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PREVALENCE OF SCIENTIFIC MISCONDUCT AMONG A GROUP OF RESEARCHERS IN NIGERIA

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Keywords
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ABSTRACT

Background: *There is a dearth of information on the prevalence of scientific misconduct from Nigeria.*

Objectives: *This study aimed at determining the prevalence of scientific misconduct in a group of researchers in Nigeria. Factors associated with the prevalence were ascertained.*

Method: *A descriptive study of researchers who attended a scientific conference in 2010 was conducted using the adapted Scientific Misconduct Questionnaire-Revised (SMQ-R).*

Results: *Ninety-one researchers (68.9%) admitted having committed at least one of the eight listed forms of scientific misconduct. Disagreement about authorship was the most common form of misconduct committed (36.4%) while plagiarism was the least (9.2%). About 42% of researchers had committed falsification of data or plagiarism. Analysis of specific acts of misconduct showed that committing plagiarism was inversely associated with years in research (Fisher exact p-value = 0.02); falsifying data was related to perceived low effectiveness of the institution's rules and procedures for reducing scientific misconduct ($X^2 = 6.44$, p-value = 0.01); and succumbing to pressure from study sponsor to engage in unethical practice was related to sex of researcher (Fisher exact p-value = 0.02).*

Conclusions: *The emergent data from this study is a cause for serious concern and calls for prompt intervention. The best response to reducing scientific misconduct will proceed from measures that contain both elements of prevention and enforcement. Training on research ethics has to be integrated into the curriculum of undergraduate and postgraduate students while provision should be made for in-service training of researchers. Penalties against acts of scientific misconduct should be enforced at institutional and national levels.*

INTRODUCTION

Results from scientific research, besides offering solutions to problems facing humanity, bring honour, fame and international recognition to the scientist who produced the landmark breakthrough discovery or innovation. Career progression for academic scientists is often determined by the number and impact of reported research in scientific journals and presentations at international conferences.[1] Furthermore, data derived from controlled trials of novel drugs are used by pharmaceutical

[1] D. Geggie. A survey of newly appointed consultants' attitudes towards research fraud. *J Med Ethics* 2001; 27: 344–346; E.R. Pryor, B. Habermann & M.E. Broome. Scientific misconduct from the perspective of research coordinators: a national survey. *J Med Ethics* 2007; 33: 365–369.

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companies to back up their application for a marketing licence for their test drug. These critical and profound roles that research plays demand that research is conducted with great integrity and in conformity with codes of ethical scientific conduct.

Unfortunately, historical events of scientific misconduct indicate that the scientific community should be alert and vigilant in preventing, detecting and reprimanding scientific misconduct. Henry Beecher in his famous article, '*Ethics and clinical research*', published in the New England Journal of Medicine in 1966, raised alarm on the continued conduct of research that fell below acceptable ethical standards.[2] Cases of notable scientists engaging in acts of scientific misconduct have been documented.[3] A recent high profile case of scientific misconduct involved Dr Anil Potti, a physician and oncologist conducting oncogenomic research at Duke University.[4] He falsified data in his studies to support his 'personalized cancer treatment' approach to lung and breast cancer. Following the discovery of the falsification, all clinical trials based on his data were stopped and nine of his publications retracted.[5]

There has not been any properly documented high-profile cases of research misconduct in Nigeria. However, the ethical standard of the Trovan study has been severely criticised, many suggesting that the conduct of the research was unethical.[6] Pfizer had utilized the opportunity of an epidemic of meningitis in a poor village in northern Nigeria to conduct trials on the oral drug TROVAXACIN. It was alleged there was no proper ethical approval in Nigeria before the study was started, the informed consent process was considered inadequate and the benefits of the research to the participants were questionable.[7]

