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Does near-vision correction improve digital data entry accuracy? A simulated within-subject crossover study among community health workers in Malawi

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ABSTRACT

Introduction Presbyopia, an age-related loss of near vision, affects approximately 80% of adults over 40 and 100% of adults over 60. Although correctable with inexpensive reading glasses, fewer than 20% of those affected in low- and middle-income countries have access to appropriate correction. Uncorrected presbyopia impairs daily functioning and productivity. The impact of presbyopia on health workforce performance remains unexplored, despite the impact of data accuracy on patient safety and the increasing reliance on mobile data entry and digital tools. This study assesses whether near-vision correction improves community health worker (CHW) data accuracy and entry speed.

Methods We conducted a mixed-methods, within-subject crossover study among 400 CHWs in Dowa district, Malawi. Participants (n=105) with screened presbyopia completed two simulated data entry tasks in Dimagi's CommCare mobile application, once with and once without reading glasses in random order. Task accuracy and completion time were assessed, adjusting for age and testing order. Post-task surveys explored perceptions of ease, accuracy and work impact.

Results Wearing appropriate reading glasses nearly doubled the odds of accurate data entry (OR=1.92, 95% CI 1.71 to 2.16; p<0.001). No statistically significant effect was observed on task speed, although 84% of participants reported glasses made data entry easier and 81% perceived themselves as faster. Nearly all (93%) believed reading glasses could increase their impact and were willing to pay for them.

Conclusion Providing low-cost reading glasses improved data entry accuracy among CHWs with presbyopia. As digital health systems expand, addressing uncorrected near-vision loss may reduce medical errors and improve care.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Presbyopia affects approximately 80% of adults over 40 years and 100% of those over 60, yet fewer than 20% of those impacted in low- and middle-income countries have access to reading glasses. While presbyopia's impact on general productivity is documented, its effect on the digital performance of community health workers (CHW) remains unexplored.

WHAT THIS STUDY ADDS

⇒ This study demonstrates that providing reading glasses to CHWs with presbyopia nearly doubles the odds of accurate digital data entry (OR=1.92). While vision correction did not measurably improve task speed, it significantly reduced errors in simulated clinical tasks.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Integrating near-vision screening and low-cost correction into health worker training is a scalable, cost-effective strategy to improve the quality of data transcription and the integrity of digital health systems. Study findings support policies that treat visual acuity as a fundamental component of workforce quality and patient safety.

INTRODUCTION

Background and significance

High-quality health data is vital for patient safety, clinical decision-making and health research. As health systems digitise and task shifting is used to address health workforce shortages, data quality increasingly depends on the frontline workforce, who must interact with mobile applications and electronic health records.

Globally, at least 2.2 billion people have a vision impairment. In at least 1 billion cases, the impairment has yet to be addressed.[1] Most (90%) people with uncorrected vision impairment live in low- and middle-income countries (LMICs). Women, people in rural areas and ethnic minorities are also more likely to have unaddressed vision issues.[2] The inability to see well leads to an estimated productivity loss of US$411 billion, with US$315 billion of that loss occurring in LMICs.[2 3] Of those

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in need of vision correction, more than 80% (approximately 1.8 billion people) have presbyopia. Presbyopia is a refractive error that makes it difficult to see up close, affecting various activities, including reading, writing, cooking, using mobile phones or other digital tools, sewing, weeding, identifying money and similar activities.[4–6] Presbyopia increases with age, starting around 40 years, including 50% of those aged 35–65 years.[1 6] In some settings, 80% of those over 40 have been found to have presbyopia.[7]

Presbyopia is correctable at a low cost. Following basic near vision screening, reading glasses, currently manufactured for under US$1 per unit, can address presbyopic vision loss.

Benefits of correcting near vision loss include enhanced self-esteem, productivity and improved mental and physical health outcomes. Studies on productivity and presbyopia to date have focused on livelihood. One study among people aged 35–65 in Bangladesh showed that those with presbyopia who received reading glasses improved their productivity by 33.4% over 8 months.[6] Some were able to return to work once treated, and earnings increased among those already employed. Another study among tea pickers in India found that reading glasses improved self-reported income by 21.7%.[8] It was unclear from the research what contributed to the increase–whether workers were able to work faster, more effectively or whether they were able to work longer hours because they did not fatigue as quickly. Many with mild presbyopia prescriptions cope by squinting, straining or shifting text distance. However, both studies found that treatment of even modest presbyopia (median glasses power of +1.00 dioptre and ages 35–42) yielded a significant impact.

