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## Home modification guidelines as recommended by visually impaired people

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### Abstract

**Purpose** – *The purpose of this paper is to provide an evidence-base for home modification guidelines for people with visual impairment due to age-related macular degeneration (AMD), from the perspective of people with AMD, by exploring the home modifications they find useful and would recommend to other people with visual impairment due to AMD as being effective.*

**Design/methodology/approach** – *People with impairments may not be aware of their own coping with inability strategies until they are asked to express their strategies. A qualitative approach using semi-structured individual interviews was used to elicit the perspectives of people with AMD with regards to their preferred home modification interventions. Interviews were recorded and then transcribed verbatim into text for thematic analysis using Nvivo 8.*

**Findings** – *In total, 31 individuals (aged  $79.1 \pm 5.6$  years) with AMD and no other ocular diseases were recruited from a low vision clinic or the Macular Degeneration Foundation database in a metropolitan city. Interviewees had not received any formal home modification assessment from a government provider. Nevertheless, 70 per cent of participants stated that they undertook home modifications themselves or with the assistance of family and friends. The most important functional modifications as perceived by the participants concerned the installation of hand rails, non-slip matting, colour contrasting safety stair nosing, single lever taps, slip resistant flooring, lift chairs and motion sensors that activated pathway lighting. Kitchens, steps and bathrooms were perceived as hazardous locations. Most participants had difficulties with reading fine-print material on kitchen appliances, washing machines, microwave ovens and remote controls for electronic devices in the home.*

**Originality/value** – *An evidence-base for useful home modifications as suggested by people with visual impairment was perceived to be a valuable resource for other people with visual impairment who may not yet have developed adaptive strategies. Industrial and interior designers and low vision rehabilitation services who aim to improve functionality of the home environment will also find these suggestions useful.*

**Keywords** *Diseases, Conditions and injuries, Eyes, Visual perception, Adaptability, Macular degeneration, Home modification, Guidelines*

**Paper type** *Research paper*

### Introduction

Home modification is the conversion or adaptation of the living environment to make task performance easier, safer and more secure (Pynoos *et al.*, 2003). Typically, modifications include changes or additions to building structure, such as installing handrails. However, modifications may also include relocating items, remodelling and redecoration (McCullagh, 2006). A home modification assessment requires individual needs, capabilities and lifestyle to be considered. Home modification is known to have a positive impact on ability to carry out activities of daily living (ADLs) (Gitlin *et al.*, 2006). People with visual impairment also have difficulties with the activities of daily living, however, less is known about the housing and modification needs for people with visual, rather than physical impairments (Hanson, 2005; Hanson *et al.*, 2004).

The authors thank the MD Foundation for assistance in recruiting participants, Vision Australia for assistance with transcribing of interviews, Dr Sharon Haymes for a copy of the MLVI and Dr Arthur Ho for access to the McMonnies-Ho visual acuity chart. Special thanks to Baqiyatallah University of Medical Sciences for their financial support of the first author.

There are many checklists and guidelines for home modification for people with visual impairment available. These tend to be over-generalised since they stem primarily from expert opinion and customary practice and little empirical research is cited. For example, most if not all guidelines do not distinguish between the different causes and characteristics of visual impairment and, as a consequence, the different interventions needed. Well meant – environmental characteristics may be unhelpful to some and apparently undesirable features may benefit others. In terms of individual needs, capabilities and lifestyle we must ask not only “is it good?” but also, “good for whom?” (Kahana, 1982). For example, the often-proposed recommendations on colour contrast between the door and walls, support structures, furniture and flooring will not be effective if a person has reduced colour discrimination which is a common feature of visual impairment. The notion of increasing light levels by a magnitude of two to three times that required needed by a normally sighted person is often uncomfortable and unhelpful for people with retinitis pigmentosa or with media opacities causing disability glare.

Age-related macular degeneration (AMD) is a major cause of visual impairment and blindness among elderly people in developed nations (Klein, 2007). It impairs central vision, which is needed for activities such as reading, writing, driving, and face recognition and results in severe effects on visual function and activities of daily living (Hassell *et al.*, 2006). Commonly affected activities of daily living include negotiating steps, using the kitchen, self-care and walking (Mann *et al.*, 1993). Since people with such visual impairment have, generally, lost vision gradually their familiarity with the home environment may make environmental interventions undesirable. Since most people with visual impairment prefer to continue to live in one place as long as possible, their increasing age and the state of their buildings means that their homes become more challenging places to live (Oswald *et al.*, 2007; Wahl *et al.*, 1999). This mismatch between the home's features and person's abilities may be reduced by home modification to improve their performance of daily activities (Cumming *et al.*, 1999).

