# Determination of a Standard Continuous-Text Print Size for People with Low Vision

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## Abstract

The purpose of this study was to establish a standard print size that enables low vision persons access print materials and improve reading performance. Case control study design was used for this study. Data was collected from 200 participants with normal vision (control group) and 200 with low vision (study group) who attended ECWA eye Hospital Kano. Normal continuous-text print size (N10/J5/0.75M) was presented at 30-40cm to 200 emmetropes/corrected ametropes (control group). The reading-aloud-speed (RAS) was taken and recorded in words per minute (wpm). The mean reading- aloud-speed (MRS) for this group was recorded as MRS1. Continuous-text prints of sizes N10/0.75M, N18/2M, N24/2.5M, N36/4M and N48/5M were presented at acceptable working distance to 200 literate low vision patients corrected and/or enhanced to N5/J1/0.37M (single letters). The RAS for each of these text sizes (RAS1-5) were recorded in wpm, and the mean values were calculated respectively. Result shows that the average RAS (99.47 wpm) for the control group, when compared with the study group, matched with the MRS3(100.93wpm) for print size N18/2M of the control group. Although statistical analysis showed a significant difference in the reading speed between the two groups ($F= 31.67$; $P<0.05$), Post Hoc analysis showed that the mean reading aloud speed (100.93 wpm) used to read N18/2M print size for the study group showed no significant difference with the (99.47 wpm) used to read print size N10/J5/0.75M for the control group ($p>0.05$). The N18/2M print size is therefore recommended as a standard print for best reading performance among low vision patients.

**Keywords: Standard-print-size. Large prints. Non-optical aids**

## Introduction

There are no available studies on the profile of reading speed among Africans neither is there a standard print size recommended for people with low vision. About 150wpm has been reported as the median reading speed and critical print size of 0.84 Log Mar among albinos[1]. There is need for reading speed studies among Africans. Moreover, print size that cut across various causes of low vision is necessary for recommendation for the Low vision group. Reading is a behavioral and learned process. With training and instructions on the use of vision and low vision aids, reading speed and reading performance could improve. While training would improve reading performance, it may not improve reading acuity. A study showed that improvement in reading speed among patients with age-related macular

1. Kinberly Merrill, Katherine Hogue, Sara Downes, Ann M. Holleshau, Beth R. Kuzbach, John T. Macdonald C. Gail Summers. Reading Acuity in Albinism: Evaluation with, MN READ Charts. Journal of American Ass. Of Pedriatric Oph and Strabismus. 2011;15 (1); 29-32

degeneration, does not translate to acuity and critical print size measurement[2]. This means that trained readers could not improve on acuity size but only on speed reading.

Low vision refers to an eye condition where individuals have reduced ability to carry out important life activities including obtaining education, living and traveling independently due to visual impairment that cannot be corrected with medical treatment ordinary glasses or contact lenses[3]. The World Health Organisation working definition of low vision states that "A person with Low vision is one who has impairment of visual functioning even after treatment and/or standard refractive correction and has visual acuity of between less than 6/18-PL or visual field of less than 100 from the point of central fixation but who uses or potentially able to use, vision for the planning or execution of a task"[4]. There are an estimated 285 million people globally with visual impairment, 80 million of them have permanent visual impairment and can benefit from low vision services, 80% live in developing countries[5,6]. Treatment for low vision include application of Low vision devices. Research show that a high number of low vision patients can cope with their schooling and employment if given appropriate instructions on the use of their low vision devices such as magnifiers and that near task is the reason most magnifiers are prescribed[7]. The material to be read must be kept at the focus of the magnifier hence depending on the level of vision and magnifier power, materials may be kept too close to the face. This may compromise some near tasks such as reading, writing and drawing.

