Development and Validation of the Persian Version of the MNREAD Acuity Chart

Roghiyeh Elham[1], Ebrahim Jafarzadepur[2,3]

[1]Private Office, Zanjan, Iran, [2]Noor Ophthalmology Research Center, Noor Eye Hospital, Tehran, Iran, [3]Department of Optometry, Faculty of Rehabilitation, Iran University of Medical Sciences, Tehran, Iran

Abstract

Purpose: To develop the Persian version of MNREAD acuity charts and test their repeatability in a normal adult population.

Methods: Two hundred sentences were constructed using the most frequent words of 8-year-olds schoolbooks. The number of characters and sentence length were adjusted based on the design principles of the Minnesota Low Vision Reading Test. Two Persian language teachers checked the sentences for syntax and meaning. The accepted sentences were read by 20 adults and then by 20 children. Using RADNER charts method, the sentences with inappropriate reading time and repeated errors were excluded. Thirty-eight sentences were approved to create charts. To check the charts' validity and repeatability, 20 adults read both charts and a paragraph of a daily newspaper. Reading acuity, critical print size, and maximum reading speed were calculated. The measured reading speeds were compared to the readers' reading speeds for a paragraph of a daily newspaper. Bland-Altman plots were used to evaluate the agreement between the two charts.

Results: Thirty-eight selected sentences were used in the final printed charts. There were significant correlations between maximum reading speed for Charts 1 and 2 ($r = 0.87$, $P < 0.0001$), Chart 1 and newspaper paragraph ($r = 0.73$, $P = 0.001$), and Chart 2 and newspaper paragraph ($r = 0.83$, $P = 0.0001$). Correlations were observed between reading acuities and critical print sizes of two charts ($r = 0.72$, $P < 0.002$ and $r = 0.77$, $P = 0.00$). The 95% limits of agreement in reading acuity, critical print size, and reading speed between Charts 1 and 2 were ± 0.034 logMAR, ±0.11 logMAR, and ±8.00 words per minute, respectively.

Conclusion: The designed Persian MNREAD charts are repeatable and could be used reliably to calculate near acuity, reading speed, and critical print size in Persian-speaking people.

Keywords: Critical print size, MNREAD, Persian, Reading acuity, Reading acuity chart, Reading speed

INTRODUCTION

The evaluation of the patients' reading ability is an important part of the eye examination. Reading is a more complex ability and testing visual acuity by single optotypes cannot entirely reflect the patients' reading ability. Reading acuity along with other factors such as binocular vision, visual field, and contrast sensitivity affect reading performance.[1,2] The individual's reading ability should be evaluated using a standardized approach to represent this function in real life. In the same way, reading acuity charts designed in the language of the tested people would eliminate the language barrier.

Among the multilingual reading cards developed for testing reading performance, MNREAD and RADNER charts are the most developed and described continuous text charts. In 1993, the Minnesota Low Vision Laboratory developed one of the first standardized continuous text near acuity chart (MNREAD).[3] Later, the designers released a uniform chart development instruction,[4,5] and it was designed in several languages such

Access this article online

Quick Response Code:

Website:
www.jcurrophthalmol.org

DOI:
10.4103/JOCO.JOCO_80_20

How to cite this article: Elham R, Jafarzadepur E. Development and validation of the persian version of the MNREAD acuity chart. J Curr Ophthalmol 2020;32:274-80.

as Greek,[6] Turkish,[7] Portuguese,[8] Italian,[9] and Japanese.[10] This reading chart has some advantages. Measurements are possible on a logMAR scale, the test has a wide range of lines, and it can measure reading speed and critical print size in addition to near acuity.[6] Charts include 19 logarithmic sentences in the logMAR range of −0.5–1.3, with 0.1 logarithmic intervals (for 40 cm distance). Each sentence of the chart consists of 3 lines and 60 characters with spaces. They are reliably used in clinical applications and in scientific research for both normal-sighted and low vision adults and children.[9,3,11,12]

