

Feasibility, acceptability and efficacy of the online MINGLE intervention for Age-related Macular Degeneration

Alexander Maloof

UNSW Sydney

Richard Kha

The University of Sydney

Nicholas Bender

Middlesex University

Charlotte Jones

University of British Columbia, Okanagan Campus

Rona Macniven

UNSW Sydney

Bamini Gopinath

Macquarie University

Diana Tang

d.tang@mq.edu.au

Macquarie University

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Abstract

Objective

Age-related macular degeneration (AMD) is a leading cause of vision impairment globally. While evidence suggests that modifying diet, exercise and smoking behaviours can slow AMD progression, there are no existing lifestyle interventions to provide support in achieving each of these goals for those with AMD. Thus, this study aimed to assess the feasibility of an online holistic lifestyle intervention for those with AMD delivered via Zoom in improving dietary behaviours, falls self-efficacy, physical activity, quality of life, loneliness and visual function.

Methods

Our pilot trial recruited older adults with AMD who had access to Zoom for a weekly hour-long intervention for 8-weeks. Half the session was allocated to informal socialising and AMD-related nutritional education, with the other half for physical activity. Outcomes included changes in scores of the Short Dietary Questionnaire for AMD, Falls Self-Efficacy Scale-International, Active Australia Survey physical activity, Assessment of Quality of Life-8-Dimensions, De-Jong-Gierveld Loneliness Scale and National Eye Institute Visual Function Questionnaire-25.

Results

Fifty-four participants were screened, and 16 completed the 8-week intervention. Of the 16 participants, 14 were 'satisfied' or 'very satisfied' with the intervention, and 15 felt that they adhered to dietary advice, would recommend the intervention to others, and felt it was worth participating.

Conclusion

Overall, the online lifestyle intervention was acceptable in this small cohort of participants with AMD, and showed trends towards improved physical activity, falls self-efficacy, loneliness and visual function. High adherence and participant satisfaction warrant further studies to optimise the intervention's recruitment and impact.

Introduction

Age-related macular degeneration (AMD) is a degenerative eye condition that leads to progressive central vision loss and is a major cause of vision impairment, accounting for 8.7% of all blindness worldwide.(Mitchell et al., 2018) Broadly, there are two types of AMD – early and late AMD. Early AMD is characterised by drusen deposits, pigment changes and minimal vision loss. Late-stage AMD is associated with moderate to severe vision loss and can be divided into dry (atrophic) and wet

(neovascular) AMD. In dry AMD, there is gradual atrophy of retinal cells and thinning of the outer retinal layers, accumulation of drusen leads to atrophy and scarring of the retina, resulting in geographic macular atrophy.(Mitchell et al., 2018) In wet AMD, there is fluid, retinal haemorrhaging, detachment of the retinal pigment epithelium, hard exudate or scar tissue.(Mitchell et al., 2018)

The decline in vision due to AMD has a serious impact on activities of daily living including driving, watching television, face recognition and reading. Vision loss also has wider psychosocial impacts including increased risk of depression, low self-worth and social isolation.(Nyman et al., 2012) Nearly one in two adults with vision impairment experience moderate or severe loneliness.(Brunes et al., 2019) High levels of loneliness lead to lower life satisfaction, poorer lifestyle behaviours, cardiovascular health risks and increased rates of depression.(VanderWeele et al., 2012) These lifestyle changes such as unhealthy dietary patterns and lack of physical activity are especially worrying for individuals with AMD because they are associated with an increased risk of AMD progression.(Dinu et al., 2019; McGuinness et al., 2017) Furthermore, the higher rate of depression is also concerning, as studies show that one in three individuals with AMD meet the diagnostic criteria for depression.(Brody et al., 2001; Casten et al., 2004) Thus, there is a strong unmet need for evidence-based interventions to address the negative social health and wellbeing impacts of vision loss in adults.

With few pharmacological treatment options available for early, intermediate and dry AMD, and treatment largely limited to intravitreal therapy for neovascular AMD, promising epidemiological evidence suggests several modifiable risk factors that play a significant role in AMD pathogenesis, including diet, physical activity and smoking. There is mounting evidence to highlight that mitigating these risk factors by adopting a Mediterranean diet, increasing physical activity and smoking cessation can slow the progression of AMD).(Dinu et al., 2019; McGuinness et al., 2017) Therefore, greater emphasis on lifestyle intervention for visually impaired adults such as those living with AMD is needed to prevent and manage the condition whilst a cure remains elusive.