Large prints are non-optical devices that enhance reading[7]. With large prints, the use of a magnifier may not be necessary or when indicated, the dioptric power could reduce and working distance improved. Large prints have the disadvantage of occupying large spaces and only few words may be read at a time. Thus, very large prints could occupy paper space and reduce reading performance. Furthermore, the cost of producing very large print books could be high. In other to perform well in school and examinations, children with low vision who read in prints will need print sizes larger than normal due to their level of vision. This was supported by the report that children with Low vision need print size larger than threshold to achieve maximum reading rate.[8]

This study provides answer to the question: what is the appropriate print size, large enough, to accommodate the advantages of large prints and small enough to alleviate the problems of very large prints. This is the critical print size which should be the standard print size for people with low vision. This standard print size recommended for large print editions of newspapers, examination question papers, and other print materials in relevant organizations. This would provide access to education and employment for many people with low vision.

## Methods

This study examined the reading -aloud- speed of 200 participants with normal vision and 200 low vision patients. Normal vision is defined as presenting or corrected, binocular or monocular distance acuity of 6/18 (Snellen) or better[10]. Low vision is defined as corrected, monocular or binocular distance acuity of less than 6/18(Snellen) or Visual field of less than 10º from the point of central fixation. The WHO working definition for Low Vision was adopted[4].

2. World Health Organization (1996). Low vision care for the Elderly. Paper presented at the Workshop of WHO/PBL/96,57
3. OSLO Workshop. Towards a reduction in the Global impact of Low Vision. The International Society for Low -vision Research and Rehabilitation. 2005: 1
4. Susana, T. L. Chung. Improving reading speed for people with central vision loss through Perceptual learning: Investigative Ophthalmology and Visual Science. 2011; 52 (2);116-117
5. World Health Organization. Magnitude and causes of visual impairment. Available at http://www.who.int/mediacentre/factsheets/fs282/en/index.html. Accessed June 2018
6. International agency for the prevention of blindness. Low vision. http://www.iapb.org. Accessed June, 2018
7. Barbie. O.M.E. Characteristics of the Nigerian Low vision population. Journal of the Nigerian Optometric Association. 2004; 11 (1): 6-10
8. Jan. E. Lovie-Kitchen, Jennifer D. Bevanm, Bronwyn Hein B. Reading performance in Children with Low Vision. Clinical and Experimental Optometry. 2001; 84 ( 3):148-154
9. Visual Standards: Aspects and ranges of Visual Loss. Report of the International Council of Ophthalmology, Sydney, Australia. 2002. 7.
10. Keziah Lathan and CharlotteA. Hazel. Reading performance in normal foveal and peripheral vision. Vision Rehabiliation: Assessment, interaction and outcome/edited by Cynthia Stuen et al. Selected papers from vision 99, International Conference on Low Vison.

## Inclusion Criteria

The cases/study group were males and females of age 6 years and above who were able to read and write (literate) in English language. They were low vision patients with distance acuity of <6/18 or visual field < 10º from the point of central fixation in the better eye, whose vision could be enhanced to N5/J1/0.37M single letters with magnifiers. The control group had similar characteristics as the study group except that they were not low vision patients. They were emmetropes/ corrected ametropes.

## Exclusion Criteria

All participants below 6 years and not literate in English Language were excluded. The age criteria was set at 6 years because assessment for magnifying aids for patients below age 6 years can be very challenging.

## Materials

The materials used for this study include: Distance and Near acuity charts (Single letters and continuous text), Retinoscope, Direct Ophthalmoscope, Standard refraction Kit (with trial lenses and frame included), Standard Low vision Kit (with trial telescopes and magnifiers included), the Collenbradder central field chart, Controlled Lights and stop clock. All assessment was carried out by Optometrists who are Low Vision Consultants.