There is no single definition of Scientific or Research misconduct, however most recent definitions would include or restrict it to fabrication, falsification and plagiarism. The Office of Research Integrity (ORI) of the United States defines research misconduct as, 'fabrication, falsification or plagiarism in proposing, performing, or reviewing research, or in reporting research results.'[8] Older definitions of scientific misconduct had been more inclusive of wider forms of unethical behaviours, for example scientific misconduct was defined as 'the non-adherence to rules, regulations, guidelines, and commonly accepted professional codes or norms.'[9] The National Science Foundation of the United States of America had defined research misconduct as, 'fabrication, falsification, plagiarism and, other serious deviations from accepted practice.'[10] Other serious deviations from accepted practice would include acts such as intentional protocol violations, dropping outliers from a data set and falsification of a biosketch or resume. In developed countries, institutions have been established to ensure credible research conduct and to investigate cases of scientific misconduct.[11] However, in many developing countries very few cases of scientific misconduct have been reported. There is no evidence to suggest that all research conducted in developing countries meet ethical standards and that scientific misconduct does not exist. Rather, it is more likely that the prevalence of scientific misconduct amongst researchers have not been systematically investigated.

In Nigeria, the National Health Research Ethics Committee (NHREC) – in addition to other functions – sets norms and standards for conducting research on humans and animals including clinical trials.[12] However, unlike the Office of Research Integrity (ORI) in the United States, the NHREC has as yet no data on scientific misconduct in the country. A search of online scientific databases showed that there is no documented study on scientific misconduct in Nigeria.

[2] H. Beecher. Ethics and research. *N Engl J Med* 1966; 274: 1354–1360.
[3] J.M. Neal. Author misconduct–a continuing saga. *Reg Anesth Pain Med* 2004; 29(2): 90–91; C. Myung-hee. 2006. *Summary of the final report on Hwang's research allegations*. Available at: http://www.nytimes.com/2006/01/09/science/text-clonereport.html?pagewanted=all [Accessed 13 June 2012]; S. Lock. 1993. Research misconduct: a resume of recent events. In: *Fraud and Misconduct in Medical Research*. S. Lock & F. Wells, ed. London: BMJ Publishing group; 5–24; J. Erikson. More fraud found in earlier Bezwoda data. *Oncology times* 2001; 23(6): 38–40; J.M. Pearce, I.T. Manyonda & GVP C. Term delivery after intrauterine relocation of an ectopic pregancy. *Br J Obs Gynaecol* 1994; 101: 716–717.
[4] Deception at Duke, *60 minutes CBS*. 12 Feb 2012. Available at http://www.cbsnews.com/video/watch/?id=7398476n&tag=re1.galleries [Accessed 13 June 2012]. Misconduct in Science: An array of errors. *The Economist*. 10 Sept 2011. Available at http://www.economist.com/node/21528593 [Accessed 13 June 2012].
[5] Ninth Potti paper to date gets retracted. The chronicle, 7 Feb 2012. Available at http://www.dukechronicle.com/article/ninth-potti-paper-date-gets-retracted [Accessed 13 June 2012]. Retraction: C.R. Acharya, et al. Gene expression signatures, clinicopathological features, and individualized therapy in breast cancer JAMA. 2008; 299(130): 1574–1587. *JAMA* 2012; 307(5): 453.
[6] A. Nyika. The Trovan trial case study: after profits or to save lives. Available at www.amanet-trust.org/discuss/viewpoint.php?t=2. [Accessed 21 April 2012].
[7] Ibid.
[8] Office for Research Integrity. Definition of Research Misconduct. Available at http://ori.hhs.gov/definition-misconduct. [Accessed 13 June 2012].
[9] M.E. Broome et al. The Scientific Misconduct Questionnaire–Revised (SMQ-R): validation and psychometric testing. *Account Res* 2005; 12(4): 263–280.
[10] D.E. Buzzelli. The definition of misconduct in science: a view from NSF. *Science* 1993 Jan 29; 259(5095): 584–585, 647–648.
[11] M. Nylenna et al. Handling of scientific dishonesty in the Nordic countries. National Committees on Scientific Dishonesty in the Nordic Countries. *Lancet* 1999 3; 354: 57–61; J.E. Dahlberg & N.M. Davidian. Scientific Forensics: How the Office of Research Integrity can Assist Institutional Investigations of Research Misconduct During Oversight Review. *Sci Eng Ethics* 2010; 16(4): 713–735.
[12] Federal Ministry of Health (FMOH) 2007. The national code for health research ethics. Federal Ministry of Health. Abuja.