Given the need for home modifications of people with visual impairment due to AMD and the lack of clear evidence that currently available guidelines are optimised for their needs, the aim of this study is to provide evidence from the perspective of people with visual impairment due AMD about the home modifications they find useful and would recommend to other people with similar visual impairment.

## Method

People with impairments may not be aware of their own styles of coping with inability until they have been asked to describe their strategies (Moore, 1999). A qualitative approach using semi-structured individual interviews was used to elicit the perspectives of people with AMD with regards to home modifications. This approach has been used previously to investigate the experiences of people with visual impairment relating to housing needs (Hanson and Percival, 2005; Moffatt *et al.*, 2006) and its advantages include that the two-way communication leads to a richness of data and deeper insight into the topic (Silverman, 2004). The interview comprised a set of open-ended questions where the participants were asked to describe their current home environment and report any strategies or difficulties encountered when carrying out tasks. The interviewer asked about the home modifications that had been made using a room-by-room sequence starting with the approach to the home followed by the front door, hallway, bathroom and toilet, kitchen, stairs, windows, doors and bedroom. The room-by-room questioning approach used in the interview is used by occupational therapists when considering safety assessment and functions in the home environment and is also the way home modification recommendations are usually considered (Barker *et al.*, 1995; Hanson and Percival, 2005; Lighthouse International, 2008; Long, 1995; McCullagh, 2006). Questions regarding each room were structured to distinguish between those home modifications regarded as useful and which are related to their vision and those which are not. For example, when asking about the approach to the home, the following questions were asked: “Tell me about your vision problems when you enter your home from the street? What do you find easy to see and difficult to see in the walkways, steps and curb?”

How may they be a risk or hazard? What kind of modification would make it easier to remove or reduce the risk? What is your strategy to cope with this problem? What should be installed or removed from this area to make it more friendly to you?" The interview was designed to elicit responses specifically about what is easy and difficult to see and the changes which can be made in behaviour and the home environment which reduce the difficulties due to vision, rather than other reasons. The final question asked participants "Is there anything else that you would like to say about your point of view in respect of modification, which may be helpful for future provision of information for people with visual impairment?" These questions and this approach were reviewed for face and content validity by an optometrist with experience in low vision research, a person expert in vision research and the occupational and environmental aspects of visual function, an occupational therapist and an expert in the area of enabling environments who is a directs a program which disseminates the evidence base for home modification interventions in Australia and ensured that they were targeted to vision, rather than other problems. Interviews took place in the UNSW Optometry Clinic over the period, August-December 2008 and were of 20-40 minutes in duration. Interviews were audio taped and transcribed verbatim into text by professional volunteer transcribers. The transcripts were checked against the audiotapes for accuracy. All transcriptions were then entered into Qualitative Research Software (QSR) Nvivo 8 for analysis of the data. Analysis of data was performed with systematic examination of the transcription in order to find similar themes and points of views. Key participant quotations were chosen to highlight the importance of specific findings.

The ocular health and visual status of the participants were characterised by clinical testing consisting of habitual visual acuity, contrast sensitivity (Melbourne Edge Test) visual fields (Humphrey threshold 30-2), ability to perform daily living activities (Melbourne Low Vision Index) and fundus photograph to grade severity of AMD (The Age-Related Eye Disease Study Research Group, 2001). Cognitive status was assessed using the mini mental exam (MMSE) and only those individuals with normal cognitive function were recruited. In addition, general medical history was also obtained to characterise the other challenges to function which are not vision-related.

Recruitment was via a mailed letter sent to either eligible subjects attending a university low vision clinic or the Macular Degeneration Foundation member database. Participant inclusion criteria were:

- visual impairment as defined by the World Health Organisation;
- diagnosed AMD and no other ocular or visual diseases;
- aged >60 years;
- living with AMD for at least six months (to ensure participant had time to develop compensatory behaviours and coping strategies to the visual impairment); and
- no cognitive problem (MMSE score > 23).

