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*Afr. J. Biomed. Res. Vol.18 (September, 2015); 171 - 180*

*Full Length Research Paper*

# Improving Research and Scientific Publications in Africa: Analysis of a Centennial issue of The FASEB Journal towards Effective Mentoring

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**ABSTRACT**

In Nigeria, the flourishing of universities and turn-out of graduates do not adequately reflect in national development. The aim of this study was to determine some factors that can guarantee career success in the field of biomedical science in Nigeria. The objectives were to examine thirty three articles of a centennial issue (April 2012) of the FASEB Journal for: a) Number of printed pages of the journal, b) Number of major studies described in the article, c) Number of figures and presentation of data within the figures, d) Number of days the journal took to review the article before acceptance for publication, e) Number of scientific references listed at the end of the article. The data showed that articles took up 10.5±1.5 printed pages, reported 8.03±0.36 major studies, utilized 49.76±7.4 references, and took 87.76± 8.4 days to be accepted. Data were presented as tables in 16/33 articles; diagrams in 18/33 articles; graphs in 21/33 articles; histograms (and other charts) in 31/33 articles; photos/pictures in 24/33 articles, blots (mainly western) in 20/33 articles; machine print-outs in 10/33 articles; and sequences, arrays, or mappings in 7/33 articles. The author concludes that young biomedical scientists need to be directed to take care of the following factors along their research career: a) quantity of work, b) quality of work, c) richness of evidence, d) planning and pacing of work, e) relationship of work with universal knowledge and development.

**Key words**: mentoring, peer reviewed articles, biomedical science, FASEB, research, Nigeria, Africa

## INTRODUCTION

The growth of nations largely depends on products of universities and other tertiary institutions. These products include the graduates, the research outcomes, and the innovations in products and services which enhance the nations' infrastructures, benefits provided for their citizens, and the way of life of their citizens.

Back in 1979, Professor of Political Science at the University of Michigan, Ali Mazrui, considered Africa's economic development in his fourth Reith Lecture from his series entitled 'The African Condition' (Mazrui, 1979). In a lecture entitled 'The Burden of Underdevelopment', Professor Ali Mazrui questions how such a resource rich region of the world accommodates some of the poorest countries in the world. Thirty five years later, much of Africa is well

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*Revised version Received: February, 2015*
*Date Accepted:, May, 2015*

***Abstracted by:***
*Bioline International, African Journals online (AJOL), Index Copernicus, African Index Medicus (WHO), Excerpta medica (EMBASE), CAB Abstracts, SCOPUS, Global Health Abstracts, Asian Science Index, Index Veterinarius*

known for its paradoxical richness in raw materials and a seeming incapacity to transform itself using its own scientific and technical expertise.

Using 2011 statistics, Nigeria produced 2,211,000 barrels of oil per day and was amongst the top 14 producers globally. It was also recorded to be the 4th biggest exporter - exporting 2.1 million barrels each day (The Richest, 2011). Even with this decades-old potential economic clout and more than fifty years of independence from colonial rule, Nigeria has not been able to stand independent in providing basic needs such as clean water, electricity, good roads, adequate foods, and health care for all its citizens.

Since independence, the number of Nigerian universities (and graduates) has been rising remarkably: 5 federal universities were established by 1962 and these increased to 27 by 2008; 6 state universities were established by 1983 and this number increased to 31 by 2008; by 1999, 34 private universities had joined the race and by 2008 the total number of universities was 92 (John, 2010). Presently by June 2015, Nigeria has 46 federal universities, 40 state universities, and 61 private universities, a total of 147 (National Universities Commission, 2015) for a population of about 180 million. (The current Nigerian population snapped from the Population Clock at 12:45:54 on 04-06-2015 was 180, 226, 144 (Countrymeters, 2015), an increase of 399.17% from the 45.15 million at Independence in 1960 (Trading Economics, 2015)).

Paradoxically, according to Nigeria's National Bureau of Statistics, Nigeria's "population in poverty" has been rising: 1980: 17.1 million; 1985: 34.7 million;1992: 39.2 million; 1996: 67.1 million; 2004: 68.7 million; 2010: 112.47 million (British Broadcasting Corporation News Africa, 2012). Thus lack of resources, lack of manpower, and lack of education are not Nigeria's problem and do not account for its poverty. Rather, how to profit from resources and education appears to be the problem. Educated Nigerians may need to become more effective change agents and bring about more of the desired development. This report aims at proposing one way of helping to reverse the bad trend: effective mentoring of professionals at the onset of their careers so that they would become transforming leaders in their responsibilities.

In the field of biomedical science research where Africa tends to trail behind, the Nigerian educational system needs to study the factors that can help to bring the Nigerian academia into the state-of-the-arts. Across the world, new patterns have set into biomedical science and these include multidisciplinary and collaborative research and state-of-the-arts utilization of cell biology, molecular biology, and other techniques (Hall and Scott, 2001; Pisano, 2002; Constans, 2002; De Franscisco, 2002; John, 2013a). Unlike research-intensive academia in the developed countries, Nigerian universities are yet to reach significant success in profitable research and to have adequate impact in the utilization of science in national development.