This report, which is part of a larger study, aimed at documenting the prevalence of self reported scientific misconduct among a group of researchers in Nigeria. Factors associated with specific acts of scientific misconduct were examined and behavioural influences on scientific misconduct determined.

METHODS

The study was an exploratory survey of a convenience sample of researchers who attended a scientific conference in 2010. A self-administered validated questionnaire was handed to all consenting researchers. The questionnaire was adapted from the Scientific Misconduct Questionnaire-Revised (SMQ-R)[13] by adding questions that elicited self-reporting of scientific misconduct. The operational definition of scientific misconduct in this study was as used in the standardised questionnaire: 'the non-adherence to rules, regulations, guidelines, and commonly accepted professional codes or norms'[14] and is thus much wider than the current ORI definition that only focuses on FFP.

A sample size of 100 was adequate for estimating proportions to an accuracy of within 10%. Allowing for a response rate of 90%, a final sample size of 110 researchers was required.

Completed questionnaires were entered into Epi Info version 3.4.3 statistical software. Initial descriptive analysis of individual items, using frequencies and proportions for all quantitative data, was performed. Further analysis was done to determine factors associated with self-reported prevalence of scientific misconduct. Likert scale responses relating to having committed scientific misconduct were transformed into dichotomous responses (never or ever). Likert response category 'never' remained as 'never committed scientific misconduct' while 'seldom', 'occasionally' and 'frequently' were transformed to 'ever committed scientific misconduct'. Fisher exact test and chi^2 test were performed for associations as appropriate. A two-tailed p-value of less than 0.05 was accepted as significant.

Ethical clearance for the study was obtained from the Ethics committees of the Faculty of Health Sciences, University of Pretoria, and the Delta State University Teaching Hospital, Oghara, Delta State, Nigeria. Permission to conduct the survey during the scientific conference was obtained from the conference organisers. Confidentiality was assured by not eliciting any personal or institutional identifying information and not requesting signed consent. Consent to participate in the study was implied by filling and returning the questionnaire. The self-administered completed questionnaires were dropped into a sealed box at the conference information/welcome area.

[13] M.E. Broome et al. The Scientific Misconduct Questionnaire–Revised (SMQ-R): validation and psychometric testing. *Account Res.* 2005; 12(4): 263–280.

[14] Ibid.

RESULTS

One hundred and thirty-three (133) questionnaires were returned out of a total number of 150 distributed, giving a response rate of 88.7%. There were no spoilt questionnaires. There were 116 (87.2%) male researchers and 17 (12.8%) female researchers. The majority of researchers (62.4%) worked primarily in academic institutions, while 25.6% worked in public hospitals, 7.3% in private hospitals, 1.5% in the ministry and 0.8% in a research centre. About 2.3% of the researchers worked in other sectors. The majority of researchers worked both as academics and clinicians. One hundred and twenty-one researchers (91.0%) were currently involved in research while 12 (9%) were not. The median duration of involvement in research was 8 years with an interquartile range of 4–13.5 years. Ninety-two (69.7%) researchers have been involved in research for ten years or less, while 40 (30.3%) had spent more than ten years in research. The median number of publications per researcher was six with an interquartile range of 2–26. Eighty-four (64.1%) of them had ten or fewer publications while 47 (35.9%) had more than ten publications. The majority of the researchers (77.5%) had attended a lecture, workshop or conference on ethics, but 22.5% had never attended any similar events.

Personal involvement in scientific misconduct

Ninety-one researchers (68.9%) admitted to having committed at least one of the eight listed forms of scientific misconduct, while 41 (31.1%) stated that they had never done so. Three out of the eight categories of listed acts of misconduct (falsification of data, falsification of biosketch, resume and plagiarism) fit into the ORI definition of research misconduct, and 56 researchers (42.2%) admitted to have committed them. Disagreement about authorship was the most common form of misconduct committed (36.4%) while plagiarism was the least (9.2%). Among those who admitted to having committed scientific misconduct, most described the frequency of its occurrence as 'seldom'. Only one researcher admitted that the occurrence of plagiarism was 'frequent'. Similarly, only one researcher admitted that the occurrence of selective dropping of data from outlier cases and pressure from study sponsors to engage in unethical practices was 'frequent' (Table 1).