Older adults with vision impairment frequently experience co-morbidity. These co-morbid conditions are usually associated with difficulties in performance of daily living activities (Crews *et al.*, 2009). Our study did not exclude participants on the basis of co-morbidities as many people with AMD have co-morbidities; however, the questioning strategy was designed so that the participants distinguished between those home modifications which were useful because of their vision difficulty and those which were useful for other reasons. It was reasoned that those people with normal cognitive function as indicated by the MMSE score >23 should be able to distinguish between these two scenarios. The lack of research on the impact of home environmental modification on the quality of life among patients with AMD points to a need to understand in-depth the processes involved in managing home environment strategies that may have been employed by these patients. Therefore, a sample target of 20-30 participants was selected as being the minimum number required (Smythe and Giddings, 2007). Thematic saturation, where the ideas unearthed by subsequent interviewees are not different from earlier participants, was used to indicate when sufficient sample size was achieved. In this study, thematic saturation was achieved at

15-20 participants. The Human Research Ethics Advisory Panel, UNSW, approved the method for this study and all participants gave their informed consent.

## Results

### Participants

42 of 450 people responded, resulting in a response rate of 9 per cent. There were 31 participants, 23 women with mean age 78.7 years (SD = 6.0) and eight men with mean age 80.5 years (SD = 4.5). The main reason for people who responded but did not participate was difficulty with transport to the clinic. Data regarding participants' demographic and clinical characteristics are presented in Table I. It may be seen that some of the participants had mild visual impairment according to visual acuity measures and WHO criteria so had impaired vision but not low vision. However, they had deficits in their visual fields and contrast sensitivity that impacted on their interaction with their home environment and their ability to complete the activities of daily living so their experiences were included. Many of the participants presented with age-related co-morbidities with the following reported and some participants having more than one condition: arthritis ( $n = 15$ ), osteoporosis ( $n = 6$ ), diabetes ( $n = 4$ ), hearing problems ( $n = 1$ ), and other problems (heart problems, lungs problems, digestive problems, asthma, high blood pressure, high cholesterol and skin cancer) ( $n = 7$ ). Only two participants presented with no comorbidities. Approximately half of the participants lived in a house and half lived in a unit. All participants were residents of Sydney, Australia, so their suggestions will reflect the housing styles of this location.

**Table I** Clinical and demographic characteristics of participants with AMD

<i>Habitual vision (log MAR)</i>	
Better eye	Mean $\pm$ SD 0.9 $\pm$ 0.7
Worse eye	Mean $\pm$ SD 1.5 $\pm$ 0.9
Both eyes	Mean $\pm$ SD 1.3 $\pm$ 0.9
<i>WHO category of visual impairment</i>	
Mild	$n = 11$
Moderate	$n = 7$
Severe	$n = 7$
Blindness	$n = 6$
<i>Type of MD</i>	
Dry	$n = 16$
Wet	$n = 15$
<i>Binocular MET contrast sensitivity (dB)</i>	
	Mean $\pm$ SD 12.4 $\pm$ 3.3
	Range 3-16
<i>Humphrey VF mean deviation (dB)</i>	
Better eye	Mean $\pm$ SD -7.6 $\pm$ 4.9
Worse eye	Mean $\pm$ SD -12.3 $\pm$ 7
<i>Educational level achieved</i>	
Did not complete secondary education	$n = 12$
Completed secondary education	$n = 11$
Completed tertiary education	$n = 8$
<i>Marital status</i>	
Married	$n = 9$
Widowed	$n = 10$
Divorced/single	$n = 12$
<i>Co-morbidity</i>	
Arthritis	$n = 11$
Osteoporosis	$n = 2$
Arthritis + osteoporosis	$n = 4$
Diabetes	$n = 4$
Hearing problems	$n = 1$
Other health problems (heart and lung problems, high blood pressure, high cholesterol, skin cancer, stroke, digestive, asthma, etc.)	$n = 7$
Healthy	$n = 2$