The RADNER reading chart was first developed in 1998 in German.[13] Later, it was developed in other languages including Spanish,[14] Italian,[15] English,[16] and Danish.[17] The chart has 14 print sizes, ranging from 1.2 to −0.2 logMAR at 40 cm. All sentences are printed on three lines except for the largest print size. The criteria used to compose the RADNER sentences are stricter. The sentences are equal in their lexical and syntactical difficulty. The RADNER charts have a rigorously standardized sentence structure. They consist of "sentence optotypes," short sentences that are highly comparable in terms of the number of words, word length, the position of words, lexical difficulty, and syntactical complexity.[15]

Both MNREAD and RADNER charts follow the reading chart design principles such as including the impact of vertical crowding on reading, considering text difficulty, and using a logarithmic scale. They also show the equivalent Snellen and M values. M values show the distances that individuals with normal eyes could read the specific print sizes. Such as MNREAD, RADNER reading charts have been developed to measure reading speed, reading acuity, and critical print size. The differences are in the ways they have been developed and have standardized the created sentences.

Although more than one hundred million people around the world communicate in the Persian language, no suitable Persian reading chart has been devised for this purpose, and the only one produced by Jafarzadehpur *et al.*[18] lacks most of the standard chart design features. Some problems are using different sentence lengths for the different font size levels, using a non-uniform number of characters on each print size level, using relatively longer words, and using punctuation marks. In addition, they have not mentioned how the size of letters was defined.

The aim of the present study was to produce a Persian text-based logarithmic reading chart. Due to the MNREAD chart's clear and available design instructions, mainly MNREAD design principles were employed. Some design principles like selecting sentences by statistical methods and chart validation methods were also adopted from RADNER chart design principles.[13,19] The created charts would be useful for clinical applications and research, in which near vision and reading performance should be assessed.

METHODS

To develop the Persian version of the chart, the outline of the MNREAD charts design principle was employed.[4,5] Statistical selection of the sentences was performed according to the RADNER charts with some modifications.[13,19] The steps were as follows:

Establishing a Persian sentence pool

In the formation of the Persian sentences, the methods that were used in the development of the other versions of MNREAD charts were adopted. The texts of the "Reading Persian" schoolbooks used by second and third grade students were typed as a continuous text in Microsoft Word. The document was made appropriate for word frequency analysis by filtering punctuation marks, deleting or adding spaces, and filtering religious, local, and proper names. An online analyzer[20] was used to analyze the text. The frequently occurring words were utilized in the formation of 200 sentences with comparable grammatical and lexical structure. The majority of the selected words were among the 1000 most frequent words and the words whose frequencies were <2 were rarely used. Every effort was made to construct sentences without meaning relation. The next stage was adjusting the number of characters per sentence and sentence length with the MN-test software which is available on the MNREAD website.[21] Since the MN-test software does not support the Persian language alphabet, to adjust the sentences' character number and length, Microsoft Word and image processing software (Adobe Photoshop CC, Adobe Systems, Inc., San Joe, CA, USA) were employed. According to the construction outline, MNREAD charts should consist of 60-character sentences with almost equal length. By analyzing different English sentences on the MN-test software and reviewing the related literature,[7,8] it was revealed that the acceptable range of character number per line was 20 ± 2 characters (with space), and the acceptable physical length for the sentences was 1.00 ± 0.03 (if the mean length is considered 1.00). Therefore, in order to adjust the sentences' character number, the candidate 60-character sentences were typed in 3 lines in Microsoft Word and the number of characters (including spaces) per sentence was controlled by its Word Count tool. The accepted sentences were transferred to Photoshop and controlled for physical length. One hundred forty Persian sentences met the criteria. Two Persian language teachers examined the sentences for grammar and meaning. They rejected 22 of them. To select the more suitable sentences, each of the remaining sentences (118 sentences) was printed on a separate paper in 3 lines at a single font and print size well above the critical print size (B Nazanin, 18 points). A group of 20 adults and a group of 20 upper elementary school children were selected. Inclusion criteria were being a native Persian speaker, the absence of any eye pathology, visual acuity of 20/20 (without any correction) in both far and near, and absence of reading problems. First, adults read 118 sentences, and some inappropriate sentences were excluded. Then children read 70 approved ones. They read the sentences in daylight

conditions at 40 cm distance (adults) and 33 cm (children). To control the reading distance and keep it constant during the test, a flexible plastic ruler was attached to the side of the reading stand supporting the pages in which sentences were written. The readers' voice was recorded and analyzed for the time (0.1 s) and the number of errors (missed or misread words) per sentence. In order to understand the readers' opinions about the sentences, they were questioned about the sentences. Reading speed for each sentence was calculated using the following formula:

Reading speed (words/min) = 60 (10-number of errors)/time (s)

The approved 38 sentences were randomly distributed to create two printed versions of the Persian MNREAD chart. An effort was made to distribute the sentences in a way that topical words were not repeated in close sentences of the chart. In addition, meaning relations were avoided in nearby sentences. According to the design principles, the optimum font would be the most commonly used font in everyday printed materials. Since Hamshahri newspaper is one of the widely circulated Persian newspapers, its font (B Nazanin) was used as the Persian chart's typeface. Each chart consisted of 19 sentences. The sentences were displayed on 3 lines to include the impact of vertical crowding on reading. To calculate the print size, the results of Abdulkader and Leat[22] were employed. Body size of each sentence was about 80% of the upper line. That is, the print size of consecutive sentences followed a logarithmic progression (0.1 logMAR). The spaces between sentences were changed logarithmically, too. To determine the space between consequent sentences, the spaces between the large fonts of the original English MNREAD chart were measured and adjusted to Persian sentences in the way that would allow them to fit the offered chart size (14 inches in length). The space between the lines of one font was similar to what appears in everyday printed materials.

Chart test re-test evaluation
Twenty normal-sighted adults read the sentences of the printed charts at 40 cm distance with their best correction in a well-lit room. The subjects read the two charts in one session. They also read a paragraph of Hamshahri newspaper (0.4 logMAR) as a sample of daily reading material during the same session.

Their voices were recorded and analyzed for reading time and errors. Reading acuity, critical print size, and maximum reading speed were calculated for each chart. Reading acuity was considered the smallest print size that a participant could read without making significant reading errors, which was calculated using the following formula:[5]

Reading acuity (logMAR) = 1.4− (sentences × 0.1) + (errors × 0.01)

Critical print size was considered the smallest print size that a participant could read with maximum reading speed.[4] It is measured in steps of 0.1 logMAR. Maximum reading speed was considered the reading speed that was not limited by print size; it is the mean speed over the critical print size in words/min.[5] Reading speed (words/min) was also measured for the

newspaper paragraph. The same researcher conducted all the tests. The correlation of reading speed of Chart 1 and Chart 2 with each other and the newspaper paragraph were evaluated using Pearson's correlation test. Bland-Altman plots were used to analyze agreement between the two charts for reading acuity, reading speed, and critical print size.[23] This method was firstly used for evaluating the reliability of RADNER reading charts by Stifter et al.[24] Statistical data processing was carried out using MedCalc 14.8.1 statistical software. The tenets of the Declaration of Helsinki were followed, and the study was approved by the Ethics Committee of Rehabilitation School of Iran University of Medical Sciences (approval code: 1398.1278). Informed consent was obtained. In case of children, the consent was obtained from a parent.

RESULTS
One hundred and eighteen sentences approved by two Persian language teachers were first read by 20 adults. Eight of them had a high school diploma, and 12 had higher education. They were 22–41 years old (30.4 ± 6.96). The sentences that were repeatedly mistaken and commonly mentioned as unclear by the readers were excluded. Mean reading time was calculated for the rest of the sentences. The 103 remaining data were not normally distributed (the coefficient of Skewness was 0.82). Mean reading time range was 3.6–6.5 s (Mean: 4.81; standard deviation [SD]: 0.72). To select sentences of similar readability, outlier data of the two ends of reading time range were removed. Reading time range became 4.2–4.86 s (Mean: 4.51; SD: 0.16), and the coefficient of Skewness decreased to 0.007. Twenty children aged 10–11 years (13 female and 7 male) read the 70 remaining sentences. According to their teacher, none of them had a reading problem. Mean reading speed was 137.15 ± 5.31 words/min (range, 125.19–150.69 words/min). The sentences that deviated by ±1 SD from the mean were eliminated. A few more sentences with repeated errors were deleted, and 38 sentences were selected to design Charts 1 and 2 of MNREAD Persian version.