The objectives of this study were to examine the thirty three articles of a centennial issue (April 2012) of the FASEB Journal for: a) Number of printed pages of the journal article, b) Number of major studies described in the article, c) Number of figures and presentation of data within the figures, d) Number of days the journal took to review the article before acceptance for publication, e) Number of scientific references listed at the end of the article. The results are proposed as guidelines for mentoring PhD research in Nigeria.

## MATERIALS AND METHODS

To harness the global trend for education direction in biomedical science in Nigerian universities and institutes, the author here presents a study of the peer-reviewed scientific publications in a centennial (2012) issue of the FASEB Journal (Volume 26(4)). The FASEB Journal was chosen because it is published by the Federation of American Societies for Experimental Biology (FASEB). It is a time-tested federation established in 1912 and celebrating its centenary in 2012. From the FASEB website http://www.faseb.org/Who-We-Are/Constituent-Societies.aspx: "FASEB's members are scientific societies that share a common vision for the advancement of research and education in biological and biomedical sciences." There are now twenty seven such societies from the pioneer, American Physiological Society (APS), to the newest, Society for Free Radical Biology and Medicine (SFRBM), which joined in 2014 (FASEB, 2015 http://www.faseb.org/About-FASEB/Constituent-Societies.aspx).

The FASEB Journal is published monthly. From the BioxBio website information (http://www.bioxbio.com/if/html/FASEB-J.html) the 2013/2014 impact factor is 5.48 with 41104 cites for a total of 466 articles. The 33 articles of the issue selected were considered a representative sample of current (2012) biomedical science published by the 100-years old Federation.

The aim of this study was to examine the papers published in the said issue of the FASEB Journal for the quantity and quality of research work required to publish a scientific paper in the journal. The quantity of research work was measured by the numbers of printed pages and

data presented in figures. The quality of research work was determined by the number of major studies subtitled within each paper and the type and variety of data presentation. The number of major studies was taken as an indication of the extent of evidence gathered in order to prove a hypothesis or to achieve the aim of the investigators. The author also examined the time taken for each paper to be accepted for publication. This was used as an indicator for pacing research and for the predictability of a person's career progress. Finally, the author also examined the number of references used by each article as an indication of conversance of the authors with existing literature and work in the field. From the findings of this study, a few tips are given for the mentoring of PhD candidates in Nigerian tertiary educational processes so that, as researchers, they would be comparable and competitive with their counterparts in advanced countries and would be capable of wielding profitable research that could have social and economic impact in Africa.

The thirty three peer reviewed scientific research articles in the April 2012 issue of the FASEB Journal (Volume 26(4): 1413-1763 were studied using the following parameters:

a) Number of printed pages of the journal article
b) Number of major studies described in the article
c) Number of figures and presentation of data within the figures
d) Number of days the journal took to review the article before acceptance for publication
e) Number of scientific references listed at the end of the article

The frequencies were recorded for each parameter. The means, medians, and modes were generated from Microsoft Excel 2010 functions. The equality or central tendency of these values for any parameter was used to indicate a valid sample of a uniform population studied and therefore to define the state-of-the-arts. These parameters were used to recommend standards that Nigerian (and other African) PhD candidates could aim for in preparing their manuscripts of scientific reports.

## RESULTS

Figure 1 depicts number of printed pages and number of major studies for individual articles. For the number of printed journal pages, the mean was 10.50±1.52, the median was 10, and the mode was 10. The printed pages included text and illustrations. The number of major studies per paper ranged from 5 to 13; the mean was 8.03 ±3.6, the median was 8, and the mode was 8. These studies were typically subtitled. Taking examples from the first five articles, they include such sub-titles as: Incremental treadmill test, Muscle metabolic enzyme activity, Western blot analysis (Huttermann *et al*.); Inhibition of TNF-alpha, osteoclasts, osteoblasts, and osteoid and new bone formation, Immunohistochemistry, Real-time polymerase chain reaction (Pacios *et al*.); Morphometric analysis, Protein extraction and quantification, Metabolic enzyme activity assays (Levett *et al*.); Cell culture and transfection, Investigation of redox status in subcellular compartments using roGFP, Cell viability (Zhang *et al*.); cDNA and miRNA microarray assays, Bioinformatics, μCT analysis of mineralized tissue (Tal *et al*.); Luciferase reporter assay, Smad phosphorylation assay and western blotting, Myogenic differentiation assay (Kemaladewi *et al*.). Other examples taken from the last five of the articles studied are: Cloning of *mxi*G $_{1\text{-}126}$, Crystallization and crystal structure determination, Immunoelectron microscopy (Barison *et al*.); Rat handling and antibiotic treatment, Ischemia/reperfusion studies *in vivo*, Blood cytokine analysis (Lam *et al*.); Establishment of the MEL fluorescent reporter cell lines, Analysis of DsRed and EGFP expression, Southern blot analysis (Chan *et al*.); $HCO_3^-$ secretion, Nerve stimulation, Immunohistochemistry (Singh *et al*.); and Liquid chromatography-tandem mass spectrometry-based metabolomics, Whole cell patch-clamp recordings in cultured DRG neurons, Pain behavioural analysis (Serhan *et al*.).