## Procedure

Routine refraction, when indicated was carried out on normal participants. Visual acuity, refraction and visual field tests were carried out on the study group before low vision was defined. Central visual field of low vision patients was determined using the Collenbradder Visual field chart thus, with the patient comfortably seated and wearing basic prescription, one eye was occluded. The chart was held at the 50cm away from the patient under room illumination. The patient was asked to fixate the central black spot on the chart. With steady fixation established, a bright point stimulus was presented from non-seeing to seeing from 8 diagnostic positions (90, 45, 360, 315, 270, 225, 180 and 130 degrees). A visual field plot was obtained and central visual field recorded for the best eye. The test was repeated for the other eye where applicable. Low vision assessment was carried out by a Low vision consultant. Low vision refraction was carried out on the selected low vision subjects.

Near magnification assessment was carried out thus: If a corrected low vision patient was able to read the 4M(N36) line at a distance of 25cm, for this patient to read the 0.75M, the Equivalent Viewing Distance(EVD) will be 5.33cm (4/0.75), approximately 5cm. A suitable magnifier with this EVD was selected. Near magnifier was prescribed to enable the low vision patients to read N5/J1/0.37M single letters and magnification reserve was considered to read continuous-text prints as small as 0.37M

Reading speed scores were obtained as follows: Normal prints (N10/J5/0.75M) was presented under room illumination at 25-40cm (Least distance of distinct vision) to 200 emmetropes/corrected ametropes (control group). The reading – aloud – speed (RAS) were taken and recorded in words per minutes (wpm). The set of reading aloud speed scores for all 200 normal subjects were recorded as RASn (Normal). The mean reading speed (MRS) for this group was recorded as MRS1. Continuous-text prints of sizes N10/0.75M, N18/2M, N24/2.5M, N36/4M and N48/5M were presented (under room illumination) at acceptable working distance to 200 literate low vision patients. Acceptable working distance was adopted because many Low vision patients accept higher magnification (accommodation reserve) to read the desired print size. This would result in an equivalent viewing distance shorter than the least distance of distinct vision.

The set of RAS scores for all 200 low vision participants for each of N10/0.75M, N18/2M, N24/2.5M, N36//4-Mand N48/5M text sizes were recorded in wpm as RAS1-5 i.e. RAS1, RAS 2, RAS3, RAS 4 and RAS 5 respectively. RAS was obtained using the stop clock. For example, in order to get the RAS for N10/0.75M, the subject was asked to read the N10/0.75M line aloud and the clock started simultaneously. The clock was stopped after 60 seconds, and the number of words read correctly was counted and recorded. If 30 words were read correctly after 60 seconds (one minute), RAS for N10/0.75M is recorded as 30wpm. The Mean(average) reading speed (MRS) each for N10/0.75M, N18/2M, N24/2.5M,

N36//4M and N48/5M for this group was recorded as MRS2, MRS3, MRS4, MRS5, MRS6, respectively. MRS1 was matched with MRS2- MRS6. The mean reading speeds of the study group (MRS2-MRS6) closest to MRS1 of the control group was selected as MRSn and taken as the standard print size. In addition, the group of data (RAS) for the 200 emmetropes/corrected ametropes reading normal prints (N10/J5/0.75M) was labelled as Normal.

## Data Analysis

The mean reading speed for the control group (MRS1) was compared with the set of Mean reading speed for the study group(MRS2-MRS6). One way ANOVA was run and mean difference between RASn (Normal) with the 5 different sets of Reading speed (RAS1-5) of the low vision group was obtained.

Approval to carry out this study was obtained from the ECWA eye Hospital, also informed consent was obtained from the participants before the study started. Those who did not give consent were excluded from the study.

