicine, 2 were from agriculture while the rest were Social Studies and Economics. The highly published journals are in the field of Medicine. Glancing through the top published journals, the citation per year emerged as rather low. This brings to the next observation which is the highest cited journal in the field of fertility. Among these journals, 8 were from the field of medicine & sciences, 4 from agriculture and 3 from economics & Statistics. The highest citation per year was the Journal of Animal Science with 21.4 citation per year, but with only 1 publication. Considering these numbers, it is seen that the highly cited journals have published very few articles. A further analysis was done on the citation per year and number of publication per journal to investigate the correlation between them. The results were negative and insignificant ( $r=-0.17$ ,  $p>0.05$ ). This suggest that one cannot conclude that publishing in a journal with low number of publication would ensure a high citation.

**Figure 2 Citation per year and average no. of authors**





**Table 5 Highly Published and Highly Cited Journals**

<b>Highly Published</b>	<b>NoP</b>	<b>CPY</b>	<b>Highly Cited</b>	<b>CPY</b>	<b>NoP</b>
<b>Fertility And Sterility</b>	114	0.95	Animal Science	21.40	1
<b>Population And Development Review</b>	98	1.11	Journal Of Mathematical Biology	14.15	1
<b>Indian Journal Of Agronomy</b>	88	0.08	Critical Reviews In Plant Sciences	9.20	1
<b>Human Reproduction</b>	87	1.35	Global Biogeochemical Cycles	8.47	1
<b>Population Studies-A Journal Of Demography</b>	57	0.99	Computational Statistics & Data Analysis	8.00	1
<b>Population</b>	50	0.08	Bmc Systems Biology	7.57	1
<b>Indian Journal Of Agricultural Sciences</b>	48	0.08	Journal Of Clinical Endocrinology & Metabolism	6.58	2
<b>Population Index</b>	39	0.00	Environmental Health Perspectives	5.32	2
<b>Demography</b>	33	1.37	Journal Of Clinical Oncology	5.25	1
<b>Demographic Research</b>	31	0.74	New England Journal Of Medicine	5.24	12
<b>American Journal Of Obstetrics And Gynecology</b>	29	0.78	Archives Of Disease In Childhood-Fetal And Neonatal Edition	5.13	1
<b>Journal Of Biosocial Science</b>	28	0.36	Journal Of Economic Perspectives	4.67	1
<b>Journal Of Population Economics</b>	25	1.59	American Sociological Review	4.64	1
<b>Studies In Family Planning</b>	24	1.08	Biological Conservation	4.57	1
<b>Population Research And Policy Review</b>	20	0.41	Journal Of Thrombosis And Haemostasis	4.25	2

\*NoP : Number of Publications ; CPY: Citation per year

**Table 6 Top 10 Author Keyword used in publication**

Author Keywords	1990 - 1995			1996 - 2000			2000 - 2005			2006 - 2011			Total
	NoP	%	R	NoP	%	R	NoP	%	R	NoP	%	R	
<b>Fertility</b>	17	54.8	1	11	39.3	1	43	52.4	1	73	37.4	1	144
<b>Fertility decline</b>	2	6.5	2	2	7.1	4	8	9.8	3	15	7.7	4	27
<b>Fertility Level</b>	1	3.2	3	5	17.9	2	10	12.2	2	20	10.3	2	36
<b>Fertility rate</b>	2	6.5	2	1	3.6	5	6	7.3	4	12	6.2	6	21
<b>IVF</b>	2	6.5	2	1	3.6	5	4	4.9	5	11	5.6	7	18
<b>Yield</b>	1	3.2	3	1	3.6	5	0	0.0	8	15	7.7	4	17
<b>Growth</b>	2	6.5	2	3	10.7	3	2	2.4	7	9	4.6	8	16
<b>Endogenous Fertility</b>	2	6.5	2	2	7.1	4	4	4.9	5	9	4.6	8	17
<b>Fertility Transition</b>	1	3.2	3	0	0.0	6	2	2.4	7	13	6.7	5	16
<b>Birth Rate</b>	1	3.2	3	2	7.1	4	3	3.7	6	18	9.2	3	24