To date, there are no lifestyle interventions that integrate social support, physical activity and dietary education for patients with AMD. Our group has previously developed successful evidence-based lifestyle interventions such as the Walk N' Talk for your Life (WTL) intervention which reduced loneliness in older adults with hearing loss in Canada and extended to the United Kingdom,(Hwang et al., 2016) and a telehealth dietary intervention for patients with AMD which improved intake of certain aspects of the recommended AMD diet.(Tang et al., 2020) To address the impacts of vision loss on social health and wellbeing, we have incorporated elements of our evidence-based interventions to develop a holistic lifestyle intervention tailored for patients with AMD called the Movement, Interaction and Nutrition for Greater Lifestyles in the Elderly (MINGLE).(Tang et al., 2022) A qualitative grounded-theory study was conducted to explore the barriers and enablers to participation in the MINGLE program.(Kha et al., 2024) This earlier qualitative work provided patient-informed input by directly eliciting the views of people living with AMD about program barriers, preferences and enablers. The findings of the qualitative study were taken into consideration during the development of the MINGLE program, which included greater emphasis on the social aspect of the program, shortening the duration of the program, providing

technical support to improve digital access, and adjusting the information delivered during each session to ensure that it was relevant and easily understood by patients living with AMD.(Kha et al., 2024) In the pilot study itself, participant perspectives were also sought through midpoint and post-intervention feedback questionnaires so that patient feedback could further inform refinement of the intervention. The aim of this pilot study is to evaluate the novel MINGLE intervention in a sample of older Australian adults with AMD to determine its acceptability, feasibility and preliminary efficacy.

Methods

Study design and participants

This study was an 8-week pre-post pilot trial which evaluated the feasibility, acceptability and preliminary efficacy of the MINGLE intervention. The study was conducted in compliance with the ethical guidelines of the Declaration of Helsinki. Ethics approval was provided by the [removed] Human Research Ethics Committee (HREC) on 10th August 2021. Participants were recruited from a private ophthalmology clinic in [removed] and through communications from the Macular Disease Foundation Australia (MDFA), a leading not-for-profit organisation that advocates for people with macular disease in Australia.

Inclusion criteria were: (1) diagnosis of any form of AMD per the AREDS classification; (2) access to a smart phone, tablet, or laptop; (3) able to use Zoom or have someone to help; (4) able to speak and understand English; (5) provide written informed consent to participate and; (5) ability to safely participate in the physical activity components of the intervention by obtaining written physician clearance for participation or passing the Physical Activity Readiness Questionnaire (PAR-Q+). Exclusion criteria were: (1) unable to ambulate or walk for exercise; (2) serious illness limiting ability to complete the trial (including mental and cognitive illness); (3) best-corrected visual acuity worse than 6/60 in both eyes; (4) contraindications to exercise (i.e. failure to fulfil prerequisites of PAR-Q+); (5) uncontrolled hypertension ($\geq 160/90$ mmHg) and; (6) signs or symptoms of alcohol/substance abuse.

Eligible participants were approached and screened by the research assistant in the clinic waiting room, or via telephone for participants from the MDFA who expressed interest in participating. Participants who met the eligibility criteria were enrolled in the study after providing written informed consent. Participants were divided into subgroups based on their preference for available session timings so that smaller Zoom groups could be scheduled at convenient times and to facilitate discussion and supervision during the sessions.

Intervention

The intervention ran for one hour per week for eight weeks online via Zoom, facilitated by a research team member with an exercise physiology qualification. Each session consisted of approximately 10 minutes of informal socialising and a recap of the prior session, 30 minutes of physical activity and 15 minutes of AMD-related nutrition education. Table 1 summarises the schedule of the educational

components. The nutrition education component focused on evidence-based content about important food groups and nutritional supplements to incorporate as part of the habitual diet according to the Australian Dietary Guidelines(NHMRC, 2013) and recommendations for AMD in the research literature. (Chapman et al., 2019) The physical activity component consisted of warm up and cool down exercises as well as tailored strength and cardiovascular exercises based on the physical ability of participants. The Borg Rating of Perceived Exertion Scale was used during the sessions to assess the intensity of the exercises .(Borg, 1982) Modified versions of the exercises were demonstrated to participants who found the exercises too easy or difficult.

Table 1
Overview of the educational components within the Movement, Interaction and Nutrition for Greater Lifestyles in the Elderly (MINGLE) intervention

Week 1	Importance of physical activity and diet
Week 2	Fruits and vegetables
Week 3	Low Glycaemic Index (GI) foods
Week 4	Fish, poultry and dairy
Week 5	Nutritional supplements
Week 6	Convenience foods
Week 7	Myths about AMD
Week 8	Recap
AMD = age-related macular degeneration, GI = glycaemic index	

Outcomes

A baseline questionnaire was administered to collect information on the participants’ AMD diagnosis including stage, type, unilateral or bilateral AMD, and any previous treatments. A pre-post intervention questionnaire was also administered online via Research Electronic Data Capture (REDCap) at baseline and immediately after the 8-week intervention period. This questionnaire captured demographics (age, sex, education, ethnicity, living situation, employment, marital status, income), physical activity, diet, falls self-efficacy, quality of life, loneliness, visual function and intervention acceptability and feasibility. Specific instruments included in this questionnaire were:

1. Short Dietary Questionnaire for Age-Related Macular Degeneration (SDQ-AMD)(Tang et al., 2019) – this is a questionnaire used to capture dietary intake of key food groups linked to management of AMD. Response options to each food item is measured as serves consumed per day or per week, or number of times consumed per week. A higher overall score indicated better alignment with the dietary recommendations.
2. Falls Self-Efficacy Scale-International (FES-I)(Delbaere et al., 2010) – this is a 16-item questionnaire used to capture individuals' concerns about falling. Responses are measured using a four-point Likert Scale ranging from 'Not at all concerned' to 'Very concerned'. The total score varies from 16–64, with a score of 16–19 indicating 'low concern', 20–27 is 'moderate concern' and 28–62 is 'high concern'.
3. Attitude to Falls-Related Intervention Scale (AFRIS),(Yardley et al., 2007) that assessed participant acceptability of the intervention by comparing pre-post mean total scores with possible scores ranging from 6 to 42, with a higher score depicting a more positive attitude towards the intervention.
4. Active Australia Survey,(Welfare, 2003) a 13-item questionnaire measuring frequency and duration of recreational physical activity in the last week, and knowledge of the health benefits of physical activity. The knowledge section of the questionnaire is presented as a five-point Likert scale with response options from 'Strongly Disagree' to 'Strongly Agree.'
5. Assessment of Quality of Life-8 Dimensions (AQoL-8D),(Hawthorne et al., 1999) a 35-item that includes eight individually scored dimensions. The scores for each dimension are: 4–22 for independent living, 7–34 for relationships, 8–41 for mental health, 3–15 for coping, 3–13 for pain, 3–16 for senses, 3–15 for self-worth and 4–20 for happiness. Total scores range from 35 to 176, with higher scores indicating worse health-related quality of life.
6. De Jong Gierveld Loneliness Scale(Gierveld & Tilburg, 2006) – this is a validated 6-item questionnaire used to measure overall, emotional and social loneliness. The scores range from 0 (not lonely) to 6 (extremely lonely).
7. National Eye Institute Visual Function Questionnaire-25 (VFQ-25)(RAND, 1998) – this is a validated 25-item questionnaire used to measure self-reported vision-related health status. The VFQ-25 subscales consist of general health, general vision, ocular pain, near activities, distance activities, social functioning, mental health, role difficulties, dependency, driving, colour vision and peripheral vision. The composite VFQ-25 score is an average of the items within each subscale where a higher score indicates better functioning.

To assess intervention acceptability and adherence, participants were asked to complete a brief feedback questionnaire at the halfway point of the intervention (week four) and immediately following the intervention period (week eight). The midpoint questionnaire included a multiple-choice question asking participants to rate their satisfaction with the sessions on a scale of 1 (Not good/boring) to 5 (Excellent/interesting), a question to select whether they wanted (1) more time to socialise with each other and/or (2) more time for nutrition education and/or (3) more time to discuss the nutrition education as a group, and/or (3) more time for the exercise component, and a free-response question to collect additional feedback or comments. The post-intervention survey included questions on

intervention satisfaction, self-rated adherence to the dietary advice and general feedback. Attendance data was also collected to report the number of sessions attended and completed, as well as any reasons for missed sessions.

Sample size

Sample size estimation was conducted using G*Power 3.1 software. Assuming a 0.4 effect size using Cohen's d and 80% power, a minimum of 52 participants were required for a full trial to achieve a significant pre-post change in the primary outcome of loneliness. This effect size was chosen because it was the average effect size of our previous WTL-related work for loneliness i.e., 0.43 and 0.35.

Data analysis

Data were collected via online self-report questionnaires linked to an online electronic database (REDCap) and analysed using SPSS version 25 (Armonk, USA). Normally distributed data were expressed as mean $\pm$ SD, and data that were not normally distributed were expressed as median $\pm$ ranges. The level of significance for all statistical analyses was $p < 0.05$. Paired t-tests were used to compare the means of the quantitative outcome measures prior to and after completing the intervention

Results

Feasibility of Recruitment, Retention and Adherence

Figure 1 summarises participant recruitment and retention for the MINGLE study. A total of 214 patients were approached, and 54 potential participants were screened between December 2022 and May 2023 (Fig. 1). Recruitment occurred through both a private ophthalmology clinic and communications from the MDFA. Thirty-seven did not meet the eligibility criteria. The remaining 17 participants were enrolled in the study, with one participant withdrawing from the study as they were no longer able to commit to the intervention. Table 2 displays the demographic characteristics of the 16 study participants who completed the intervention and follow-up. The 16 participants who completed the 8-week intervention had a mean age of 77.0 ± 8.4 years, 62.5% were female, 75% were Caucasian, and 75% had university or college degrees.

Table 2
Demographic characteristics of enrolled participants
at baseline (N = 16).