The impact of presbyopia on the healthcare workforce productivity has not been addressed in the literature. Research on health workforce productivity has identified factors that include stress and burnout, training and development and personal health.[9 10] Studies on presbyopia in the health workforce that do exist have looked only at prevalence, which is generally high.

This lack of attention to the impact of presbyopia on the healthcare workforce productivity is noteworthy. The average age of the community workforce is over 35 in most places where it has been reported.[11–14] In the USA, nearly 70% of the community health workforce is over 35.[15] Community health workers (CHWs) measure vital signs, read rapid diagnostic tests, administer medications and enter clinical data into mobile applications, often while navigating outdoor environments with limited infrastructure. Their ability to see well up close and enter data accurately is paramount for quality care, especially given that data entry consumes a large portion of their time.[16] One time-motion study of CHWs in Neno, Malawi, found that CHWs spend as much time on documentation as they do on psychosocial support.[17] Clinicians spend more than one-third of their day engaging with electronic health records.[18]

Accurate health data is fundamental to patient care and population health management and depends on input accuracy.[19] Medical errors are one of the leading causes of preventable morbidity and mortality globally.[20] More than 50% of patient harm is preventable, with medication, diagnostic and surgical errors among the most common sources. Medication errors alone account for half of all avoidable harm.[21] Although research examining the relationship between health workforce visual acuity and patient safety outcomes remains limited, adequate vision correction may serve as a preventive intervention against such errors. For instance, factors contributing to preventable medication harm include transcription and documentation errors, as well as selecting the wrong medication if two look alike. Improved vision may help reduce both of these types of errors.[22]

To directly examine the role of vision correction in frontline healthcare delivery, this study assessed the impact of reading glasses on the accuracy and speed of data entry of CHWs. We hypothesised that CHWs with presbyopia would demonstrate improved speed and accuracy in mobile application data entry when provided with appropriate refractive correction.

MATERIALS AND METHODS

To test this hypothesis, this study surveyed CHWs and tested the accuracy and speed of their data entry in the CommCare mobile application with and without reading glasses, using a simulated exercise and within-subject crossover design. CommCare, developed by Dimagi, was selected because it is the most widely used mobile data collection and service delivery platform for frontline workers.[23]

One of the many organisations leveraging CommCare, Parent and Child Health Initiative Trust (PACHI) in Dowa district, Malawi, facilitated the study on the ground using a convenience sample. PACHI attained local institutional review board approval for the work, and Mass General Brigham reviewed a protocol documenting the authors' involvement. Standards for Quality Improvement Reporting Excellence (SQUIRE) reporting guidelines were followed.[24]

Eligibility for participation included:

- Being a community health volunteer or health surveillance assistant.
- Working in Dowa district, Malawi.
- Age 40 years or older.
- At least 6 months of experience.
- No known diagnosis of cataracts, glaucoma, diabetic retinopathy or other vision issues that cannot be corrected with reading glasses.

PACHI and Dimagi trained a team of surveyors and recruited eligible participants to attend the study location, where they set up tents during 2 week-long periods. All participants were compensated for their time at their standard hourly rate and consented to participation.

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Surveyors collected basic demographic information and then screened for presbyopia on standardised mobile devices that ensured font size consistency. They used the tumbling E near-vision chart that assesses the ability to read N6 font at 40 cm and determined the correct glasses strength (dioptre). The tumbling E near-vision chart was selected because it is the WHO recommended standard for basic near-vision screening in low-resource settings.

Those who met the inclusion criteria and had presbyopia answered survey questions about factors that might affect their ability to complete the examination efficiently and effectively, their CommCare data entry practices, attitudes toward reading glasses and history of glasses use. Responses included multiple-choice and Likert-scale options. Participants then completed two short exercises simulating a CHW's routine data entry tasks: entering data from a vaccination card and from a birth certificate into the application, a total of 40 data entry fields, while seated indoors under natural light. Participants were assigned to two groups: those who wore glasses to complete the two exercises first (Group 1) and those who wore them the second time they completed the exercises (Group 2). The order was assigned randomly, and the vaccination card and birth certificate used for each exercise were different to avoid memorisation. In this way, each participant served as their own control. The application recorded both the entries and the time it took for each exercise.

Patient and public involvement

Patients were not involved in this study.

Data analysis

Descriptive statistics were generated to summarise respondent characteristics and survey responses.