## RESULTS

Results show that the mean age of the control group was 36.7 years (age range 6 - 75 years), 137 (68.5%) were males, 63 (31.5%) were females (Figure 1). For the study group, mean age was 31.68years (age range 6-88years), 53 (26.5%) were females and 147 (73.5%) were males (Figure 2). The Mean Reading-Aloud speed(MRS1) for the control group was 99.47wpm, approximately 100wpm, the average for males were 97.62wpm and females 103.49wpm (Figure 3). The relationship between reading speed and age groups of the control group is shown in Figure 4. The mean reading speed in children, adults and elderly adults were 109.3wpm, 99.9wpm and 77.09wpm respectively. This showed that the reading speed decreased with age. The relationship between reading speed and print sizes among low vision patients (study group) is shown in figure 5. In this group, mean reading speed MRS2, MRS3, MRS4, MRS5 and MRS6 were 76.08, 100.08,114.19, 132.61 and 136.65 words per minute respectively. This shows that reading speed increased with print size. When compared, MRS3 for set of scores for print size N18/2M was 100.08wpm and was found to be closest to the Mean reading speed of 99.47wpm(MRS1) of the control group.

Table 1 shows the result from one way ANOVA in which mean scores of RAS (reading-aloud-speed of the control group at N10/J5(0.75M print ) was compared with RAS1-5 (the set of reading-aloud-speed scores for print sizes. N10//0.75M (RAS1), N18/2M (RAS2), N24/2.5M (RAS3), N36/4M (RAS4) and N48/5M (RAS5) of the low vision (study) group. The difference between groups was significant (P<0.05) This shows that there is a significant difference in reading speed between the control group and the low vision (study group). The control group clearly read more words per minute. Post Hoc analysis was conducted, and the difference was not Significant within RAS2 and RAS3 (P>0.05) in reading aloud speed with the Normal(control) group. The set of RAS2 (N18/2M) print size showed no difference (P=1.00) with the RASn (N10//0.75M) of the control group.