Variable	
Age (years), mean (SD), range	77.0 (8.4), 63–91
Sex (female), n (%)	10 (62.5)
Ethnicity (Caucasian), n (%)	12 (75.0)
Education, n (%)	
High school	4 (25.0)
College	1 (6.2)
University	11 (68.8)
Living alone, n (%)	6 (37.5)
Married/de-facto, n (%)	11 (68.8)
Currently employed, n (%)	1 (6.2)
Living in rental housing, n (%)	5 (31.3)

Preliminary estimates of change in quantitative outcome measures

Table 3 summarises the pre-intervention and post-intervention changes in outcome measures. There were no statistically significant differences in quantitative outcome measures at baseline versus eight weeks post-intervention. Non-significant improvements in moderate-to-vigorous physical activity, falls self-efficacy, loneliness and visual function were observed. There were non-significant declines in adherence to dietary recommendations for AMD, attitudes towards falls intervention, and an increase in AQoL-8D scores, indicating worse health-related quality of life.

Table 3

Baseline, post-intervention and preliminary estimates of change in outcome measures for participants who completed the 8-week pilot study.

Outcome measure	Baseline, mean (SD)	Postintervention, mean (SD)	Change, mean (SD)	Improved or declined	p-value	95% CI for change
Moderate-to-vigorous physical activity (MVPA) (minutes/week)	512.2 (451.0)	576.9 (426.0)	64.7 (315.0)	Improved	0.42	-103.2 to 232.6
Diet score (0–30 points)	18.6 (4.2)	17.4 (4.4)	-1.2 (6.67)	Declined	0.49	-4.7 to 2.4
Attitude to Falls-Related Intervention Scale (AFRIS) (6–42 points)	34.6 (5.8)	32.9 (7.2)	-1.7 (6.7)	Declined	0.32	-5.2 to 1.9
Falls Efficacy Scale International (FESI) (16–64 points)	27.8 (11.8)	26.5 (9.9)	-1.3 (7.3)	Improved	0.50	-5.1 to 2.6
De Jong Gierveld Loneliness Scale (DJGLS) (0–11 points)	2.0 (1.5)	1.9 (1.6)	-0.1 (1.4)	Improved	0.86	-0.7 to 0.8
Assessment of Quality of Life – 8 Dimensions (AQOL-8D) (35–176 points)	72.9 (14.1)	75.9 (13.2)	3.0 (6.4)	Declined	0.08	-0.4 to 6.4
Visual Function Questionnaire (VFQ-25) (0-100 points)	70.0 (27.1)	72.2 (25.6)	2.2 (6.3)	Improved	0.18	-16.8 to 21.2

Acceptability of the MINGLE intervention

Of the 16 participants enrolled in the MINGLE intervention, attendance rates out of a total of eight sessions ranged from four to eight sessions, with 12 (75%) participants attending at least seven sessions. Reasons reported for non-attendance included illness or medical appointments, competing personal commitments, travel, and temporary difficulty joining the online session.

From the mid-point feedback survey delivered after Session 4, 12 (75%) participants found the intervention ‘really good’ or ‘excellent’. Most (n = 11, 68.8%) wanted more time for nutrition education and group discussion on this, while half wanted more time for casual conversation and seven participants (43.8%) wanted more time for the group exercise activity. Additional comments or feedback indicated

that participants were interested to learn more about practical strategies to use to improve their diet and physical activity at home:

"...what I would appreciate is knowing how people who already have low vision due to their AMD-particularly if they live on their own, prepare healthy meals, i.e. how do they cut their fruit and vegetables?" ID11

"I'd like diagrammatic info on the exercises emailed so I can practice them between sessions." ID17

In the post-intervention feedback survey, we found that: 14/16 (87.5%) were 'satisfied' or 'very satisfied' with the intervention; 15/16 (93.8%) felt they adhered to the dietary advice discussed in the intervention; 15/16 (93.8%) would recommend the intervention to a friend and felt it was worth participating in.

Discussion

This study evaluated the acceptability, feasibility and preliminary efficacy of an online, holistic lifestyle intervention delivered via Zoom for older adults living with AMD. The intervention was acceptable to participants based on their feedback and adherence rates. However, small participant numbers indicate a need for longer recruitment timeframes and wider target populations to improve feasibility and ensure adequate study power to detect changes in key outcome measures.