To evaluate the impact of reading glasses on data entry accuracy and ensure minor formatting variations did not skew results, participant responses underwent standardised data cleaning procedures. Spacing and punctuation were removed, and accents and superscripts converted to standard alphanumeric characters (A–Z, 0–9). While a weighted accuracy metric was considered, a binary exact-match approach was adopted to ensure a standardised assessment across participants who may have skipped digits or lines or provided incomplete answers. Responses that matched the target exercise answer exactly after cleaning were classified as 'accurate'. Responses that differed from the target answer were classified as 'inaccurate', using a binary approach. Approximately 10% of timing data were excluded from the final analysis due to application-specific logging errors when participants toggled between pages.

Two complementary statistical approaches were used to assess the impact of glasses on accuracy:

Approach 1: analysis by individual question (paired comparison):

In the paired comparison approach, for each participant, responses to the same question under both experimental conditions (with and without glasses) were paired to enable within-individual comparisons. The analysis focused on instances where response accuracy differed between the two conditions. McNemar's test was first applied to assess whether wearing glasses improved accuracy for each question. Subsequently, a generalised linear mixed model was fitted to evaluate whether wearing glasses increased overall response accuracy across all questions, with participant and question included as random effects, and age and testing order (glasses first – Group 1 vs no-glasses first – Group 2) as fixed effects. Effect sizes were reported as ORs with corresponding 95% CIs.

Approach 2: composite accuracy score (aggregated comparison):

In the aggregated comparison approach, the total number of accurately completed questions was summed for each participant, yielding an individual composite accuracy score (eg, out of 14 or 40 points, depending on the exercise). Each accurate response contributed one point to the overall score. The mean composite scores were then compared between the 'with glasses' and 'without glasses' conditions using a linear mixed model, with participants included as a random effect, adjusting for age and testing order (Group 1 or 2). Effect sizes were reported as mean score differences with corresponding 95% CIs.

All statistical analyses were completed using R V.4.5.1.

RESULTS

Demographic and survey results

Surveyors screened 400 people for presbyopia. The average reported age was 47.25 years. Just over half were female, and 195 were male. Of the 400, 295 were ineligible. Those who were not eligible were slightly younger, on average, and 280 had perfect vision. The remainder of those found ineligible had multiple eye issues.

The 105 eligible participants with presbyopia had a mean age of 50.26; 60 were female and 45 were male. The strength of required near-vision correction generally increased with age. Most participants (55, 52%) required a+1.00 dioptre correction, while 36 (34%) required +1.50 dioptre, 10 (10%) required +2.00 dioptres and 4 (4%) required +2.50 dioptre.

Survey results showed that 57% and 60% have trouble reading on a smartphone or tablet, respectively, and that their eyes get tired when looking at the screen for data entry. Of those with presbyopia, 40% had never had an eye examination; just 13% knew about when their last examination was. The most common reason for not having an examination was not thinking there was a problem; not thinking to go was the second most common reason cited, followed by not knowing where to go, not having time, not wanting to pay and not wanting glasses. Fewer than 30% of participants had ever used close-up glasses. Those who no longer used them had broken or lost them. Almost all (89.5%) agreed or strongly agreed

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Table 1 Odds of data accuracy with and without glasses by age and group

Approach 1: considering each question independently		
	All	
	OR (95% CI)	P values
Glasses		
Without	Ref	
With	1.92 (1.71 to 2.16)	<0.001
Age		
≤51	Ref	
>51	0.82 (0.5 to 1.32)	0.411
Group		
1	Ref	
2	0.53 (0.33 to 0.86)	0.01

Table 2 Mean score for data accuracy with and without glasses by age and group

Approach 2: each question as 1 point			
		All (40 points)	
	Mean score (out of 40)	MD (95% CI)	P values
Glasses			
Without	26.8	Ref	
With	30.5	3.66 (2.18 to 5.14)	<0.001
Age			
≤51	29.6	Ref	
>51	27.7	−1.47 (−4.5 to 1.55)	0.343
Group			
1	30.6	Ref	
2	26.5	−3.9 (−6.93 to −0.87)	0.013

MD, mean difference.

that it is normal to lose near vision with age; 96%, that glasses could help them, and 93%, that glasses are expensive. There was a range of responses to the question of whether they need to see as well as they used to, with half agreeing or strongly agreeing and half disagreeing or strongly disagreeing that they still need to see well. As for the use of technology, 5 considered themselves experts, 41 proficient, 13 intermediate and 46 novices.