The typeface, print size, and chart creation
Using Abdulkader and Leat[22] for calculating body size, in the B Nazanin font, logMAR 0.00 (at 40 cm viewing distance) was calculated 4.3 points. Therefore, the print size of the upper and lower lines was achieved in a logarithmic order by multiplying or dividing by 1.2589, respectively. Print sizes were from logMAR −0.5–1.3 at 0.1 logMAR steps (corresponding to Snellen 20/6.3–20/400), for a standard reading distance of 40 cm. The space from the descenders of the 1st sentence to the ascenders of the 2nd sentence was 38 mm. The space between the remaining sentences was calculated on a logarithmic scale (divided by 1.2589).

Two 19-sentence charts were printed on a matt surface with a phototypesetting method according to MNREAD charts characteristics (11 × 14 inches, contrast >80%, resolution: 3600 dpi). Figure 1 shows the layout of one of the charts.

Testing chart validation and repeatability

Twenty adults (10 women and 10 men; 39.6 ± 8.4 years old; range: 25–55) read the two designed charts and a paragraph of a newspaper for testing the charts' repeatability and validity. Twelve of them had a high school diploma, and ten had higher education. Figure 2 shows the readers' performances. For each participant, the critical print size, maximum reading speed, and reading acuity were calculated. The mean critical print size of Chart 1 was −0.068 ± 0.047 logMAR, and the mean critical print size of Chart 2 was −0.056 ± 0.051 logMAR. The mean reading acuity for Chart 1 and Chart 2 were −0.13 ± 0.011 and −0.14 ± 0.018 logMAR, respectively. Correlations were observed between reading acuities and critical print sizes of the two charts ($r = 0.72$, $P < 0.002$ and $r = 0.77$, $P = 0.00$). The average reading speed for Chart 1, Chart 2, and the newspaper paragraph was 125.95 ± 6.85 words/min (range, 116.33–136.52 words/min), 128.45 ± 7.66 words/min (range, 115.56–137.76 words/min), and 123.43 ± 5.76 (range, 115.5–132 words/min), respectively.
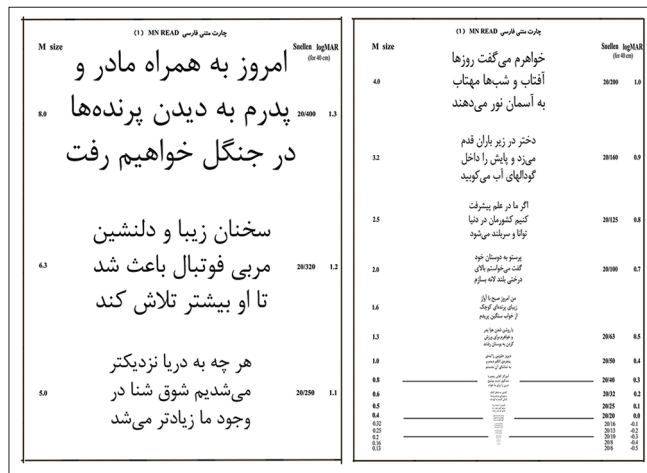
Figures 3-5 show the agreement in measuring reading acuity, reading speed, and critical print size. The 95% limits of agreement in reading acuity, critical print size, and reading speed between Charts 1 and 2 were 0.034 logMAR, 0.11 logMAR, and 8.00 words per minute, respectively.

There were significant correlations between maximum reading speed for Charts 1 and 2 ($r = 0.87$, $P < 0.0001$), Chart 1 and the newspaper paragraph ($r = 0.73$, $P = 0.001$), and Chart 2 and the newspaper paragraph ($r = 0.83$, $P = 0.0001$).