Table 1. Researchers' involvement in committing scientific misconduct

	Never	Seldom	Occasionally	Frequently	Number of responses	Number of non-responses
Plagiarism	118 (90.8%)	3 (2.2%)	8 (6.2%)	1 (0.8%)	130	3
Falsifying data	95 (72.5%)	28 (21.4%)	8 (6.1%)	0 (0.0%)	131	2
Intentional protocol violations related to subject enrolment	99 (76.2%)	24 (18.4%)	7 (5.4%)	0 (0.0%)	130	3
Intentional protocol violations related to procedures	101 (77.1%)	25 (19.1%)	5 (3.8%)	0 (0.0%)	131	2
Selective dropping of data from 'outlier' cases	87 (70.2%)	31 (25.0%)	5 (4.0%)	1 (0.8%)	124	9
Falsification of biosketch, resume, reference list	113 (88.3%)	11 (8.6%)	4 (3.1%)	0 (0.0%)	128	5
Disagreements about authorship	82 (63.6)	33 (25.5%)	14 (10.9%)	0 (0.0%)	129	4
Pressure from study sponsor (e.g. pharmaceutical company or device company) to engage in unethical practices	104 (80.6%)	13 (10.1%)	11 (8.5%)	1 (0.8%)	129	4

Table 2. Association between having ever committed scientific misconduct and various parameters

	Sex		Perceived effectiveness of institution's rules and procedures for reducing scientific misconduct		Education in ethics		Years in research		Number of publications	
	F	M	Effective	Ineffective	Yes	No	1–10 yrs	>10 yrs	1–10	>10
Has ever committed scientific misconduct N = 91 (68.9%)	14	77	38	52	71	18	65	25	56	34
Never committed scientific misconduct N = 41 (31.1%)	3	38	15	26	28	11	28	15	27	13
Test of statistical significance	Fisher exact p-value = 0.20 NS*		X^2 ** = 0.37 p = 0.54 NS		X^2 = 0.99 p = 0.32 NS		X^2 = 1.03 p = 0.31 NS		X^2 = 0.33 p = 0.56 NS	

* NS = not statistically significant.
** X^2 = chi square.

Analysis of associated factors showed that there was no statistically significant difference between those who had 'ever' committed scientific misconduct and those who had 'never' committed scientific misconduct in terms of sex, work environment, education in ethics, years of involvement in research and number of publications (Table 2).

However, further analysis of association done with the specific acts of scientific misconduct showed that committing plagiarism was inversely associated with years in research (Fisher exact p-value = 0.02); falsifying data was related to perceived low effectiveness of the institution's rules and procedures for reducing scientific misconduct (X^2 = 6.44, p-value = 0.01); and succumbing to pressure from study sponsor to engage in unethical practice was related to sex of researcher (Fisher exact p-value = 0.02). The association between disagreement about authorship and number of publications approached the level of significance with a p-value of 0.05 (Table 3).

There was no significant association between other acts of scientific misconduct (intentional protocol violations related to subject enrolment; intentional protocol violations related to procedures; selective dropping of 'outlier' cases; and, falsification of biosketch, resume, reference list) and any of the independent variables.

Behavioural influences on scientific misconduct

Table 4 shows the thoughts of the researchers about the varying contributions of certain behavioural influences on scientific misconduct. More than fifty percent of researchers thought that pressure for external funding, need for recognition, need for publications and insufficient censure of misconduct had a 'strong influence' on scientific misconduct. Pressure for tenure, unclear definition of what constitutes misconduct, financial conflicts of interest and the level of involvement of the principal investigator in enrolment of subjects were considered by

Table 3. Association between having ever committed specific acts of scientific misconduct and various parameters