According to power calculations, 52 participants were required. Difficulties in achieving this target were linked to the inclusion criteria specificity, as 37 out of 54 screened participants were excluded. Technological access and utilisation were key limiting factors in the targeted demographic as 19.6% (n = 11) of potential participants lacked access or ability to use Zoom. This also highlights the issue of digital exclusion in older adults, where barriers can include limited access to devices or internet, low digital confidence, reduced digital literacy, and concern about using unfamiliar technology.(Wilson et al., 2023) According to a qualitative study by Wilson et al., some older adults who did have access to technology for social connection expressed that their use was limited by a perception of low self-efficacy and fear. (Wilson et al., 2023) We attempted to improve the usability of Zoom by offering individualised one-on-one calls to educate participants on how to interface with Zoom and providing a user-guide on it. However, integrating education sessions about technology and/or digital literacy in general may help to better address usability concerns and digital exclusion in future iterations. Lack of time to participate in the 8-week intervention (17.9%, n = 10) was another reason for non-participation. This reason was also identified in qualitative interviews prior to the piloting of MINGLE and led to a reduction in intervention duration from 10 weeks to eight weeks.(Kha et al., 2024) As these preferences were elicited in the midpoint survey after Session 4, where participants selected whether they wanted more time for socialising, nutrition education, nutrition discussion, and/or exercise, future iterations of MINGLE could more directly reallocate session content in response. For example, the intervention could retain brief chair-based exercise during the Zoom sessions while shifting more of the 60-minute session toward nutrition education, peer discussion and practical problem-solving, with home exercise handouts or emailed exercise diagrams to support activity between sessions. A revised format could also test

shorter or less demanding online sessions to reduce participation burden while preserving the social support and education components.

Lack of time to participate in the 8-week intervention (17.9%, $n = 10$) was another reason for non-participation. This reason was also identified in qualitative interviews prior to the piloting of MINGLE and led to a reduction in intervention duration from 10 weeks to eight weeks.(Kha et al., 2024) The originally proposed 10-week MINGLE intervention was adapted from the 10-week in-person Walk, Talk and Listen intervention by.(Jones et al., 2019) Accounting for the feedback from MINGLE participants where 68.8% preferred additional time for nutrition education and discussion compared to 43.8% in favour of more exercise time, the MINGLE intervention could be revised to involve less commitment via Zoom. That is, the revised intervention would focus on nutrition education and discussion during the Zoom calls, with recommendations for how participants integrate the taught exercises into their own schedules. This change may also enable participants who have contraindications to exercise due to pre-existing health conditions, to be included.

Regarding the preliminary efficacy of the MINGLE intervention, statistical analyses of data from 16 participants does not offer adequate power but shows an indication of improvements in moderate-to-vigorous physical activity, falls self-efficacy, loneliness and visual function. Interestingly, these preliminary data identified the intervention to have been associated with declines in self-reported adherence to dietary recommendations for AMD and subjective quality of life reporting. The apparent decline in dietary adherence was observed at the post-intervention assessment and may reflect that, after exposure to the educational content, participants judged their own diets more critically against the recommended AMD diet. Decline in dietary adherence may also be associated with the program running towards the end of 2023 and close to the year-end holidays like Christmas, which is associated with dietary fluctuations.(Abdulan et al., 2023) Nevertheless, coupled with participant feedback and adherence, the intervention could be well-received and beneficial to older adults with AMD following changes to intervention design and recruitment strategy. Similar digital health initiatives have been shown to benefit older adults. The evidence provided by Boucher et al. underscores that older adults can indeed engage with and benefit from digital wellbeing platforms, showing improvements in subjective wellbeing and anxiety when adhering to the recommended levels of engagement.(Boucher et al., 2022) Similarly, another recent study demonstrated that tele-exercise interventions could mitigate the negative impacts of isolation and promote physical and psychological benefits among older adults, even during high-stress periods like the COVID-19 pandemic.(Ho & Merchant, 2022) Additionally, a systematic review further confirms that home-based digital interventions can effectively enhance physical function, reduce fall risk, and improve quality of life in older adults.(Solis-Navarro et al., 2022) Together, these studies provide support for the MINGLE intervention's potential to facilitate community, physical engagement, and disease education among older adults with AMD, validating its design within the broader success of digital health interventions in this population.

Strengths and Limitations

A strength of this pilot study is that it contributes important knowledge about the feasibility and acceptability of a virtually delivered holistic lifestyle intervention for older adults with AMD. It provides insight into participant perspectives on such an intervention and highlights the challenges and barriers that need to be addressed before wider implementation. In addition, this study utilised self-reported outcome measures that have been validated in terms of reliability in previous studies. A major limitation of this study was its small sample size, which resulted in underpowered statistical analyses.

Recommendations for Future Research

Future studies seeking to implement an online intervention akin to our pilot should explore alternative strategies to improve recruitment and consider optimising inclusion criteria to promote the eligibility of a wider pool of participants from diversified recruitment sources. Additional recruitment methods could include the use of social media, local newspaper advertisements, posters in clinics, or direct distribution of information sheets via healthcare providers. Moreover, modifying the design of the MINGLE intervention to reduce commitment burden, or offering in-person delivery to eliminate challenges with technology usage may also improve recruitment. However, the benefits of a proposed in-person extension are partially speculative, as only a virtual modality was assessed for its feasibility in our study.