Table 1 displays the various manners in which data were presented by the 33 published articles. The number of illustrations per article ranged from 13-84 (tables, graphs, picture series, blot series, printouts, arrays, etc.); the mean number of illustrations was 33.7±2.8, the median was 30, and the mode was 30. The actual number of figures ranged from 4 to 10, the mean being 6.49, the mode being 7, and the median being 6. Figures were composite, made up of series of pictures, graphs, histograms, blots, etc., blots and densitometry histograms, or a mixture of these. For example, Figure 1 in Hirota *et al*. had 12 pictures; Figure 4 in Yamashita *et al*. had 12 confocal imaging pictures; Figure 1 in Hifumi *et al.* had 10 sequences; Figure 2 in Hifumi *et al*. had 7 protein structures; Figure 4 in Liu *et al.* had 33 pictures and 11 electronmicrographs; Figure 3 in Huttemann *et al*. had five series of blots, a histogram, and a graph; Figure 8 in Zhang *et al*. had 3 graphs and 5 histograms; Figure 1 in Tal *et al*. had a series of 7 pictures, 2 histograms, 2 diagrams, and 1 graph; Figure 5 in Kemaladewi *et al*. had a series of 16 pictures, 3 series of blots, 1 diagram, and 5 histograms; Figure 6 in Kemaladewi *et al*. had 3 series of composite blots; Figure 5 in Zuo *et al*. had 7 histograms, 2 graphs, and 1 diagram; Figure 5 in Dancyger *et al*. had 8 protein

structures; Figure 1 in Mirakaj *et al*. had 24 confocal images in 3 series, 4 flow cytometry printouts, 4 histograms and 1 diagram; Figure 4 of Mirakaj *et al*. had 6 histograms and a series of 8 photomicrographs; Figure 2 in Tarcic *et al*. had 2 arrays, 5 series of blots, 1 histogram, 1 graph, and 1 diagram; Figure 2 in Engel *et al*., had 5 histograms and 3 printouts; Figure 2 in Khaperskyy *et al*. had 36 confocal imaging pictures, 1 histograms, and 2 series of composite blots; Figure 7 in Bosmann *et al*. had 14 flow cytometry print outs, and 2 histograms; Figure 3 in Goudet *et al*. had 6 series of electrophysiology records and 1 graph; Figure 4 of Goudet *et al*. had 4 protein structures and 4 sequences; Figure 1 of Serhan *et al*. had 3 chromatograms and 3 protein structures; and Figure 6 in Serhan *et al*. had 8 electrophysiology records, 1 graph, and 1 histogram.