	Sex	*Perceived effectiveness of institution's rules and procedures for reducing scientific misconduct*	*Education in ethics*	*Years in research*	*Number of publications*
Plagiarism	Fisher exact p-value = 0.49 NS	Fisher exact p-value = 0.08 NS	Fisher exact p-value = 0.08 NS	Fisher exact p-value = 0.02 **SIGNIFICANT**	Fisher exact p-value = 0.40 NS
Falsifying data	Fisher exact p-value = 0.47 NS	$X^2 = 6.44$ p-value = 0.01 **SIGNIFICANT**	$X^2 = 0.22$ p-value = 0.64 NS	$X^2 = 2.59$ p-value = 0.11 NS	$X^2 = 1.04$ p-value = 0.31 NS
Intentional protocol violations related to subject enrolment	Fisher exact p-value = 0.38 NS	$X^2 = 2.95$ p-value = 0.09 NS	$X^2 = 0.45$ p-value = 0.50 NS	$X^2 = 1.90$ p-value = 0.17 NS	$X^2 = 0.19$ p-value = 0.66 NS
Intentional protocol violations related to procedures	Fisher exact p-value = 0.20 NS	$X^2 = 0.69$ p-value = 0.41 NS	$X^2 = 1.40$ p-value = 0.23 NS	$X^2 = 0.18$ p-value = 0.67 NS	$X^2 = 0.02$ p-value = 0.88 NS
Selective dropping of data from 'outlier' cases	$X^2 = 0.10$ p-value = 0.75 NS	$X^2 = 1.47$ p-value = 0.23 NS	$X^2 = 2.13$ p-value = 0.14 NS	$X^2 = 1.48$ p-value = 0.22 NS	$X^2 = 0.50$ p-value = 0.48 NS
Falsification of biosketch, resume, reference list	Fisher exact p-value = 0.57 NS	Fisher exact p-value = 0.29 NS	Fisher exact p-value = 0.17 NS	Fisher exact p-value = 0.53 NS	Fisher exact p-value = 0.17 NS
Disagreements about authorship	$X^2 = 0.19$ p-value = 0.66 NS	$X^2 = 0.00$ p-value = 0.99 NS	$X^2 = 2.81$ p-value = 0.09 NS	$X^2 = 1.80$ p-value = 0.18 NS	$X^2 = 3.83$ p-value = 0.05 NS
Pressure from study sponsor (e.g. pharmaceutical company or device company) to engage in unethical practices	Fisher exact p-value = 0.02 **SIGNIFICANT**	$X^2 = 0.02$ p-value = 0.90 NS	$X^2 = 1.89$ p-value = 0.17 NS	$X^2 = 0.02$ p-value = 0.88 NS	$X^2 = 0.03$ p-value = 0.86 NS

Table 4. Researchers' views of behavioural influences on scientific misconduct

	No influence	*Some influence*	*Strong influence*	**Total no of resp.[N]*	*+Non resp*
Pressure for tenure	14 (10.9%)	79 (61.8%)	35 (27.3%)	128	5
Pressure for external funding	3 (2.3%)	62 (47.7%)	65 (50%)	130	3
Need for recognition	4 (3.1%)	49 (38.0%)	76 (58.9%)	129	4
Need for publications	0 (0%)	35 (26.9%)	95 (73.1%)	130	3
Unclear definition of what constitutes misconduct	14 (10.8%)	87 (66.9%)	29 (22.3%)	130	3
Insufficient censure for misconduct	3 (2.4%)	57 (44.9%)	67 (52.7%)	127	6
Financial conflict of interest	9 (7.0%)	72 (56.3%)	47 (36.7%)	128	5
Insufficient involvement of Principal Investigator in enrolment of subjects	14 (10.8%)	89 (69.0%)	26 (20.2%)	129	4
Strong involvement of Principal Investigator in subjects	35 (27.6%)	69 (54.3%)	23 (18.1%)	127	6
Low interest of Principal Investigator in study, enrolment and outcomes	21 (16.3%)	79 (61.2%)	29 (22.5%)	129	4
High interest of Principal Investigator in study, enrolment and outcomes	31 (24.2%)	73 (57.0%)	24 (18.8%)	128	5
Number of research protocols Principal Investigator is responsible for	18 (14.2%)	76 (59.8%)	33 (26.0%)	127	6
A belief that the level of risk to subjects is quite low in a given study protocol	20 (15.7%)	79 (62.3%)	28 (22.0%)	127	6

the majority to have 'some influence' as were the level of interest of the principal investigator in study enrolment and outcomes, number of research protocols principal investigator is responsible for, and a belief that the level of risk to subjects is quite low in a given study protocol.