*Author Keyword and KeyWords Plus® on citation per year*

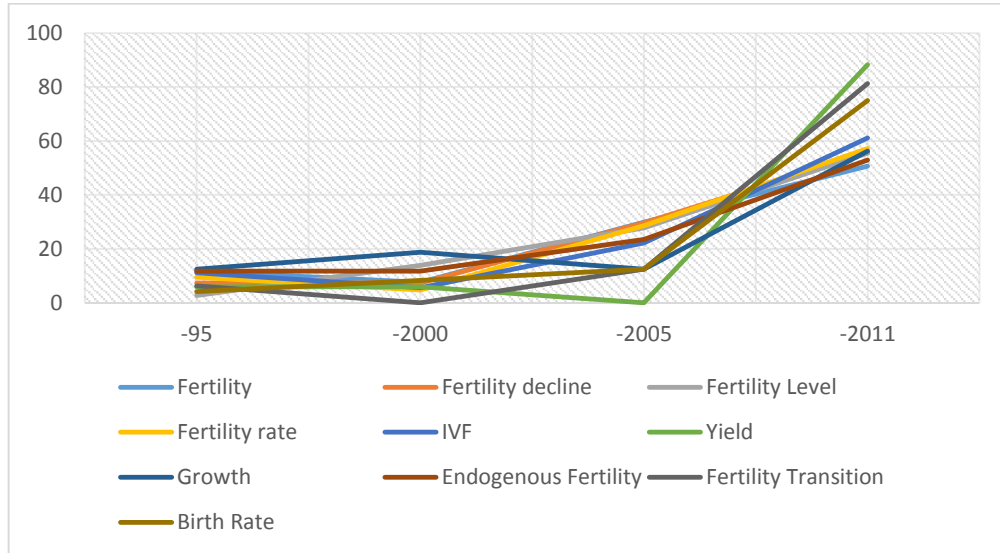
The author keyword analyses for data collected from 1990-2011 were ranked and the percentage within each year range were computed. A graphical representation of the percentage within author keyword is depicted in Figure 3. Fertility was largely used as the author keyword and ranked number 1 regardless of year category. There is a drastic increase in the usage of Fertility from 11 in 1996-2000 to 73 in year 2006-2011. Among the top ten author keywords, 7 were used in the titles of the published paper and were the search keyword used to extract the articles in the Web of Science. The words that emerged to be new were the IVF, Yield and Growth. Among others, pregnancy, Caesarian Section, infant mortality, demographic transition, intercropping, live birth rate and live birth were also seen to have emerged as popular, but in separate year category. Birth Rate and IVF seemed to be also a keyword that has increased quite a bit, and this could be due to the increase in search for alternative ways to handle infertility. The graph indicates that all the author keyword have increased over the time proving that the studies on fertility are reaching a substantial interest.

There is a considerable difference in the similarity of the Author Keyword and KeyWords Plus®. Author Keywords are keywords that is given by the author for each article. On the other hand the KeyWords Plus® are keyword given by the Web of Science for each article. Table 7 lays out the top ten KeyWords Plus® and Author Keywords with the frequency in the published article and its rank in the KeyWords Plus®. Out of the top ten author keyword only IVF and Growth are in the top ten KeyWords Plus®. Fertility which is ranked one in the authors keyword fall in rank 16 with frequency of 25, while fertility decline, fertility level and fertility rate are not used as a KeyWords Plus®.

Table 8 shows the descriptive statistics for the similarity of the keywords selected by authors and KeyWords Plus® using the Mann Whitney test. The highly cited articles were selected to compare the mean difference in citation per year should the keyword be similar or different. The variance of the groups were assumed similar ( $F=0.6$ ,  $p>0.05$ ) and the mean

difference in the citation per year was found to be not significant. This suggest that whether the author selects keywords for the article as close to the KeyWords Plus®, the citation per year will not significantly be affected. The choice of keywords can be based on authors expert opinion, while not on the basis of the probable choice of the KeyWords Plus®.

**Figure 3 Author Keyword trend over 1990 – 2011**



**Table 7 Comparison of Top ten KeyWords Plus® and Author Keyword**

KeyWords Plus®	N	R	Authors Keyword	N	R
<b>In Vitro Fertilization</b>	98	1	Fertility	25	16
<b>Population</b>	81	2	Fertility decline	0	NIL
<b>Women</b>	63	3	Fertility Level	0	NIL
<b>Age</b>	63	3	Fertility rate	0	NIL
<b>United States</b>	59	5	IVF	98	1
<b>Pregnancy</b>	54	6	Yield	11	70
<b>transition</b>	51	7	Growth	34	10
<b>Impact</b>	44	8	Endogenous Fertility	1	above 2000
<b>Risk</b>	44	8	Fertility Transition	2	above 600
<b>Growth</b>	34	10	Birth Rate	0	NIL

N: Frequency of KeyWords Plus®; R: Rank in KeyWords Plus®

**Table 8 Comparison between Author Keyword and KeyWords Plus®**

	Frequency	Mean	Std Dev	Significance
<b>Similar*</b>	213	3.82	3.47	NS**
<b>Different*</b>	86	3.48	3.09	
<b>* Similar : Articles with similar Author Keyword and KeyWords Plus® ;</b>				
<b>Different : Articled with different Author Keyword and KeyWords Plus®</b>				
<b>**NS: not significant with the equal variance assumed</b>				

## Conclusions

This analytical study has provided several key findings of the research trend in the Fertility field throughout 1980 to 2011. A total of 2333 articles were found and the number of publications presented an upward trend. Noting that cumulative total citation is not reliable, the citation per year over every decade has steadily increased one average by 0.3. This indicates that in the next decade, the similar trend could probably take place. Among all these, the categories that are produces many articles on fertility are Demographics, Obstetrics, Reproductive Biology, Sociology and Economics. There is still much room for the publication in categories that are not human related, such as Veterinary and Agriculture. The common idea that the more authors in an article would subsequently increase the number of citation, may not hold for the fertility research as there is weak association. It was also found that similarity in Authors Keyword and KeyWords Plus® does not play a role in the votality of the citation per year. As the research on the fertility field grow in interest, bibliometric analysis would assist reseachers in identifying key elements and characterization of the fertility literature research. In the light of that, more efforts should be channeled in bibliometric studies in all fields.

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