## Use of home modification services

The majority of participant had made some kind of home modification either by themselves or through their family and friends. None of the participants had accessed low vision rehabilitation professionals to recommend home modifications. All participants agreed that use of home modifications could assist in adaptation and better quality of life when adapting to vision loss and had the potential to reduce difficulties experienced in the performance of daily living but participants were unaware that this could be a formally structured intervention. Despite this lack of knowledge about access to professional home modification services, personal recommendations about useful home recommendations in relation to their visual impairment due to AMD were readily forthcoming and are categorised by room, lighting and magnification subheadings in Table II. Contrast was a recurring theme in their recommendations and recognised as necessary for object or item visibility (door, walls and furniture) and task performance. Lighting modification was another major theme with suggestions for how lighting could aid specific tasks. Participants stated that lights should be installed inside cupboard to decrease reliance on room lighting, over keyholes, in portable key-rings, lamps and lighting should be relocated so that they do not cast shadows while reading or while walking, lighting along walkways particularly staircases should be even (not just at the top and bottom of staircases) and they noted that lights could benefit from automation (motion sensors and timers) so that there is less need for a person to locate a light switch to turn lights on and off. In illuminating engineering terms, they were recommending task lighting over general lighting. Finally, location of their home was found to be a factor related to their personal functionality. The majority of participants did not wish to move from their current residence because of proximity to valued amenities but a few participants did want to move because the distance from amenities was too great.

The most important and functional modifications in relation to visual impairment from the perspective of the participants with AMD was the installing of handrails, non-slip matting, high contrast safety stair nosing between the nosing and the back of the stair tread, single lever taps, slip resistant flooring, chair lift, living in single-level housing and the use of motion sensors to turn on lights. A few participants also reported on the usefulness of light motion sensors that are usually used at the entrance doors and in the yard. The most striking aspect of the recommended home modifications was that they are primarily concerned with safety, especially mobility and the avoidance of falls and other accidents in the home. The participants' recommendations also include non-visual strategies in order to address a problem due to visual impairment. For example, difficulty with seeing steps were addressed by three major suggestions, improving the lighting so that the steps are more visible, increase the visibility of each step by installing high contrast nosing on the steps and the installation of handrails. The first two suggestions target the improved use of the visual system by increasing visibility of the steps. Participants indicated that the handrail acts as a means of support should they trip due to inability to see the steps adequately, however, from a design stand-point, a handrail also has the advantage (perceived and actual) of providing support and guidance.

Kitchens, steps, and bathrooms were three hazardous locations noted by all participants. The majority of participants reported that slippery surfaces are a major hazard in the bathroom. In particular, the inability to see small, irregular sections of the floor that may lead to tripping were of particular concern. The risk of falling over loose carpets, mats and rugs was another concern for some participants, but no-one reported actually falling on a loose mat or carpet. Nearly all participants believed that the home should have no steps or stairs, with the fear of falling being the main reason. A few participants had had the experience of falling on steps in the home and believed that this was due to insufficient lighting. However, some believed that vision loss is not the only reason for falls, for example, lack of concentration may lead to a fall. "The only way in which I could possibly fall on the stair would be if I tried to go down too quickly and maybe wasn't concentrating". Moreover, although glass doors provide more light into homes or other environments, people with central vision loss have difficulty in seeing these types of doors. Therefore, glass doors were perceived and reported to be a source of hazard for the participants with AMD. From the perspectives