DISCUSSION

To the best of our knowledge, this is the first study that has looked at the prevalence and perception of scientific misconduct amongst any group of researchers in Nigeria and probably in Africa.

This study showed a high prevalence of self-reported involvement in various aspects of scientific misconduct. On the whole, about 69% of researchers admitted to at least one of the eight listed forms of scientific misconduct. Using the ORI narrower definition of misconduct still gives a high prevalence of 42%. This figure is much higher than the 5.7% reported by Geggie in a study of newly appointed consultants in the United Kingdom.[15] Our figure is also considerably higher than the 33.7% recorded by Fanelli in a systematic review of publications on scientific misconduct mainly from the United States and United Kingdom.[16]

The most common type of misconduct committed by researchers in this study was disagreement about authorship (36.4%). Misconduct relating to authorship ranges from omissions of names of contributors, inappropriate listing order of authors and gift authorship. Our study, however, did not ask for the specific form of disagreement about authorship and this could be an interesting area of future research. The International Committee of Medical Journal Editors (ICMJE) issued guidelines for authorship of published studies.[17] They propose three criteria for authorship – 1) substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; 2) drafting the article or revising it critically for important intellectual content; and 3) final approval of the version to be published. Authors are expected to meet all three criteria to qualify for authorship. Many biomedical journals now require authors to state their individual contribution to a submitted manuscript. If rigorously implemented, this measure will go a long way in minimising misconduct relating to authorship.

[15] Geggie, *op. cit*. note 1.

[16] D. Fanelli. How many scientists fabricate and falsify research? A systematic review and meta-analysis of survey data. *PLoS One* 2009; 4(5): e5738.

[17] ICMJE. 2010 *Uniform requirements for manuscripts submitted to biomedical journals: ethical consideration in the conduct and reporting of research – authorship and contributorship*. Available at: http://www.icmje.org/ethical_1author.html [Accessed 13 June 2012].

Plagiarism was the least common form of scientific misconduct reported in our study, with only 9.2% of researchers admitting to ever having plagiarised. It is however doubtful that plagiarism is truly such an infrequent event; rather, it is probable that there is poor awareness of what constitutes plagiarism. Despite this suspicion of under-reporting of plagiarism, our figure of 9.2% ranks higher than the 2% reported by Martison in his survey of 3247 scientist in the US.[18] Researchers should develop a conscious effort to avoid plagiarism. Although plagiarism does not distort scientific knowledge to a large extent compared to fabrication and falsification as it does not entail the changing of any data, but rather the wrongful appropriation of another's work, it none-the-less has severe implications for the career of the researcher and the academic institution.

A worrisome finding of our study is that over one-quarter of researchers admitted to having falsified data. Again, this is a very high proportion compared to 1.97% recorded by Fanelli in a systematic review and metanalysis.[19] It is also very high compared to a recorded four out of 189 (2.1%) newly employed consultants in the UK.[20] While it will be interesting to probe into the nature of the falsification of data, suffice it to say that falsification of data in whichever form deviates from the truth of the study and is a serious form of scientific misconduct. Many documented notable cases of scientific misconduct had involved falsification of data or outright fabrication of data.[21] Bezwoda, a cancer researcher in South Africa, was found to have fabricated data concerning his research.[22]

What could possibly be the factors responsible for this high prevalence of self-reported scientific misconduct? Although we did not find any association between having 'ever' committed scientific misconduct and the sex of researchers, work environment, education in ethics, years of research, and number of publications, none-the-less specific acts of scientific misconduct were associated with certain factors. There was an inverse association between committing plagiarism and years in research. This is quite understandable since one can assume that several acts of plagiarism were committed out of ignorance about what constitutes plagiarism. Therefore, the more experienced and informed the researcher is, the less likely he or she is to express someone's idea without giving due credit. This underscores the value of training on credible research conduct and scientific writing.

[18] B.C. Martinson et al. Scientists behaving badly. *Nature* 2005; 435: 737–738.