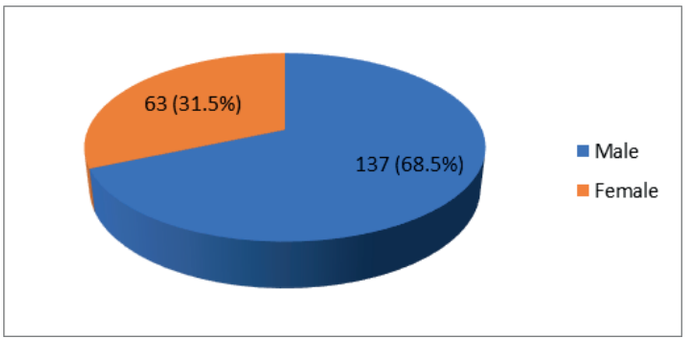


**Fig. 1 Gender Distribution among normal subject (Control Group)**

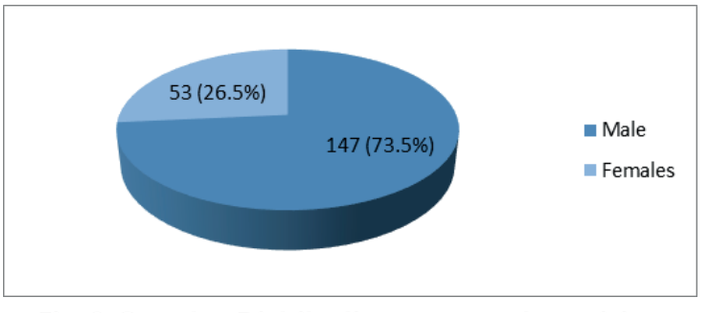


**Fig.2 Gender Distribution among low vision patients (Study group)**

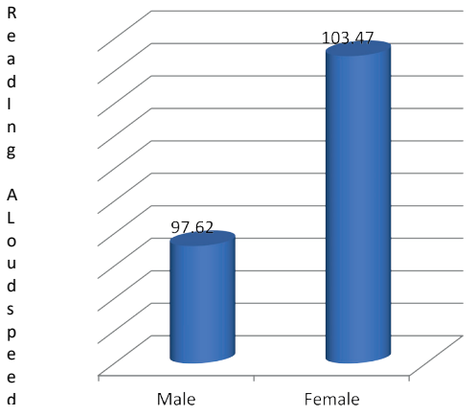


**Fig 3. Mean Reading Speed(wpm) among Males and Females in normal subjects.**

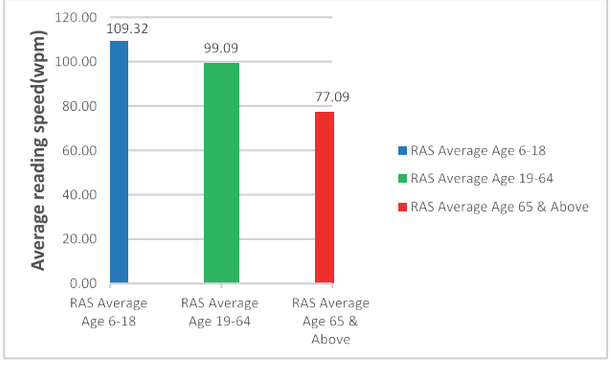


**Fig. 4 Age group and reading aloud speed of the control group**

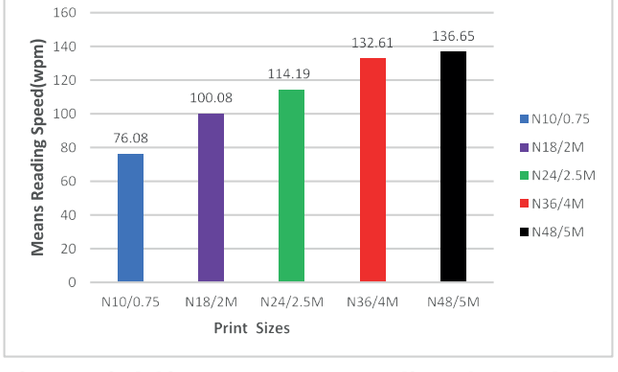


**Fig 5 Print Sizes versus Reading Speed among low vision patients**

## Table 1
**Mean difference in reading aloud speed between normal (RASn) and RAS 1-5 of the study group**

| F-value | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 519519.770 | 5 | 103903.954 | 31.674 | .000 |
| Within Groups | 3916800.150 | 1194 | 3280.402 | | |
| Total | 4436319.920 | 1199 | | | |

**ANOVA test statistics P<0.05 @ 95% CI**

## Table 2
**POST HOC**

| NORMAL (control group) | RAS 1-5 (Low vision group) | Mean Difference (I-J) | P-value | 95% Confidence Interval | |
|---|---|---|---|---|---|
| | | | | Lower Bound | Upper Bound |
| RASn | RAS 1 | 23.39500 | .001 | 6.5498 | 40.2402 |
| | RAS 2 | -.11000 | **1.000*** | -16.9552 | 16.7352 |
| | RAS 3 | -14.71500 | **0.155*** | -31.5602 | 2.1302 |
| | RAS 4 | -32.89000 | 0.000 | -49.7352 | -16.0448 |
| | RAS 5 | -37.18000 | 0.000 | -54.0252 | -20.3348 |

***not significant**

## Discussion

Results from this study revealed that the average reading speed in people with normal vision was 100 words per minute and reading speed decreased with age. This is in

agreement with the work of Deyue et al[11]. They examined 17 normally sighted young adults, average age 23.8 years and old adults, average age 66years. They found that the reading speed was higher (191 versus 124wpm) in young adults than old participants. Calabrese et al[12] in a recent study found MRS for normally sighted people to decrease with age, 140-200wpm for children and 175wpm for elderly, but it is higher than what is reported in this study. This may be due to differences in speed articulation rate, nature of text used, and method used in assessing MRS. We also found that the reading speed improved with print size, which is in agreement with similar studies[11-13]. William and Delamater[13] also reported that although the reading rate increased with print size , it got to a maximum where it began to decline. They stated that in dyslexics, the fastest rate was obtained at a significantly larger character size than control. This supports our argument that a critical print size that would address the advantages of small prints and disadvantages of very large prints is required for optimum reading performance. Furthermore, it suggests that in visually challenged individuals, reading performance improves with critical (i.e. standard) print size. There is slight difference in reading speed among males and females. Females read faster. We determined that the N18/ 2M print size should be employed in writing reading materials in schools and work place as this would enable people with low vision have access to print materials and enable them to cope with reading in school, work and leisure. This way, psychological, social and economic impact of irreversible visual loss would reduce and society made more civilized.