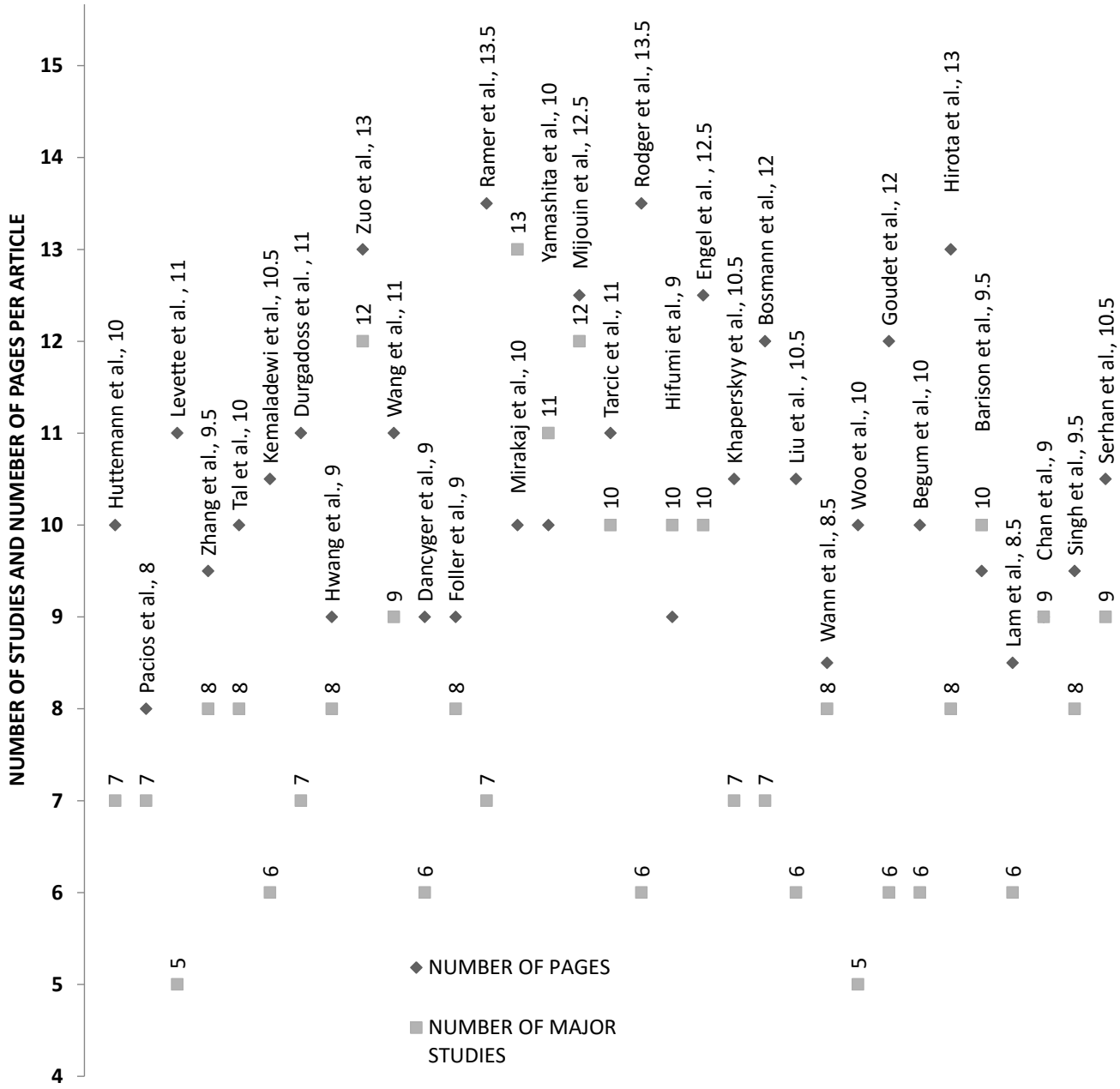


**Figure 1**
The research articles studied showing the number of major studies and printed pages per article In the April 2012 (Volume 26) issue of FASEB journal

**Table 1**
Data presentation by the 33 biomedical science research articles published in the FASEB Journal of April 2012

| | TABLES | DIAGRAMS | GRAPHS | HISTOGRAMS, OTHER CHARTS | PHOTO/PICTURE SERIES, VIDEO | BLOT SERIES | MACHINE PRINT OUTS | SEQUENCES, ARRAYS, MAPPINGS, MODELS | ACTUAL NUMBER OF FIGURES |
|---|---|---|---|---|---|---|---|---|---|
| Huttemann *et al.,* | 3 | | 1 | 7 | | 9 | | | 4 |
| Pacios *et al.,* | 1 | | | 18 | | | | | 7 |
| Levette *et al.,* | 4 | 1 | | 12 | 4 | | | | 5 |
| Zhang *et al.,* | | | 9 | 21 | | 22 | | | 8 |
| Tal *et al.,* | 1 | 4 | 1 | 22 | 2 | | | | 6 |
| Kemaladewi *et al.,* | 1 | 2 | | 21 | 4 | 10 | | | 7 |
| Durgadoss *et al.,* | | 4 | 3 | 36 | 5 | 36 | | | 10 |
| Hwang *et al.,* | | | 1 | 19 | 2 | 2 | | | 5 |
| Zuo *et al.,* | 1 | 2 | 7 | 24 | 2 | 19 | 3 | | 5 |
| Wang *et al.,* | | | | 25 | 4 | | | | 7 |
| Dancyger *et al.,* | 1 | 5 | 9 | | | 5 | | 1 | 5 |
| Foller *et al.,* | 1 | | | 15 | 10 | 11 | 4 | | 7 |
| Ramer *et al.,* | 2 | | 4 | 11 | 2 | 29 | | | 8 |
| Mirakaj *et al.,* | | 1 | | 34 | 6 | 4 | 4 | | 5 |
| Yamashita *et al.,* | 1 | | | 6 | 10 | | | | 8 |
| Mijouin *et al.,* | 2 | 1 | | 13 | 4 | 10 | | | 10 |
| Tarcic *et al.,* | | 3 | 4 | 5 | 4 | 4 | | 3 | 6 |
| Rodger *et al.,* | 2 | 3 | 3 | 16 | 1 | | 1 | 4 | 7 |
| Hifumi *et al.,* | 2 | | 8 | 1 | | 2 | | 12 | 6 |
| Engel *et al.,* | | 1 | | 28 | 10 | 4 | 21 | | 8 |
| Khaperskyy | | | 2 | 2 | 14 | 10 | | | 6 |
| Bosmann *et al.,* | | | 2 | 40 | 3 | | 16 | | 7 |
| Liu *et al.,* | | 1 | 1 | 2 | 26 | | | | 5 |
| Wann *et al.,* | | | 5 | 5 | 5 | 5 | | | 4 |
| Woo *et al.,* | | 1 | | 24 | 5 | 11 | | | 8 |
| Goudet *et al.,* | 1 | 7 | 15 | | | | 10 | 1 | 7 |
| Begum *et al.,* | | 6 | | 18 | | | | 2 | 6 |
| Hirota *et al.,* | 2 | | | 26 | 3 | 4 | 2 | | 8 |
| Barison *et al.,* | 2 | 1 | 1 | 1 | 1 | 3 | | 4 | 4 |
| Lam *et al.,* | | | 1 | 13 | | | | | 6 |
| Chan *et al.,* | | 2 | 3 | 8 | | 4 | 8 | | 7 |
| Singh *et al.,* | | | 9 | 3 | 14 | | | | 6 |
| Serhan *et al.,* | | 4 | 7 | 4 | 3 | | 16 | | 6 |
| TOTAL | 27 | 49 | 96 | 480 | 144 | 204 | 85 | 27 | 214 |