[19] Fanelli, *op. cit*. note 16.

[20] Geggie, *op. cit*. note 1.

[21] Neal, *op. cit*. note 3; Myung-hee *op. cit*. note 3.

[22] Erikson, *op. cit.* note 3.

Falsification of data was related to low effectiveness of an institution's rules and procedures for reducing scientific misconduct. Outright falsification of data becomes difficult if an institution has an effective method for reducing scientific misconduct. Processes such as ethical and scientific review and approval of research protocols, effective monitoring of the research process by the ethics committee, departmental presentations of research work, clear policy on storage of research materials, and policies on punishment for scientific misconduct are some ways through which institutions could reduce misconduct. Falsification of data should become detectable under these circumstances and researchers might be more likely to desist from it.

Further insight into factors that influence scientific misconduct was gained from the researchers' responses about behavioural influences on scientific misconduct. Over 73% of researchers believed that the need for publications was a strong influence on scientific misconduct. This view was echoed by research coordinators in the US.[23] The phrase '*publish or perish*' is well-known in academic circles and characterises the enormous pressure that is placed on researchers to produce results.[24] Tenure-track and promotions are invariably linked to the number of publications. Many commentators have suggested that a researcher should be asked to submit only his best publications for assessment, thereby placing the emphasis on quality, rather than on quantity.[25] This might also reduce the tendency to create multiple publications through fragmentation of data – *salami slicing*.[26] In medicine, where most academics are also involved in teaching and clinical duties, perhaps more weight should be placed on these activities in the consideration for career progression.

This study had some limitations. Firstly, it was a non-probability sample of researchers. Consequently, the extent to which the findings can be generalised to other researchers in Nigeria may be disputed. Secondly, the sample size for this study was calculated primarily based on the need to generate a set of descriptive data, the sample size for the inferential analysis of subgroups for associations may have been insufficient to identify true associations in some cases. Subsequent studies focusing on these areas would need to use a larger sample size. Female researchers were not equally represented in this sample and any association with misconduct and gender might therefore be spurious. Thirdly, these data on the prevalence of scientific misconduct depended on self-report. While every conceivable measure was put in place to encourage openness and truthfulness of response, it is doubtful that the reported prevalence reflects the true prevalence. It is possible that the true prevalence may still be higher than reported. Similar studies that were based on self-reporting of scientific misconduct have acknowledged this limitation.[27] Underreporting is a very real issue for sensitive and socially undesirable actions. Finally, having used a quantitative method, certain aspects of the study findings could not be explored deeply. There is a need to design qualitative studies that could explore in an in-depth fashion some of our findings. Studies using qualitative methods can yield a rich amount of information that can augment and validate our findings.[28]

Recommendations

Tackling scientific misconduct in Nigeria will require a multi-faceted approach involving many stakeholders. Interventions should be targeted at the environmental/institutional level, the national or regional regulatory level and the individual/personal levels. Arising from this study and the review of literature on scientific misconduct, the following recommendations are made:

Environmental/institutional level

1. Increased awareness of scientific misconduct in Nigeria should be created through the conduct of research into such areas and the dissemination of these findings. Similar studies, that might validate or dispute these findings in other groups of researchers, would expand the circle of participants in the discussions. Discussions on misconduct should be facilitated using every available forum like conferences, symposia and lectures.
2. Research ethics and credible conduct of research should be incorporated into the curriculum of both undergraduate and postgraduate education.

[23] Pryor, *op. cit*. note 1.

[24] S.W. Fletcher & R.H. Fletcher. Publish wisely or perish: quality rather than quantity in medical writing. *Ann Acad Med Singapore* 1994; 23: 799–800; T. Jefferson. Redundant publication in biomedical sciences: scientific misconduct or necessity? *Sci Eng Ethics* 1998; 4(2): 135–140.

[25] M. Holaday & T.E. Yost. A preliminary investigation of ethical problems in publication and research. *J Soc Behav Pers* 1995; 10: 281–291.

[26] S.M. Mojon-Azzi & D.S. Mojon. Scientific misconduct: from salami slicing to data fabrication. *Ophthalmologica* 2004; 218: 1–3; P.A. Lawrence. The politics of publication. *Nature* 2003; 422: 259–261.