**Table II** Some recommendations made by people with AMD regarding home modifications according to a room-by-room

<i>Strategies and modifications</i>	<i>Evidence from direct quotations</i>
<i>Entrance and access to home</i>	
Colour rim on the key	I have a key that has a pink rim on it for the front door. You know I have it coloured, and that opens the security door, and it opens the door and I literally only have to put my hand around the corner and turn the light
Lighting over key hole	It is just that the key hole is often just a little difficult to see, but then I have fingers to feel it, and have a little key light that I can put on
<i>Negotiating stairs</i>	
Lighting on the stairs	Well, for a visually impaired person I would probably put another light halfway up the stairs, 'cause we have one at the top and one at the bottom. I'd probably put, for a vision impaired person, I'd put another light in, or re-angle the light at the top
Safety stair nosing	The steps are white at the edges
Sensor light	A sensor light, in the hallway, that would come on, I have seen them reasonably priced, I would say they'd be very handy for people vision impaired. And, in the bathroom and in toilet, sensor lights that come on with proximity switches or switches that come on due to the falls in light intensity, like light sensors. I think that would be very handy for people. I will put one in the bathroom and one in the hallway, a motion detector light, which I think would be very useful for people
Avoid shiny floors	I am also afraid of ( <i>an upmarket department store</i> ) where everything is very, very shiny. And I do not know why everywhere, this is a new and modern fashion, to have the shiny floors everywhere. For elderly people that is deadly. So I recognise myself, going on tiptoes like a silly child instead of walking normally, because I am scared in the slippery surfaces everywhere. It is beautiful and it is nice and it is modern, but it's very bad
<i>Kitchen</i>	
Buzzer system	I think would be useful for making sure when you turn the gas off it goes to right to the end rather sometimes you just have to have a small fraction of an inch and that can be enough for some gas to be leaking so I think that if's off a buzzer system could be made useful
Colour contrast on the bench top	Well I think open plan living, I find that very comfortable, very easy. I suppose colour contrast would help people perhaps. I have a very nice bench top that is all mottled and I did find one day this pale yellow on it, and I probably thought 'oh I've spilled curry on it or something' and I cleaned and I cleaned and it was a sunbeam
Tungsten light	I'm contemplating removing the florescent light from the kitchen, and putting in a tungsten light, because I find that with florescent lights, I have a tendency to get, uh, lose contrast with fluorescent lights, and these energy saving globes are absolutely useless as far as I'm concerned
Labelling and marking	I cannot see the knobs on the microwave, but the daughters put a red mark on, so I know when it is on and off, kind of thing
Older-style designs of home appliances	I found the biggest thing that they make everything so high-tech these days. All I need is a simple stove; I do not need six different things that I can cook on
Large print size material on home appliances	And I would probably need magnifying on the panels on the microwave and the oven. Large numbers on the dryer. I have very big black lettering on the top of the lids for that
Lighting inside of cupboard	You open the cupboard. I find it hard to see everything, but thought that I could get a light put in the cupboard
<i>Bathroom</i>	
Desired water temperature	Apart from that the other thing we do, we actually don't do it because it's not been done by law I think, the temperature of the hot water system is set to a maximum of 50 degrees can't exceed that because I've been in places where I can scald my hand just by putting it under a hot water tap, the law doesn't seem to be universally observed
Mats and non-slippery surfaces	I suppose you could slip when you step into the bath, but we have a mat on it, so I don't slip, and I have two rails, one there and one on the sides. ( <i>NB mats can also constitute a trip hazard so this is not advisable according to many occupational therapists</i> )
Single lever tap	If you have arthritis, one single bug tap is much simpler than two taps. Much simpler. And maybe for a person with bad vision it would be good because you know you have a hold of it. You turn it that way for heat and this way for a bit of cold. It is simpler

*(Continued)*



**Table II**

<i>Strategies and modifications</i>	<i>Evidence from direct quotations</i>
Non-slippery tiles	Beautiful Italian tiles. They are non-slip you could slip over easy if you stood on soap, you cannot slip over and there is no glass shower door. It is plastic
Home renovation for level bathroom and lighting	Well we have not had to modify our home because, I do not know if it is fortunate or unfortunate, we moved into a home that you would call renovated, thinking of our age. And it has been a perfect home. Because it lets in a lot of light for me, the back of the home is very modern. Lots of glass, lots of light, polished floors, and a very level bathroom with a big shower. Everything is so easy for me, so I have been very fortunate, I do not even have to think about that. We put in extra lighting
Larger mirrors	I think that the of cause you can get larger mirrors that will make a difference and can see better in a larger one than a small one ah shaving I find that sometimes if get close to be able to see to shave properly and get the odd hairs
Grab rails, and handrails <i>Bedroom</i> Bigger clock	Well the grab rails have been a marvellous help. There is a good strong handrail  Putting bigger electrical clock beside my bed so that if I wake up in the middle of the night I can see clearly what time it is ah I know those are the small things to make a difference being your eye sight may be reduced ah
<i>Living room</i> Bigger TVs	The bigger TV has made a big difference. It has given me a lot of freedom I find I do not have to crowd in on the TV set I can keep a reasonable distance away now and can be quite normal
Get rid of floor rugs and loose carpets	Sometimes I see my carpet is moving. Some special material to put under the carpet to make it stick flat
<i>Lighting</i> Task lighting	Extra overhead light in one corner, so it shines on the main workbench directly
Fluorescent lamp	I only have one double fluorescent. I take the white one, same as this one
House should face north	There is plenty of light in the house, because it is a long house and it faces north, so there is plenty of sunlight, There is plenty of light in the house, because it is a long house and it faces north, so there is plenty of sunlight,
Place lamp in appropriate position	There is light there, it is at the back of us and we make, when we are standing in front of our door it makes like a shadow
More lighting	I need a lamp. I will get a stronger lamp Lighting is about the only thing we would change
Torch	I would think that anybody vision impaired, a little torch would be very handy, I should imagine. At one stage, I did have a key ring with a torch, with a little light on it. I found after using it for a while I did not need it
Timer for lighting	In the bedroom, I have a night light in the bedroom, which is on a timer, and I have about a fifteen-minute timer on it. And when I switch the main light out, it comes on, it's a little switch, and it gives me a few minutes to get into bed and get settled, because my bedroom is rather dark
<i>General design principles</i> Colour code	What I have done was bought coloured, red coloured purses and green coloured glass cases and things like that so I can see. So that's what I do in the kitchen and in the bathroom, is I colour code it, so I can see it without any problem
Minimise glare	I keep the blinds semi closed because if I am sitting, and I am near a window, the glare will bother me, so I have to sit away from the windows and not look out the windows, because it gets extremely glary
<i>General strategies</i> Easy threading needle and wire loop	You can buy needles that you do not have to look at to thread. At the head of them, they have two eyes. The top eye has a split in it, and you pull the thread over the needle and pull it down, and it goes into the second slot. Then it is as good as it is done. You do not need to look at it. And to thread the sewing machine, you get one of those little wire loops, and you push it through the eye of the machine needle, and it is coming out there. Then you get one of yourself threading needles, which you thread up, and then you push it through there, and then you pull that back, and you've done it