DISCUSSION

The aim of the present study was to design and validate the Persian version of MNREAD acuity chart according to the design principles of the developers. The researchers' effort to design reading acuity charts in several languages indicates the importance of using continuous text charts in evaluating visual function in clinical practice and research. The reading charts created in various languages helps the practitioners and facilitates international communication about the reading

Figure 1: One of the produced versions of the Persian MNREAD charts

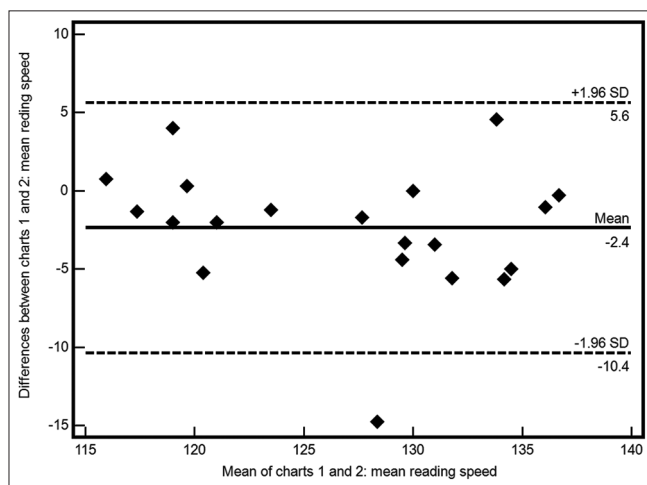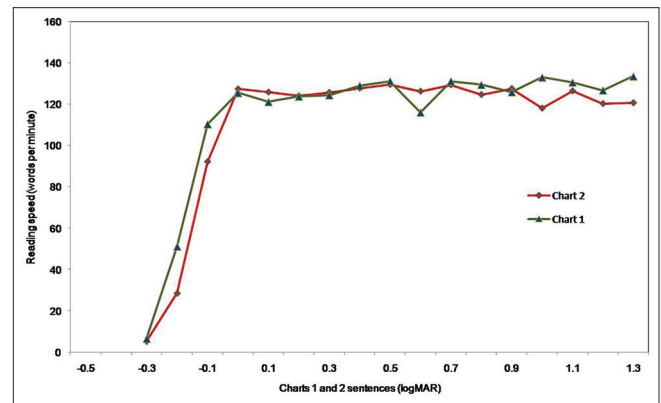**Figure 2:** Persian MNREAD charts reading speeds for normal individuals

Figure 3: Bland–Altman plot for reading speed of Persian MNREAD Charts 1 and 2 in words per minute. The upper and lower dashed lines are the 95% confidence intervals; the solid line represents the mean
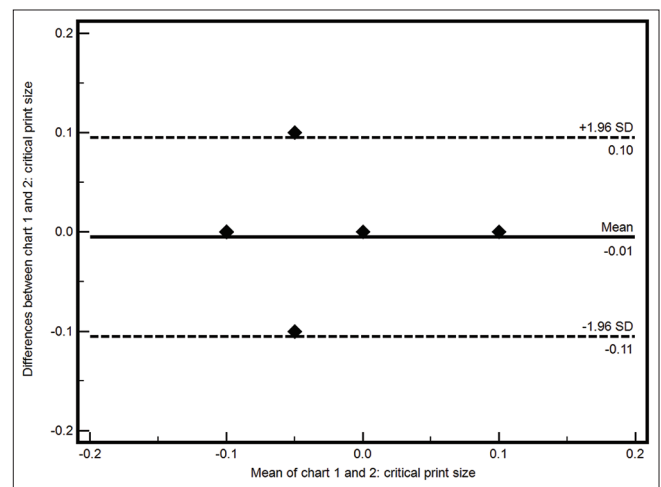
Figure 4: Bland–Altman plot for critical print size of Persian MNREAD Charts 1 and 2 in logMAR. The upper and lower dashed lines are the 95% confidence intervals; the solid line represents the mean. The figure has several overlapping points because critical print size is measured in steps of 0.1 logMAR

performance of patients. By assessing the time every sentence is read, calculating other parameters such as critical print size and maximum reading speed would be possible. Testing reading acuity, critical print size, and maximum reading speed in low vision patients are required to decide about needed magnification and treatment effect.

In the development of the Persian version, all parts of the instruction for sentence design and suitability of the context, as far as the properties of Persian language allowed, were taken into account. The most complicated and important part of this study was constructing standard sentences. It was a challenging puzzle to construct simple and reasonable sentences from a limited number of words which simultaneously met both the 60-character constraint and the physical length constraint. In addition, the sentences should be dividable into three equal parts. Different properties of the Persian language made the job more complex. The available online program offered by MNREAD chart developers did not support the Persian alphabet. Therefore, an alternative should be found to perform the rules of chart construction. In this study, Adobe Photoshop and Microsoft Word were used to adjust the character number and physical length of the sentences. To the authors' knowledge, this method has not been used in other studies.