People with Low vision suffer from irreversible visual impairment caused by eye disease conditions that cannot be cured medically, surgically and optically[14]. They do not have normal eye sight neither are they totally blind[15]. There are children with low vision who can benefit with large prints but are placed in schools for the blind to learn in Braille alone. Young adults drop out of school due to inability to cope with learning on the basis of prints 14. Furthermore, adults may go into early retirement due to inability to cope with reading and writing in places of work.

Low vision patients can be helped with the aid of low vision devices which could be optical or non-optical[15,16]. Magnifiers are low vision devices that enlarge materials for near work and enable tasks such as reading, writing, treading of needles and looking at money. The material to be read must be kept at the focus of the magnifier hence depending on the level of vision and magnifier power, materials may be kept too close to the face. This may compromise some near tasks such as writing and drawing and may also influence the use of the devices which is currently poor in Nigeria[17].

Large prints are non-optical devices[15]. With large prints, the use of a magnifier may not be necessary or when indicated, the dioptric(optical) power could reduce and working distance improved. Large prints have the disadvantage of occupying large spaces and only few words may be read at a time. Furthermore, the cost of producing very large print books could be high. This research got answer to the question: what is the print size that would adequately address the advantages of small prints and the problems of enlarged prints. If appropriately determined, that standard print size would be employed in writing school books, examination materials, office memos, newspapers and religious books. This would enable access to education, employment and activities of daily leaving by a great majority of the low vision population and reduce the psychological, social and economic impact of low vision. The major limitation to this study is that the study did not consider the influence of visual acuity reserve, contrast reserve


11. Deyue Yu, Sing-Hig Chueng, Susana TL Chung, Gordon E. Legge. Age effects on Reading Speed in Peripheral Vision. Journal of Vision.2006; 6: 1001. Doi:10.1167/6.6. 1001
12. Calabrese A, Cheong AMY, Cheung S, He Y, Kwon M.et al. Baseline MNREAD measures for normally sighted subjects from childhood to old age. Investigative ophthalmology & visual science. 2016; (57) 8: 3836 3843
13. William E, Delamater, M.Ed . How larger font size impacts Reading and the implication for Educational use of Digital Text readers. 2010. eReedia..
14. Ejukonemu BOM. The Socio-economic implications of unattended True Low Vision in Sub-Sahara Africa. Journal of Low Vision Rehabilitation and Blindness. 2014; 3: 62-64
15. Minto H, Butt I A. Low vision devices and training. Community eye health J. 2004;17 (49):6-7
16. Ekpenyong BN, Ndukwe OC. Restoration of near normal vision in an elderly patient. Blindness and Low vision Journal. 2012; (1) : 11 -14.
17. Ekpenyong BN, Ndukwe. Provision of Low Vision Services in the Department of Ophthalmology, University of Calabar Teaching Hospital: Journal of the Nigerian Optometric Association 2010; 16 : 20 - 24

and cause of low vision on reading performance and speed, also reading accessibility index was not calculated. However this is the first attempt in the study area.

## Conclusion

The average reading -aloud speed among Nigerians with normal vision is 100 words per minute and reading speed decreased with age. Reading speed increased with print size. Females read slightly faster than males. The N18/2M print size should be adopted as standard print size and recommendation for advocacy for large print editions of reading materials in relevant organizations. Studies on the reading speed profile among Nigerian cultures is necessary to address cultural factors in reading speed among societies. There is also a need for further research to determine if there is a difference between quiet reading and reading aloud speed.