*(Continued)*

**Table II**

<i>Strategies and modifications</i>	<i>Evidence from direct quotations</i>
<i>Magnification</i>	
Large print	Large print is not much help, because the large print varies so much. I think that is pretty stupid. At least they should put the same type of reading matter into sections
Looking for strong magnification (CCTV)	But you have to move what you are reading, to focus it, you know? Well it does help, yes, if I need it. But I mean those expensive, where you put your paper underneath, they are about three or four thousand dollars, I mean I cannot afford to buy that
Low vision aids	Well I improvised I found the glasses that were given to me by the optometrist just weren't adequate enough I had to use a small magnifying glass and I found when going to the blind institute or Vision Australia I got these magnifying glass that was the secret way to be able to read but it was slow and I have a magnifying glass under my halogen lamp, but the magnifying glass is not much help

of participants with AMD there are also a number of other difficulties and hazards outside the familiarities of the home environment and they also had recommendations for environmental modifications in public areas such as buses, stations and buildings which would be beneficial for them outside the home but these suggestions are outside the scope of this paper.

## Discussion

### *Living alone*

The majority of participants (71 per cent) reported that they live alone since many were single, divorced or widowed. They also reported a high level of perceived difficulties in the performance of activities of daily living, which confirms previous reports (Marback *et al.*, 2007; Mitchell and Bradley, 2006), and living alone may be related to the high level of difficulties expressed. For example, asking others for help is a strategy that some of the participants with visual impairment reported using regularly but there is limited opportunity for people who live alone to ask others for help for tasks such as reading medicine labels, cooking, writing, reading, inserting plugs, etc. Therefore, people who do not live alone have this as a strategy to cope with poor visual function. There is a need for researchers and clinicians to distinguish between people whose adequate function is dependent on help from others, from those who are independently functional.

### *Reading print on home appliance controls*

People with visual impairment have difficulties in reading materials (Crossland *et al.*, 2005; Nguyen *et al.*, 2007). The majority of our participants had difficulties with reading small size print materials on kitchen appliances, washing machines, microwaves, ovens, remote controls for televisions (TVs) and other electronic devices. The participants stated that many of these products, particularly "newer" designs are unsuitable or "troublesome" for people with visual impairment. The reasons included design features such as too many small buttons on remote controls. An often-reported fear of the participants is that an inability to detect the right button and pushing the wrong button on the microwave may lead to fire and accidents. It should be noted that for older styles of microwaves, cooking level and time are typically adjusted using a rotary dial. Generally, it is easier to mark or put some embossed labels and large print materials on such controls to increase utility (Burton, 2006). However, many newer versions are designed with digital electronic visual displays that require buttons to be pushed and this may be a problem for people with visual impairment. Participants in this study reported that they were unable to see the displays even when using a magnifier, as participants stated that they still experience difficulty seeing, perhaps due to the location of the objects and the changes in posture required to view through their low vision aids. Participants stated that they preferred to use previous versions of appliances because they were easier to use: "All I need is a simple stove; I don't need six different things that