The other problem of the present study was print size calculation. In Roman languages, x-height is considered a criterion for print size. It is the measure from the baseline to the height of the lowercase letters. For non-Latin alphabets, the designers have recommended using the height of a

Figure 5: Bland–Altman plot for reading acuity of persian MNREAD Charts 1 and 2 in logMAR. The upper and lower dashed lines are the 95% confidence intervals; the solid line represents the mean

well-known character as a criterion for calculating the print size. But in fact, some features make the Persian language different, and an attempt to find a specific character for using as print size criterion failed. In Persian, depending on the location within a word, the letters' width, height, and shape change. The 32 Persian letters come in 1–4 shapes depending on their position in the word. Thus, in writing texts, letters are represented in at least 100 shapes. Their widths change when they join the neighboring characters, and some of them like ⸯⸯⸯ and ⌒ have a shorter height but a longer width compared to other shapes. Some of the letters like ه and ھ are very short compared to other letters. There are some ascenders and descenders in the Persian alphabet which could have a positive influence in recognition of words and therefore in legibility.[24] Some of the letters only differ in the number of dots. Another feature of Persian is that there is no vocalization in written Persian texts, and many words have the same spelling but a different pronunciation and meaning. To pronounce and understand the words correctly, one has to discover the context and grammatical points.

In a recent reading acuity chart design study, Alabdulkader and Leat[22] did an empirical calibration for equating Arabic point to logMAR. They compared the reading acuity of their designed text against reading acuity measured with the English version of MNREAD and RADNER charts. The result of their study showed that the equivalent of 0.00 logMAR for the MNREAD and RADNER charts was an average of 0.655, which was equal to 0.7 log-point (5 points for Arabic Times New Roman) at 40 cm. They suggested the results as a criterion for creating standard reading charts. The Arabic and Persian alphabets have many common features. Of the 32 Persian letters, 28 are commonly used in Arabic, and their written texts have similar properties. Because of the similarities between the two languages, the above research results were used to adjust the print size of the recent charts. According to the result of their study, the height of the letter "Alef" (ا) would be 2.2 mm for the line 0.4 logMAR (1 M on English charts) and therefore 0.87 mm for the line logMAR 0.00 for the viewing distance of 40 cm. "Alef" was the most common character in the present chart and also in everyday Persian texts [Table 1].

Using their results, logMAR 0.00 (for 40 cm viewing distance) was calculated 4.3 points for B Nazanin. That is, in B Nazanin font when the height of "Alef" is 0.87 mm, the body size would be 4.3 points. The relation between the height of characters and font body size is different in various fonts. In the Arabic chart, logMAR 0.00 (for 40 cm viewing distance) has been
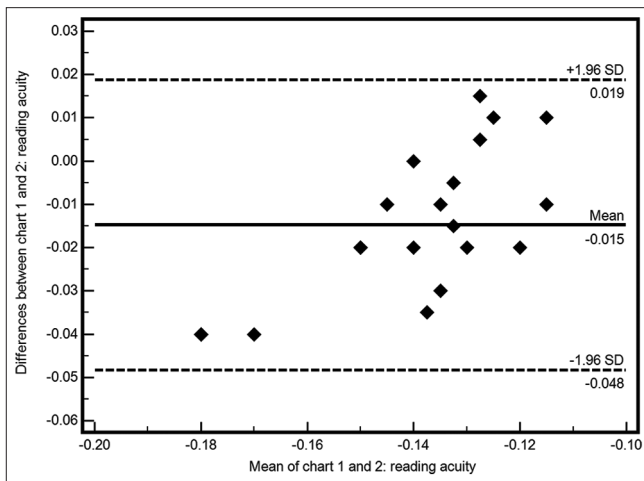
Table 1: Number of words, characters, and character "Alef" in Chart 1, Chart 2, and a newspaper paragraph

Chart	Number of character "Alef", n (%)	Number of words	Total number of characters with space	Total number of characters without space
Chart 1	141 (14.3)	253	1194	983
Chart 2	140 (14.8)	247	1142	946
Newspaper paragraph	102 (13.21)	208	980	772

calculated 5 points for the Arabic Times New Roman font. This little difference could be related partly to the difference between two fonts and partly to the rounding they did for print size calculation at the end of their work.