Figure 2 depicts the time taken by the FASEB Journal to review and accept the published articles. The time ranged from 33 to 235 days. The average number of days was 87.76±8.41, the mode was 90, and the median was 89.

Figure 3 shows the number of references utilized by each of the 33 published articles. The number of references ranged from 27 to 119; the mean was 49.76±2.74, the mode was 49, and the median was 49. The majority, 24/33 articles, used 40-60 references.

## DISCUSSION

As discussed in the Introduction, the number of universities in Nigeria has grown from 5 in 1962 to 147 in 2015 – a 2940 % increase; the population of Nigeria has grown from 45,150,000 in 1960 to 180, 226, 144 in 2015 – a 399.17% increase; and Nigeria is currently amongst the 14$^{th}$ biggest crude oil producers in the world. The abundance of universities in Nigeria (1 per 1.23m people) makes the country potentially rich in graduates that could contribute enormously to the development of the country and the betterment of the lives of its people.

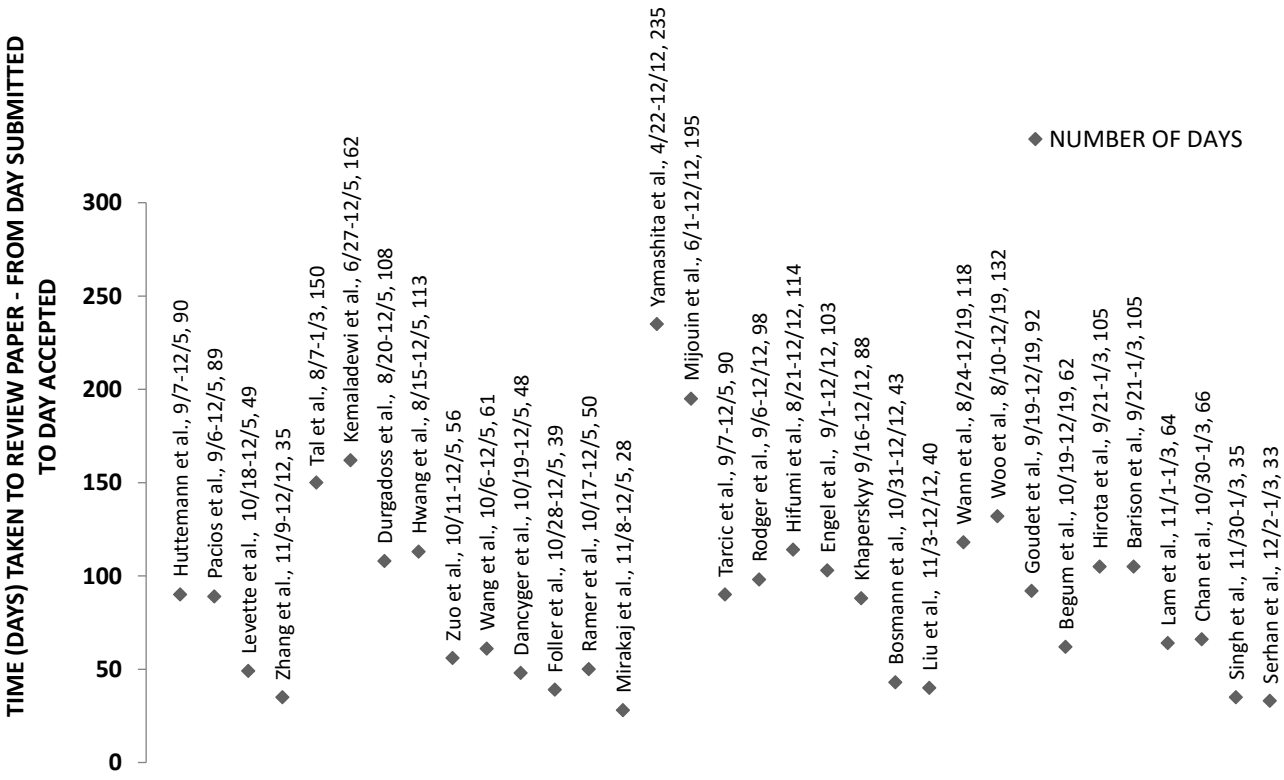


**Figure 2**
Time taken by the FASEB Journal to review and accept the 33 articles studied. The times given for each article show the date the article was submitted, the date the article was accepted for publication, and the total number of days for the review process before acceptance.