I can cook on.” (Table II). One explanation as to why older appliances are easier to use may be because people have lived with them for a long period of time and were experienced in their use (Norman, 1988). Designers who are seeking the widest market may benefit from examining previous designs in order to reduce mental load needed to interact with new technologies (You and Chen, 2007). This is because a deeper understanding of visually impaired users can transform technology with a particular functionality into a “product” that people desire to interact with and from which they derive more benefits. Interestingly, in the current checklists and guidelines (Barker *et al.*, 1995; CNIB, 2008; Duffy, 2002; Hanson and Percival, 2005; Lighthouse International, 2008; Long, 1995; McCullagh, 2006; Rees and Lewis, 2003) for home modifications, there are very few suggestions as to how to use these essential appliances. The most effective solution is for manufacturers and designers of these items to realise that good design will improve the useability for people with visual impairment. Specific suggestions for design modifications by the participants included making things bigger (“bigger clock”, “bigger televisions”, “large print and numbers” on home appliances especially microwave, oven and dryer), using colour coding, adding sound as a cue (“buzzer systems” for strength of heat from stoves), having presets (e.g. “set hot water system set to a maximum of 50 degrees Celsius”) and improving the visibility of labels, buttons and knobs (“I cannot see the knobs on the microwave”).

### *Specificity of recommendations to visual impairment due to AMD*

Some home modifications recommended by the participants are useful for people with visual impairment due to AMD for reasons which are different from why they are useful for frail elderly people in general. For example, a handrail on a steps will benefit people with visual impairment as they indicate the presence of a trip hazard (i.e. steps, uneven flooring) and provide physical support to compensate for poor contrast sensitivity or visual acuity of the perhaps low contrast trip hazard. Frail older people would find the physical support the main benefit. Another example is slip-resistant flooring which can obviate the need for bathmats as an anti-slip aid particularly as they are also a known trip hazard for people with and without visual impairment. In particular, people with visual impairment may find it difficult to perceive the trip hazard. The majority of participants stated that the single lever mixer tap is very useful because it makes running water at the appropriate temperature easier and is only one tap handle to detect and grab. One participant also noted that having only one tap with a lever motion would also be easier to use for people with arthritis. These are examples of modifications that are not primarily vision related but which people with visual impairment due to AMD reported as being particularly helpful for other people with vision impairment due to AMD. Apart from ease in handling, it reduces mental load regarding differentiation of hot and cold tap placement which while customarily placed with cold on the left and hot on the right do vary within many homes (Meindl and Freivalds, 1992).

Mental load is an issue that is brought up by many of the participants although they called it the necessity to “concentrate” and have a good memory. Many of them stressed that they had to concentrate, keep track of the number of steps they have walked, remember where they put items, remember to walk more slowly, be methodical as a coping strategy for their visual impairment therefore the participants perceived modifications that can reduce the mental load as beneficial.

How relevant are these results to visual impairment due to other conditions? The results may also be useful for other visual conditions which result in the same kinds of changes to visual function such as macular degeneration due to other causes such as Stargardts’ disease, Bests Disease and Juvenile MD. These particular examples typically affect younger people so there may be differences in the kinds of tasks and activities which are of concern between this AMD cohort and a younger cohort. Other visual conditions such as retinitis pigmentosa and glaucoma typically result in greater impairment of the peripheral visual fields, in contrast to AMD which results in greater impairment of the central visual fields, so they are likely to encounter different difficulties than people with AMD for that reason and may therefore recommend different home modifications as being beneficial. Retinitis pigmentosa and glaucoma can also be a problem at younger ages than AMD so the kinds of activities of concern can also impact on findings. To understand which home modifications are likely

to be beneficial for visual impairment due to other causes, or to elderly people without any visual impairment, the study must be repeated on participants drawn from these other groups.