Using audio-recording for recording the voice of the readers was the strength of the current study. It has been mentioned as a more repeatable and accurate method than timing with a stopwatch.[25,26] The results of words and characters analyses, and the high correlation of mean reading speeds of sentences of the two versions of the charts ($r = 0.87$, $P < 0.0001$) prove that they consist of a comparable set of sentences. They could be used as alternative versions for controlling the visual performance of the right and left eye in one session. A similar result has been reported for the Turkish version[7] of the MNREAD ($r = 0.88$, $P < 0.01$). The high correlation between reading speeds of the charts and a newspaper paragraph (0.73 for Chart 1 and 0.83 for Chart 2) shows that the charts could represent the daily reading material. For the Turkish and Portuguese versions,[7,8] the correlations were reported about 0.7 and 0.8, respectively. Coefficient of repeatability for reading acuity (±0.034 logMAR) was better than Subramanian and Pardhan who tested the repeatability of the English version of MNREAD, but for reading speed and critical print size the findings were similar.

In the present study, the mean reading speed for a paragraph of a newspaper and constructed charts was about 130 words/min while according to the related literature for Roman letter languages, it is about 200 words/min.[6,7,27] One reason for this lower reading speed could be the testing method. During the testing process, the participants were asked to read as accurately as possible and not sacrifice accuracy for speed. In Persian, there are many homographic words whose written forms are the same, but the pronunciations differ due to their meanings, and the readers must understand the context of the sentences to pronounce the words correctly. Since accurate reading was emphasized, the time needed to discover contextual cues and read accurately might take time and reduce their speed. The other feature of the Persian alphabet which could affect the reading speed is that in Persian, some of the letters are distinguished by the number or the position of their dots, and their basic forms are the same. As a result, correct reading is visually demanding for readers, and it may take a longer time. The absence of word vocalization marks could reduce the reading speed as well.[28] In Persian, vocalization marks are not present in regular print and are not considered in the character count of the written sentences when adjusting the sentences' character number and length. Therefore, the Persian written texts with the same number of characters may take more time to read than Roman letter texts and result in slower reading speeds.

The created Persian reading charts are highly consistent, and their reading speed is statistically similar to a newspaper text. They allow reliable evaluation of reading performance in Persian patients and could be useful for measuring reading performance in clinical practice and research. The reading charts created in various languages helps the practitioners and facilitates international communication about the reading performance of patients.

Conflicts of interest
There are no conflicts of interest.