Feedback from the midpoint survey suggests several potential improvements to the MINGLE program. Future versions may benefit from incorporating community-based education sessions on AMD and modifiable risk factors, which could serve both to inform participants and support recruitment. To enhance acceptability and feasibility, future iterations of the MINGLE program may benefit from longer session durations to allow more time for social connection and peer learning, particularly around challenges and solutions related to daily activities, nutrition, and exercise. Additional strategies to enhance engagement could include structured group nutrition education, expanded exercise components, and the use of printed handouts or personal journals to support knowledge retention and self-monitoring both in and out of sessions to enhance participant adherence. Lessons learned from this pilot were that recruitment for an online AMD intervention should account for digital exclusion from the outset, participant burden appears lower when session content emphasises practical nutrition education and peer discussion, exercise support may be better delivered in a simplified or partly home-based format, and ongoing patient feedback during the intervention is valuable for refining delivery.

Conclusion

The findings of this study support the hypothesis that our virtually delivered lifestyle intervention for AMD is feasible and acceptable in a small cohort of older adults with AMD. Although there were improvements in moderate-to-vigorous physical activity, falls self-efficacy, loneliness and visual function, these were not statistically significant, likely owing to the small sample size of our study. There were non-significant declines in adherence to dietary recommendations for AMD, attitudes towards falls intervention, and health-related quality of life due to sample size. However, the high adherence to the intervention and participant satisfaction warrants further studies to optimise the intervention due to the potential benefits for AMD patients. Future studies should evaluate the MINGLE intervention using a

larger cohort and longer follow-up time, as well as explore ways to improve recruitment and accessibility, potentially by delivering the intervention face-to-face or through other programs which optimise digital adherence.

Declarations

Competing Interests

The authors declare that they have no relevant financial or non-financial interests to disclose.

Ethics Approval

Local Health District Human Research Ethics Committee (HREC) Approval was granted on 10th August 2021.

Consent to Participate

Informed consent was obtained from all individual participants included in the study.

Consent to Publish

Not applicable. This manuscript does not contain any individual person's identifiable data, images, or videos. Anonymised participant quotations included in the manuscript are reported with participant ID numbers only, and cannot be used to identify any individual.

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Author Contribution

D.T, B.G, R.M, C.J and N.B contributed to the study conception and design. D.T, B.G, R.M and C.J secured funding. A.M and R.K wrote the main manuscript, and contributed to data collection and analysis. All authors read and approved the final manuscript.

Data Availability

Anonymised aggregate data is available upon request.

References

1. Abdulan, I. M., Popescu, G., Maștaleru, A., Oancea, A., Costache, A. D., Cojocaru, D. C., Cumpăt, C. M., Ciuntu, B. M., Rusu, B., & Leon, M. M. (2023). Winter holidays and their impact on eating behavior—A systematic review. *Nutrients*, 15(19), 4201.
2. Borg, G. A. (1982). Psychophysical bases of perceived exertion. *Medicine & science in sports & exercise*, 14(5), 377–381.
3. Boucher, L. M., Shoemaker, E. S., Liddy, C. E., Leonard, L., MacPherson, P. A., Presseau, J., Martin, A., Pineau, D., Lalonde, C., & Diliso, N. (2022). They're all struggling as well: social and economic barriers and facilitators to self-managing chronic illness among marginalized people who use drugs. *International Journal of Qualitative Studies on Health and Well-Being*, 17(1), 2082111.
4. Brody, B. L., Gamst, A. C., Williams, R. A., Smith, A. R., Lau, P. W., Dolnak, D., Rapaport, M. H., Kaplan, R. M., & Brown, S. I. (2001). Depression, visual acuity, comorbidity, and disability associated with age-related macular degeneration. *Ophthalmology*, 108(10), 1893–1900.
[https://doi.org/10.1016/s0161-6420\(01\)00754-0](https://doi.org/10.1016/s0161-6420(01)00754-0). discussion 1900 – 1891.
5. Brunes, A., M, B. H., & Heir, T. (2019). Loneliness among adults with visual impairment: prevalence, associated factors, and relationship to life satisfaction. *Health And Quality Of Life Outcomes*, 17(1), 24. <https://doi.org/10.1186/s12955-019-1096-y>
6. Casten, R. J., Rovner, B. W., & Tasman, W. (2004). Age-related macular degeneration and depression: a review of recent research. *Current Opinion In Ophthalmology*, 15(3), 181–183.
<https://doi.org/10.1097/01.icu.0000120710.35941.3f>
7. Chapman, N. A., Jacobs, R. J., & Braakhuis, A. J. (2019). Role of diet and food intake in age-related macular degeneration: a systematic review. *Clinical & Experimental Ophthalmology*, 47(1), 106–127.
8. Delbaere, K., Close, J. C., Mikolaizak, A. S., Sachdev, P. S., Brodaty, H., & Lord, S. R. (2010). The Falls Efficacy Scale International (FES-I). A comprehensive longitudinal validation study. *Age And Ageing*, 39(2), 210–216. <https://doi.org/10.1093/ageing/afp225>
9. Dinu, M., Pagliai, G., Casini, A., & Sofi, F. (2019). Food groups and risk of age-related macular degeneration: a systematic review with meta-analysis. *European Journal Of Nutrition*, 58(5), 2123–2143. <https://doi.org/10.1007/s00394-018-1771-5>
10. Gierveld, J. D. J., & Tilburg, T. V. (2006). A 6-Item Scale for Overall, Emotional, and Social Loneliness: Confirmatory Tests on Survey Data. *Research on Aging*, 28(5), 582–598.
<https://doi.org/10.1177/0164027506289723>
11. Hawthorne, G., Richardson, J., & Osborne, R. (1999). The Assessment of Quality of Life (AQoL) instrument: a psychometric measure of health-related quality of life. *Quality Of Life Research*, 8(3), 209–224. <https://doi.org/10.1023/a:1008815005736>
12. Ho, V., & Merchant, R. A. (2022). The acceptability of digital technology and tele-exercise in the age of COVID-19: cross-sectional study. *JMIR aging*, 5(2), e33165.
13. Hwang, J., Wang, L., & Jones, C. (2016). Tackling social isolation and loneliness through community exercise programs for seniors. *UBC Medical Journal*, 8(1), 40–41.