Data entry findings

In completing the two data transfer exercises, participants were more accurate while wearing the appropriate reading glasses than without glasses. Accuracy proportions on individual questions with glasses ranged from 0.41 to 0.98; without glasses, they ranged from 0.24 to 0.88. The relative odds of accurate data entry when using glasses were significantly higher in most questions (see table 1). When treating each question as an independent observation, the overall odds of accurate data entry were substantially greater with glasses (OR=1.92, 95% CI 1.71 to 2, p<0.001).

When considering an aggregated or summary score (eg, out of 40 points), participants with glasses had a higher mean accuracy (30.5) than those without glasses (26.8) or an absolute improvement of 9.15% (see table 2). This translated to a mean difference (MD) of 3.66 points (95% CI 2.18 to 5.14), p<0.001.

In general, the highest accuracy was observed for simpler questions (such as first and last names), but glasses improved performance across both simple and complex questions (eg, dates, national ID numbers). There was no statistically significant difference in accuracy by age (51 and under vs over 51 years) after adjusting for glasses use. The beneficial effect of glasses persisted across Groups 1 and 2, though a small learning effect was observed, indicating that most participants had greater accuracy the second time they completed the exercises.

Reading glasses did not significantly affect the speed of data entry tasks in either the immunisation or birth record modules, and there were no significant differences in time by participant age or group assignment (see tables 3 and 4). Participants took about 21 min to complete the immunisation card exercise with and without glasses, and about 12 min to complete the birth certificate exercise. Although there was a 47-second reduction in time to complete the birth certificate exercise with glasses compared with without, neither exercise showed a statistically significant difference. Likewise, while those aged 51 and younger were on average 1.75 min faster than those aged 51 and older, and those completing the exercise for the second time were also faster, neither comparison was statistically significant.

Self-reported perceptions

A large majority (84.4%) of participants reported that using reading glasses made the exercises easier to

Table 3 Time to complete immunisation exercise with and without glasses by age and group

Immunisation card exercise			
	Mean time (s)	MD (95% CI)	P values
Glasses			
Without	1211	Ref	
With	1177	−33.61 (−162.72 to 95.49)	0.611
Age			
≤51	1216	Ref	
>51	1168	−43.39 (−296.29 to 209.51)	0.738
Group			
1	1220	Ref	
2	1168	−48.21 (−300.7 to 204.28)	0.709

MD, mean difference.

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Table 4 Time to complete birth certificate exercises with and without glasses by age and group

Birth certificate exercise			
	Mean time (s)	MD (95% CI)	P values
Glasses			
Without	696	Ref	
With	650	−45.4 (−118.86 to 28.06)	0.23
Age			
≤51	672	Ref	
>51	675	8.16 (−141.74 to 158.06)	0.915
Group			
1	700	Ref	
2	647	−53.98 (−203.64 to 95.67)	0.482

MD, mean difference.

complete (see table 5). Some (3.8%) were not sure, and 11.4% did not think they helped. Despite quantitative findings, most (81%) felt that the reading glasses also helped them work faster. Only 5.7% felt they worked more slowly, while the remainder (13.3%) believed the glasses did not affect their speed. A high proportion (93.3%) thought they worked more accurately with glasses, and the same per cent believed reading glasses could greatly improve their impact on the community, with only 1.9% believing they would not have much impact. Almost all were willing to invest a modest amount for a pair of glasses, with more than 12% willing to pay more than 20 000 kwacha (US$11.50; the price range in Malawi at the time was 12 000–24 000 kwacha).

DISCUSSION

This study is among the first to assess the impact of near vision correction on the accuracy and speed of front-line health workers' mobile data entry in a low-resource setting. Results clearly showed that providing appropriate near-vision glasses to adults 40 and over with presbyopia significantly improved data accuracy, regardless of age or whether participants used glasses for the first or second set of exercises.

While data entry may seem simple, it is the foundation on which health decisions are made and accounts for a significant portion of the workday.[11] Improving data accuracy by magnitudes—nearly a four-point gain in composite scores and almost a twofold increase in odds of accurate entry with near vision glasses—is both statistically and practically significant. Given the percentage of adults 40 years and older who are believed to have uncorrected presbyopia in low- and middle-income settings, addressing presbyopia may be a means to support data integrity and patient safety.