REFERENCES

1. Whittaker SG, Lovie-Kitchin J. Visual requirements for reading. Optom Vis Sci 1993;70:54-65.
2. Han Y, Ciuffreda KJ, Kapoor N. Reading-related oculomotor testing and training protocols for acquired brain injury in humans. Brain Res Brain Res Protoc 2004;14:1-2.
3. Mansfield JS, Ahn SJ, Legge GE, Leubeker A. A new reading acuity chart for normal and low vision. Ophthalmic Vis Opt 1993;232-5.
4. Mansfield JS, Legge GE, Luebker A, Cunningham K. Mnread Acuity Charts: Continuous-Text Reading-Acuity Charts for Normal and Low Vision. USA, Minneapolis: University of Minnesota; Minnesota Laboratory for Low-Vision Research; 1994.
5. MNREAD Acuity Charts, available from: Available from: http://legge.psych.umn.edu/mnread-acuity-charts.. [Last accessed on 2020 Jun 15].
6. Mataftsi A, Bourtoulamaiou A, Haidich AB, Antoniadis A, Kilintzis V, Tsinopoulos IT, *et al*. Development and validation of the Greek version of the MNREAD acuity chart. Clin Exp Optom 2013;96:25-31.
7. Idil ŞA, Çalişkan D, Idil N. Development and validation of the Turkish version of the MNREAD visual acuity charts. Turkish J Med Sci 2011;41:565-70.
8. Castro CT, Kallie CS, Salomão SR. Development and validation of the MNREAD reading acuity chart in Portuguese. Arq Bras Oftalmol 2005;68:777-83.
9. Virgili G, Cordaro C, Bigoni A, Crovato S, Cecchini P, Menchini U. Reading acuity in children: Evaluation and reliability using MNREAD charts. Invest Ophthalmol Vis Sci 2004;45:3349-54.
10. Fujikado T, Asonuma S, Ohji M, Kusaka S, Hayashi A, Ikuno Y, *et al*. Reading ability after macular translocation surgery with 360-degree retinotomy. Am J Ophthalmol 2002;134:849-56.
11. Subramanian A, Pardhan S. Repeatability of reading ability indices in subjects with impaired vision. Invest Ophthalmol Vis Sci 2009;50:3643-7.
12. Merrill K, Hogue K, Downes S, Holleschau AM, Kutzbach BR, MacDonald JT, *et al*. Reading acuity in albinism: Evaluation with MNREAD charts. J AAPOS 2011;15:29-32.
13. Radner W, Willinger U, Obermayer W, Mudrich C, Velikay-Parel M, Eisenwort B. A new reading chart for simultaneous determination of reading vision and reading speed. Klin Monbl Augenheilkd 1998;213:174-81.
14. Alió JL, Radner W, Plaza-Puche AB, Ortiz D, Neipp MC, Quiles MJ, *et al*. Design of short Spanish sentences for measuring reading performance: Radner-Vissum test. J Cataract Refract Surg 2008;34:638-42.
15. Calossi A, Boccardo L, Fossetti A, Radner W. Design of short Italian sentences to assess near vision performance. J Optom 2014;7:203-9.
16. Radner W, Diendorfer G. English sentence optotypes for measuring reading acuity and speed-the English version of the Radner Reading Charts. Graefes Arch Clin Exp Ophthalmol 2014;252:1297-303.
17. Munch IC, Jørgensen AH, Radner W. The Danish version of the Radner Reading Chart: Design and empirical testing of sentence optotypes in subjects of varying educational background. Acta Ophthalmol 2016;94:182-6.
18. Jafarzadehpur E, Hashemi H, Abdollahinia T, Norouzirad R, Yekta A, Ostadimoghaddam H, *et al*. Design and validation of Persian near reading card: A pilot study. Iran J Ophthalmol 2013;25:216-21.
19. Radner W, Obermayer W, Richter-Mueksch S, Willinger U, Velikay-Parel M, Eisenwort B. The validity and reliability of short

German sentences for measuring reading speed. Graefes Arch Clin Exp Ophthalmol 2002;240:461-7.

20. Text analyzer. Available from: http://online-utility.org/text/analyzer.jsp. [Last accessed on 2019 Feb 02].

21. MN-test software. Available from: http://gandalf.psych.umn.edu/groups/gellab/MNREAD2000/mntest. [Last accessed on 2019 Feb 02].

22. Alabdulkader B, Leat SJ. A standardized Arabic reading acuity chart: The Balsam Alabdulkader-Leat Chart. Optom Vis Sci 2017;94:807-16.

23. Bland JM, Altman DG. Statistical methods for assessing agreement between two methods of clinical measurement. Lancet 1986;1:307-10.

24. Stifter E, König F, Lang T, Bauer P, Richter-Müksch S, Velikay-Parel M, et al. Reliability of a standardized reading chart system: Variance component analysis, test-retest and inter-chart reliability. Graefes Arch Clin Exp Ophthalmol 2004;242:31-9.

25. Peña E. About Visual Acuity and Type Design: A Protocol, the Winnower; 2016.

26. Patel PJ, Chen FK, Da Cruz L, Rubin GS, Tufail A. Test-retest variability of reading performance metrics using MNREAD in patients with age-related macular degeneration. Invest Ophthalmol Vis Sci 2011;52:3854-9.

27. Subramanian A, Pardhan S. The repeatability of MNREAD acuity charts and variability at different test distances. Optom Vis Sci 2006;83:572-6.

28. Trauzettel-Klosinski S, Dietz K; IReST Study Group. Standardized assessment of reading performance: The new international reading speed texts IReST. Invest Ophthalmol Vis Sci 2012;53:5452-61.