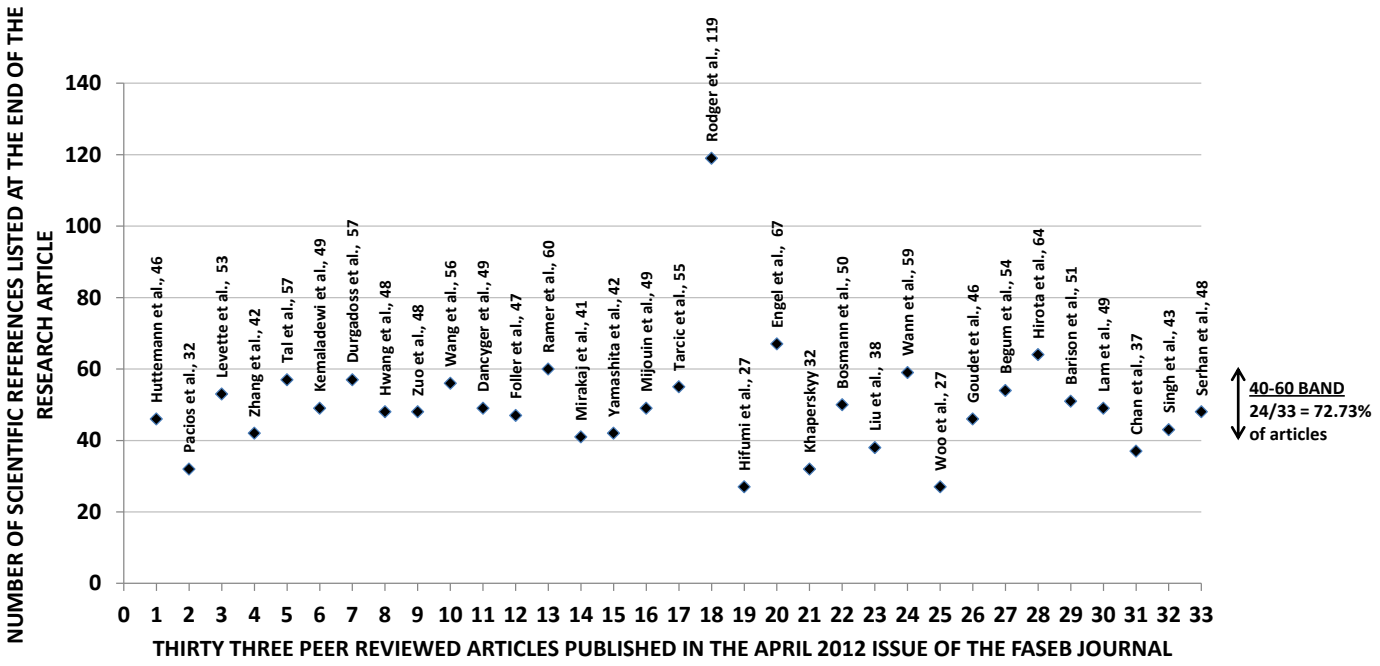


**Figure 3**
Extent of literature utilization by the 33 biomedical science research articles published in the FASEB Journal of April 2012

**Table 2.**
Numbers of specially mentioned persons in the Acknowledgement sections of published reports in the April 2012 issue of the FASEB Journal

| AUTHORS | SPECIALLY ACKNOWLEDGED PERSONS |
|---|---|
| Huttemann *et al.,* | 0 |
| Pacios *et al.,* | 2 |
| Levette *et al.,* | 4 |
| Zhang *et al.,* | 0 |
| Tal *et al.,* | 8 |
| Kemaladewi *et al.,* | 0 |
| Durgadoss *et al.,* | 2 |
| Hwang *et al.,* | 5 |
| Zuo *et al.,* | 0 |
| Wang *et al.,* | 0 |
| Dancyger *et al.,* | 0 |
| Foller *et al.,* | 5 |
| Ramer *et al.,* | 0 |
| Mirakaj *et al.,* | 3 |
| Yamashita *et al.,* | 2 |
| Mijouin *et al.,* | 1 |
| Tarcic *et al.,* | 0 |
| Rodger *et al.,* | 0 |
| Hifumi *et al.,* | 2 |
| Engel et al., | 1 |
| Khaperskyy | 7 |
| Bosmann *et al.,* | 3 |
| Liu *et al.,* | 2 |
| Wann et al., | 1 |
| Woo *et al.,* | 2 |
| Goudet *et al.,* | 7 |
| Begum *et al.,* | 2 |
| Hirota *et al.,* | 5 |
| Barison *et al.,* | 12 |
| Lam *et al.,* | 3 |
| Chan *et al.,* | 0 |
| Singh *et al.,* | 3 |
| Serhan *et al.,* | 4 |