14. Jones, C. A., Siever, J., Knuff, K., Van Bergen, C., Mick, P., Little, J., Jones, G., Murphy, M. A., Kurtz, D., & Miller, H. (2019). Walk, Talk and Listen: a pilot randomised controlled trial targeting functional fitness and loneliness in older adults with hearing loss. *British Medical Journal Open*, 9(4), e026169. <https://doi.org/10.1136/bmjopen-2018-026169>
15. Kha, R., Wen, Q., Bender, N., Jones, C., Gopinath, B., Macniven, R., & Tang, D. (2024). Understanding barriers and enablers to participation in a proposed online lifestyle intervention for older adults with age-related macular degeneration to guide programme implementation. *Journal of Health Psychology*, 29(4), 317–331.
16. McGuinness, M. B., Le, J., Mitchell, P., Gopinath, B., Cerin, E., Saksens, N. T. M., Schick, T., Hoyng, C. B., Guymer, R. H., & Finger, R. P. (2017). Physical Activity and Age-related Macular Degeneration: A Systematic Literature Review and Meta-analysis. *American Journal Of Ophthalmology*, 180, 29–38. <https://doi.org/10.1016/j.ajo.2017.05.016>
17. Mitchell, P., Liew, G., Gopinath, B., & Wong, T. Y. (2018). Age-related macular degeneration. *Lancet*, 392(10153), 1147–1159. [https://doi.org/10.1016/s0140-6736\(18\)31550-2](https://doi.org/10.1016/s0140-6736(18)31550-2)
18. NHMRC, N. (2013). Australian dietary guidelines. *National Health and Medical Research Council, National Resource Management Ministerial Council*.
19. Nyman, S. R., Dibb, B., Victor, C. R., & Gosney, M. A. (2012). Emotional well-being and adjustment to vision loss in later life: a meta-synthesis of qualitative studies. *Disability and rehabilitation*, 34(12), 971–981.
20. RAND (1998). *Visual Function Questionnaire (VFQ-25)*. Retrieved Accessed 15 Mar 2023 from https://www.rand.org/health-care/surveys_tools/vfq.html
21. Solis-Navarro, L., Gismero, A., Fernández-Jané, C., Torres-Castro, R., Solá-Madurell, M., Bergé, C., Pérez, L. M., Ars, J., Martín-Borràs, C., & Vilaró, J. (2022). Effectiveness of home-based exercise delivered by digital health in older adults: a systematic review and meta-analysis. *Age and ageing*, 51(11), afac243.
22. Tang, D., Macniven, R., Bender, N., Jones, C., & Gopinath, B. (2022). Development, implementation and evaluation of the online Movement, Interaction and Nutrition for Greater Lifestyles in the Elderly (MINGLE) program: The protocol for a pilot trial. *PLoS One*, 17(5), e0267581.
23. Tang, D., Mitchell, P., Liew, G., Burlutsky, G., Flood, V., & Gopinath, B. (2019). Evaluation of a Novel Tool for Screening Inadequate Food Intake in Age-Related Macular Degeneration Patients. *Nutrients*, 11(12). <https://doi.org/10.3390/nu11123031>
24. Tang, D., Mitchell, P., Liew, G., Burlutsky, G., Flood, V. M., & Gopinath, B. (2020). Telephone-delivered dietary intervention in patients with age-related macular degeneration: 3-month post-intervention findings of a randomised controlled trial. *Nutrients*, 12(10), 3083.
25. VanderWeele, T. J., Hawkey, L. C., & Cacioppo, J. T. (2012). On the reciprocal association between loneliness and subjective well-being. *American Journal Of Epidemiology*, 176(9), 777–784. <https://doi.org/10.1093/aje/kws173>