[27] Martinson, *op. cit.* note 18; W. Gardner, C.W. Lidz & K.C. Hartwig. Authors' reports about research integrity problems in clinical trials. *Contemp Clin Trials* 2005; 26: 244–251.

[28] De Vries, M.S. Anderson, B.C. Martinson. Normal misbehaviour: Scientists talk about the ethics of research. *J Empir Res Hum Res Ethics* 2006; 1: 43–50; N.S. Wenger et al. The ethics of scientific research: an analysis of focus groups of scientists and institutional representatives. *J Investig Med* 1997; 45: 371–380.

3. Regular in-service training of researchers on credible conduct of research should be implemented by institutions. Training could be on-site or on-line and made mandatory for researchers.
4. Institutions should develop what is referred to as an 'internal control model' that should promote research integrity.[29] The internal control model is typically used in finance and business to construct systems that reduce risk for low occurrence but high impact breaches in financial integrity within companies. This model consists of the internal control environment, risk assessment, internal control activities, monitoring, information and communication. The application of this model to the research environment will assist in refocusing attention away from the behaviour of the individual researcher to the examination of organisational control processes within the research environment. Incorporated into this model are a series of activities which could be tailored to the unique circumstances of the institutions. Such activities may include adoption of a mission and value statements, research protocol review and auditing, adequate communication of policies regarding publications and authorship, and processes for recognising and addressing potential conflicts of interest.[30]
5. Institutions should have well articulated and documented guidelines for investigating and dealing with alleged cases of scientific misconduct. This system should be transparent, fair and consistently applied. The results of such investigations should be made known to the scientific community.
6. There should be adequate protection for whistle blowers. This will encourage the reporting of suspected cases of misconduct without any inherent fear of a backlash to the whistle blower.
7. Editors of biomedical journals in Nigeria should adhere strictly to the laid down ethics for publishing, including requesting authors to state the individual contributions of each author and ethical approval for the study.
8. Editors or academic institutions should also strive to acquire software that could detect plagiarism in submitted manuscripts. Where this is not feasible to acquire due to cost restraints, a collaborative agreement could be reached with publishing companies in developed countries for assistance in this regard.
9. Institutions should empower local ethics committees with adequate human and capital resources to enable them to adequately monitor research conducted within their institutions. Ethics committees, when adequately resourced, might also serve as ethics training fora where researchers might observe their proceedings and deliberations.

National or regional regulatory level

10. The Federal Government of Nigeria should very strongly consider establishing a body similar to the US Office for Research Integrity (ORI) to draw up national guidelines on research integrity and scientific misconduct and also investigate cases of misconduct. Alternatively, the functions of the National Health Research Ethics Committee (NHREC) should be expanded to assume this role.

Personal/individual level

11. Finally, there is a role for the teaching of virtue ethics to every researcher. Notwithstanding the external factors that are said to promote scientific misconduct, there is a lot of truth in Aristotle's saying:

> *"In cases of this sort, let us say adultery, rightness and wrongness do not depend on committing it with the right woman at the right time and in the right manner, but the mere fact of committing such action at all is to do wrong."*
> (Nicomachean Ethics II.1107a15)[31]

CONCLUSION

The emergent data from this study is a cause for serious concern and calls for prompt intervention. The best response to reducing scientific misconduct will proceed from measures that contain both elements of prevention and enforcement. Several well-articulated interventions have to be made and this would involve creating a conducive institutional environment that will foster credible research conduct and at the same time discourage scientific misconduct. Training on research ethics has to be integrated into the curriculum of undergraduate and postgraduate students while provision should be made for in-service training of researchers. There are lessons to be learnt from countries like the United States that have developed institutions and processes that foster credible conduct of research.

[29] B.R. Jeffers & R. Whittemore. Research environments that promote integrity. *Nurs Res* 2005 Jan–Feb; 54(1): 63–70.
[30] Ibid.

[31] J. Barnes. *The complete works of Aristotle: The revised oxford translation*. Princeton, NJ: Princeton University Press; 1984.

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Biography

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