Ezema (2010) records that Nigeria produces 148/351 or 42.2% of African Journals OnLine's listings, followed by South Africa's 67/351 or 19.1%, the rest of Africa contributing less. Of the 351 journals listed, 107 are in the field of medicine, while the rest are in other sciences and arts. Thus Nigerians are not unscholarly. Paradoxically, many of the high-tech, logistic, science-based tasks or needs of Nigeria are still necessarily entrusted to foreign experts. Very few Nigerians are portrayed as inventors, discoverers, innovators, or producers and on the contrary, Nigeria, like several other African countries is surprisingly a beggar nation in unwarranted respects and still suffering the burden of chronic poverty amongst its masses. These issues may be related to such factors as: the standards of Nigerian universities (John, 2009), facilities available in the universities (John, 2010; 2013a; 2014) and scientific skills within the university systems (John, 2012a). There is need for more intervention in the country's huge tertiary education system and to steer the process to obtain a better national outcome.

The Nigerian Government recently, in September 2011, announced a new Science, Technology, and Innovation (STI) policy which recognizes the various ways in which improvement of science and technology can benefit the country (Federal Ministry of Science and Technology, 2011). The knowledge and training imparted could be more profitable for the nation and the common good of humanity.

For graduates, knowledge and training should be profitably transformed into good performance, needed service, necessary innovation, transforming creativity, enriching productivity, sustainable progress, economic boom, and other positive impacts. Research is important for development of our environment and progress of human living. As emphasized in the Introduction, Africa is a continent that is rich in natural resources and to avoid continual poverty and misery amongst African peoples, there is need for Africans themselves to turn their natural wealth into communal benefits. As discussed above, in Nigeria, there are already ample universities and other tertiary institutions and evident scholarly activity. The ability of university graduates to effectively steer and pace nation building during the course of their future career partly depends on how they are mentored at the onset of their careers. In the field of biomedical science, Nigeria and most of Africa presently lack momentum in productivity and in the solving of Africa's health and economic challenges. Encouraging good quality research and ethical professionalism and thus the turning of research into wealth by local and global stakeholders is an important aspect of development.

The present study establishes a few standards in biomedical science research that can be referred to in

order to help to raise the bar for professional biomedical science research in Nigerian universities and institutions. Using the FASEB Journal as a guide, a standard biomedical science research publication takes an average of 10.5±1.52 printed pages in the journal. These include texts, illustrations, and references. Typically, authors subtitled major studies comprising the research article both in the Methods and in the Results sections. The average number of major studies per article was 8.03±0.36. These studies stood on their own to answer different questions posed by the investigators to prove the same hypothesis. They also used different methodologies, a continuum of methodologies, and different biological levels (molecular, cellular, tissue, systemic, and/or whole organism). This is thus the nature of best evidence in biomedical science research that Nigerian and African PhD students could aspire for.

This multivariate approach to biomedical science research requires multipurpose infrastructure, multidisciplinary technical support, multidisciplinary personal skills, and a diversity of funding and support. The creation and/or improvement of such an enabling environment would also be part of the responsibilities of biomedical science graduates.

To help to improve quality of research work amongst Nigerian PhD candidates, we can also look at the data presentation in the published articles studied (Table 1). The data presentation in part reflects the methodologies employed (John, 2013a) which are generally diverse in each paper. Data were presented as tables in 16/33 articles; diagrams in 18/33 articles; graphs in 21/33 articles; histograms (and other charts) in 31/33 articles; photos and pictures in 24/33 articles, blots (mainly western) in 20/33 articles; machine print-outs in 10/33 articles; and sequences, arrays, or mappings in 7/33 articles. Histograms and pictures were the most popular means of presentation. A total of 480 histograms were counted in all 33 articles. A total 144 series of pictures was counted in all 33 articles. As stated in the results these series often contained several pictures, e.g. Khaperskyy *et al*. had 36 confocal images in Figure 2, counted as one series. Overall data from pictures may outweigh that from histograms as many histograms were densitometry of numerous western blots, a total of 204 series of blots. PhD students need to learn to include data formats that help to tell a story with ease. While tables, diagrams, graphs, histograms, and machine print outs are used to depict processes and changes in function, it is also important to add pictures and blots of biological materials studied. In the published articles studied, we actually see in the Acknowledgements sections that some specially mentioned persons are included for various types of research supports (Table 2) from use of instruments, provisions of materials, to actual technical expertise provided (e.g. Pacios *et al*., Levette *et al.*, Tal *et al*., Durgadoss *et al*.). PhD candidates thus should learn the importance of networking and obtaining the support of established researchers with means to help them diversify their data acquisition and solidify their evidence as necessary.