Our sample demonstrated a relatively low prevalence of presbyopia at approximately 26%, considerably below the reported global estimates of 50% for adults aged 35–65 and 80% for those aged 40+. Several factors may explain this discrepancy. First, the accuracy of self-reported age data is uncertain, as participants were not required to present identification. Second, some participants seemed to erroneously believe that they needed to be strong and healthy to qualify for the study, believing that those who qualified would be responsible for distributing eyewear. This may have led to selection bias. The severity of presbyopia in our sample was also found to be modest: the majority of affected participants (55 individuals) required only +1.00

Table 5 Post-exercise survey findings

Post-exercise survey question	Answer	# (n=105)	Per cent
It was easier to complete the tasks with reading glasses			
	No	12	11.40
	Not sure	4	3.80
	Yes	89	84.80
How do you think the reading glasses impacted your speed?			
	No change	14	13.30
	I worked faster	85	81
	I worked more slowly	6	5.70
How do you think the reading glasses impacted your accuracy?			
	No change	1	1
	More accurate	98	93.30
	Less accurate	6	5.70
How much do you think reading glasses could improve your impact over the course of a work day?			
	A little	5	4.80
	A lot	98	93.30
	They could not	2	1.90

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dioptre of correction, with only 13 requiring ≥+2.00 dioptres. This limited severity may be due to the selection of the Tumbling E test not providing a granular assessment and may attenuate the measured effects of presbyopia on both task speed and accuracy. Consequently, the impact of correcting more advanced presbyopia on healthcare workforce productivity may be substantially greater than our findings suggest, warranting further investigation in populations with more severe refractive errors.

Survey results revealed that most participants did not perceive near-vision loss as readily correctable. Although the majority acknowledged experiencing visual fatigue during screen-based tasks and data entry, they appeared to normalise this experience as an inevitable consequence of ageing rather than a treatable impairment. This suggests a lack of awareness regarding the potential benefits of corrective lenses, reflecting broader gaps in health literacy about presbyopia management.

There were several limitations to our study: The use of a simulated task may not reflect real-world conditions, and being studied could impact behaviour, a phenomenon known as the Hawthorne effect. Our study exercises also may have been too short to capture the full impact of fatigue on data entry accuracy and speed over the course of a full workday. However, even with the brief exercises, we observed a remarkable improvement in accuracy when participants wore appropriate reading glasses. Our findings suggest that wearing the proper reading glasses nearly doubles the odds of CHWs entering data correctly. This improvement underscores the potential for simple vision interventions to enhance the quality of health information systems. We believe this is a strong proxy for quality care but did not measure the impact on patient outcomes.

This study did not find that the use of reading glasses significantly affected data entry speed; however, self-reported data indicated that the majority of participants perceived reading glasses as facilitating easier workflow and enhancing both accuracy and speed. Our quantitative findings may be due to the relatively short exercises and application design challenges, limiting accurate data collection for about 10% of the sample and reducing the sample size. Non-significant trends toward reduced completion times among younger participants and those completing the exercises for a second time may indicate modest age-related or practice effects. These effects may be more pronounced in populations with limited prior experience in application data entry, as was the case in this study participant cohort.

Nearly all participants reported that corrective lenses could improve their work performance and expressed a willingness to pay more than most readers cost to make and distribute. This suggests both perceived value and potential demand for vision correction interventions within the community health workforce.

In the context of health workforce shortages and burnout, low-cost interventions that measurably improve both performance and sense of self-efficacy should be prioritised. Addressing presbyopia is a low-cost solution. Integrating screening and corrections into routine onboarding and training could yield immediate gains in accuracy, productivity and satisfaction across cadres. As more health systems rely on accurate digital data for clinical care, reporting and resource allocation, the consequences of uncorrected near vision extend beyond the individual to system-level performance.

These findings provide a clear rationale for embedding presbyopia screening and correction within health workforce strategies. Ministries of health, donors and implementing partners will need to work together to ensure that vision is a core component of workforce capacity and not an ancillary benefit. Ensuring that frontline workers can reliably see and, therefore, accurately read and record information is essential for data quality, patient safety and strong health systems.

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Contributors JR, ST, NL and RW conceived of and designed the study. ST and AC developed the data collection app. AC acquired the data. JR led the data analysis and interpreted the results. SA-Z supported data cleaning and analysis and led project administration. JR drafted the manuscript. All authors revised and approved the final version of the manuscript. JR is the guarantor.

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Competing interests None declared.

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Patient consent for publication Not applicable.

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Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request. De-identified data are available upon request from the corresponding author JR at julie@globalhealthdelivery.org.

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