26. Welfare, A. I., & o., H. (2003). *The Active Australia Survey: a guide and manual for implementation, analysis and reporting*. Retrieved Accessed 15 Mar 2023 from <https://www.aihw.gov.au/reports/physical-activity/active-australia-survey/summary>
27. Wilson, G., Gates, J. R., Vijaykumar, S., & Morgan, D. J. (2023). Understanding older adults' use of social technology and the factors influencing use. *Ageing & Society*, 43(1), 222–245.
28. Yardley, L., Donovan-Hall, M., Francis, K., & Todd, C. (2007). Attitudes and beliefs that predict older people's intention to undertake strength and balance training. *Journals Of Gerontology. Series B, Psychological Sciences And Social Sciences*, 62(2), P119–125.
<https://doi.org/10.1093/geronb/62.2.p119>

Figures

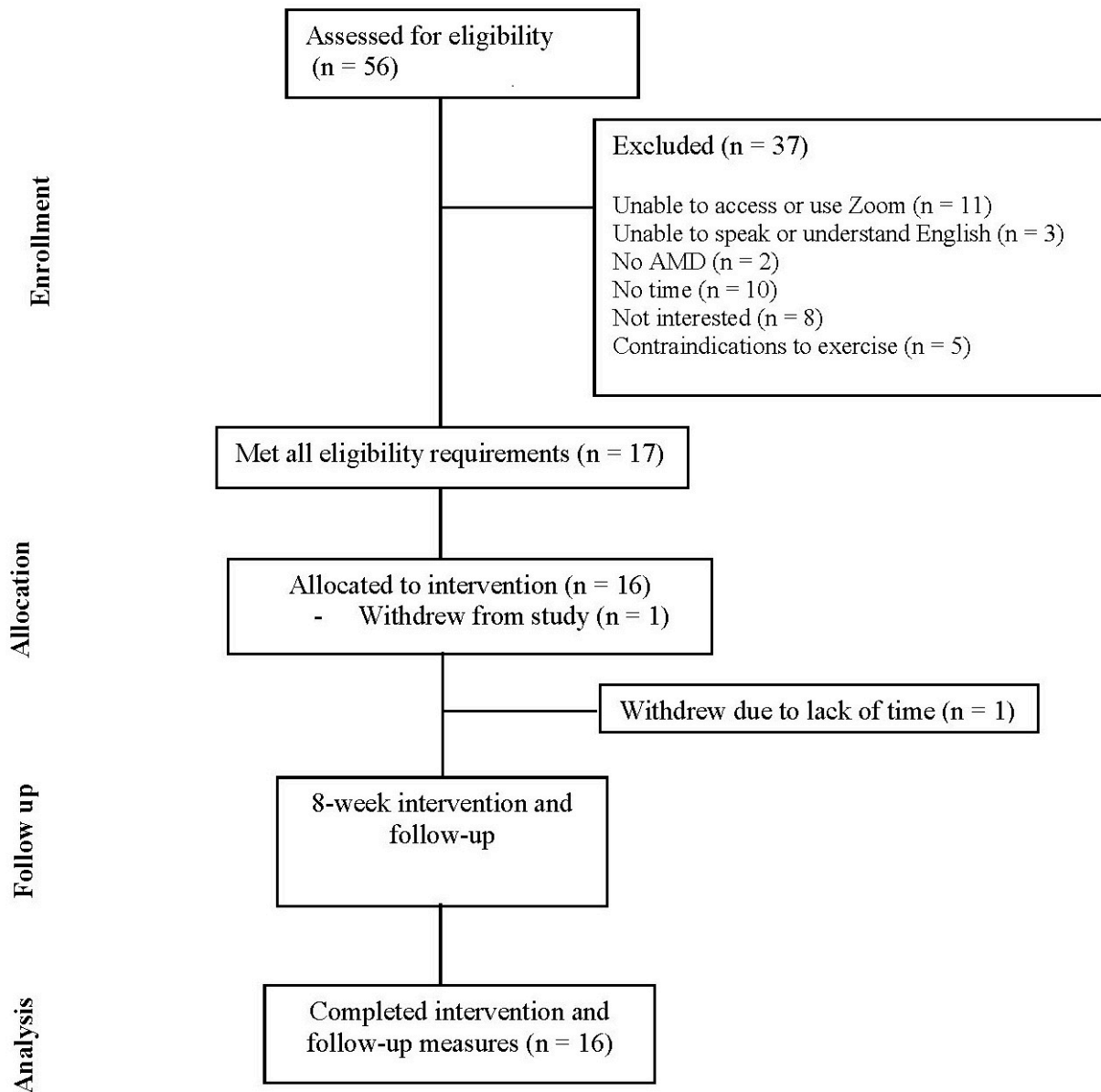


Figure 1. This flow chart summarises participant recruitment and retention for the MINGLE study

Figure 1

See image above for figure legend