It took 33-235 days to accept a paper for publication in the issue of the FASEB Journal studied. The average number of days was 87.76 (<1/3 of a year). Thus at least one research article could be published within a year if one spends 2/3rds of the year doing good research work. It has long been believed that in academia one must publish or perish (Alpert, 1985). Young academics may feel the pressure to rush to publish and therefore compromise integrity, quality, and valuable or useful contribution. One advantage of multidisciplinary approach to research is the greater collaboration it yields amongst workers. It is thus possible to be a co-author in several quality papers each year without the rush to submit self-serving publications. PhD candidates in Nigerian and other African universities could be encouraged along this line against the background of difficulties that already exist to steer them into publish-or-perish anxiety.

Every new research outcome positions itself within the field by relating to past and current inputs by other researchers. The authors need to show awareness of past key contributions, what is novel about their own contribution, how their own contribution adds to, improves, or disproves the existing contributions and how their own contribution constitutes an advancement in the field. The body of scientific references utilized in the papers is thus important. The present study establishes that 49.76±2.74 references are used per paper. The range is actually 27-119 with most papers (24/33) quoting 40-60 references (Figure 3). One of the reasons for tardy development in Africa is possibly failure to build upon or utilize established knowledge and available support or inertia in doing so. The PhD candidate needs to know that he or she becomes a link in the chain of development which may turn out to be a weak link or a strong link.

Africa has its own recognized capacities and challenges (Nwaka *et al.*, 2012; Langer *et al*., 2012). Improvement of research and direction of research are pertinent in the various aspects of African economies. Though African challenges are different from those of advanced countries (John, 2003; 2011; 2012b), we do have examples from the advanced countries. In 1999, technology transfer from universities to industry

contributed $38 billion to the (US) economy, creating over 300,000 jobs and forming hundreds of new companies (Hall and Scott, 2001). Recent 2014 reports from Canada show the top universities' research incomes - University of Toronto, $1.1 billion and the University of British Columbia, $0.57 billion (Research Infosource, 2014). Likewise the numbers from top British universities (2012/2013) are impressive: University of Oxford – £436,800,000.00; University College London £334,733,000.00 and the small specialist London School of Economics had £23,731,000.00 (http://en.wikipedia.org/wiki/Golden Triangle (UK_universities)). In Nigeria, inadequacy of means (infrastructure, funding, supplies, and technical knowhow) is often blamed as a sole reason for low quality and low productivity in biomedical science research. Inadequate means is indeed part of the problem (John, 2009; 2010; 2012a) when comparing with advanced countries (John 2013a; 2014), but obviously from statistics of scholarly activity mentioned above (Ezema, 2010), it is not the only problem. Since this study was first presented (John, 2013b), researchers have been having access to the new Tertiary Education Trust (TET) Fund with delight and the author opines that mentoring starting scientists can be an important factor in the long term outcomes. Already, before the advent of the TET Fund in 2011, some pioneering attempts and successes exist in Nigeria, an example being development of Niprisan by Nigeria's National Institute for Pharmaceutical Research and Development and Xechem, Nigeria and such attempts highlight some of the challenges that can be faced by present scientists in the future (Al-Bader *et al*., 2010).

This report therefore encourages the mentoring of PhD candidates towards raising their awareness of factors that predict their success as contributors to innovation, financial gains, and nation building. They should be encouraged to be problem-solvers by managing well existing resources through effective planning and pacing of their own research towards good quality and profitability, networking, collaboration, and sharing. They, in the near future, would become the transforming leadership Africa needs, through their services, products, and innovations. In conclusion, from the parameters studied in the April 2012 issue of the FASEB Journal (Volume 26(4): 1413-1763, we identify the following as factors to watch for improved research output:

a) Number of printed pages of the journal article – quantity of work
b) Number of major studies described in the article – quality of work
c) Number of figures and presentation of data within the figures – richness of evidence
d) Number of days the journal took to review the article before acceptance for publication – planning and pacing of work
e) Number of scientific references listed at the end of the article – relationship of work with universal knowledge and development

The author opines that these are bound to help Nigerian scientists do science that has better possibility of transforming the nation positively.

***ACKNOWLEDGEMENT***

*Thanks to the Federation of American Societies for Experimental Biology for the gift of the April 2012 edition of the FASEB Journal to the author at their booth during Experimental Biology, 2012, San Diego, California, USA.*

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