### ***Lighting***

The impact of lighting on functional vision has been reported in several studies (Cook *et al.*, 2005; Haymes and Lee, 2006; Pitch and Bridge, 2006). The majority of participants were in agreement regarding the use of tungsten filament lamps as well as task lighting for home activities and support the checklists (Barker *et al.*, 1995; CNIB, 2008; Cocke, 1992; Duffy, 2002; Hanson and Percival, 2005; Lighthouse International, 2008; Long, 1995; McCullagh, 2006; Rees and Lewis, 2003; Vision Australia, 2008) recommendations that use of task lighting and more illuminance may improve vision for task performance. However, some participants stated that fluorescent lighting is better and a few stated that low illumination is good enough for doing tasks. "In my case, strong light hurts my eyes. So I have a darker light, I can't stand the bright light." Variations in sources of discomfort glare, retinal sensitivity, photosensitivity and personal preference may account for preferences of low illumination in the home by some participants and it has been noted that some people with low vision are more functional under low levels of illuminance (Lovie-Kitchin *et al.*, 1983). Recommendations for brighter lighting levels should not be regarded as universally helpful for people with visual impairment. Lighting requirements for people with visual impairment should be considered individually and current guidelines modified to reflect this fact.

### ***Colour contrast***

Use of colour to provide better contrast may make a positive difference in the home environment of the people with visual impairment and the majority of guidelines and checklists include colour contrast as an important modification for people with visual impairment (Percival, 2007) which may aid mobility (Bright, 1997). However, only three participants mentioned that using colour contrast coding for walls and furniture is helpful: "What I do in the kitchen and in the bathroom, I colour code it, so I can see it without any problem." The MLVI contained one test of colour recognition (red, green, yellow, blue cards) which indicated that none of the participants had difficulty identifying primary colours, which is not to say that colour vision is unaffected by the disease but that the red, green, yellows and blues were usually recognised. This may be the reason why this group of people reported nothing with regard to the impact of colour contrast on functional vision. Interestingly, the majority of participants had no experience of the impact of colour contrast on visibility, which shows how individual end-users may not be aware of potential solutions although the knowledge may be contained within a larger group of people with AMD. It may be that the effect of colour contrast needs to be illustrated to people with visual impairment because these people may not be aware of the positive impact of colour contrast on improving visibility for some activities of daily living, e.g. increasing visibility of vegetables on chopping boards or food on the dinner plate.

### ***Fear of accidents***

The results from this study have also illustrated that people with AMD perceive that they are at risk of accidents and falls in the home. This perception may be justified as studies have shown that there is a positive association between home accidents and visual impairment in older people (Evci *et al.*, 2006; Wood *et al.*, 2011). In addition, when an older person has an accident, the consequences are more serious than for younger adults (Dessypris *et al.*, 2009) such as injuries to the head, hip fractures and death (Morley, 2007) and this may contribute to the fear experienced by the participants. The participants perceived many parts of the home as hazardous for people with visual impairment, including the kitchen, stairs and bathroom, which agrees with previous findings (Mann *et al.*, 1994). For example, participants stated that pouring boiling water or pulling out trays from stoves or ovens may lead to accidents, a fear which is justified according to the study findings of Wood *et al.* (2009) which found that in a sample of 76 older people with AMD, within a 12-month period there were 151 injurious accidents including 12 scalds and 102 falls, although it is not known

whether this accident rate or pattern of accidents is significantly different from older people with normal vision due to the absence of a control group.

Visual impairment is a risk factor for falls (Lord *et al.*, 2006) by impacting on the ability to see the edge of steps and misjudge the depth of the walking surface and perhaps by modulating posture and gait (other risk factors include as a history of previous fracture, body weight, cognitive problems, physiological factors and balance are other elements leading to falls in the elderly (Lord *et al.*, 1994; Sambrook *et al.*, 2007), however, the majority of our participants believed that falls in the home are due to a lack of adequate lighting and poor concentration despite the research indicating that falls are multifactorial (Lord and Dayhew, 2001; Lord *et al.*, 2005) and that non-visual risk factors are also important (Lord *et al.*, 1994; Sambrook *et al.*, 2007).

The participants were unaware of some simple strategies which may decrease risk of accidents so may decrease their fear of accidents. For example, they were unaware that assistive devices such as the liquid level indicator may help to reduce the risk of accidents when pouring boiling water into a cup.

Although there were no reports of accidents by the participants of this study that they associated with their visual impairment, there was a considerable sense of fear about accidents that may be vision related. Participants expressed much fear in regard to accidents on stairs, tripping on loose carpets, falling on slippery flooring, and stepping into glass doors. The greatest fear was about stairs and for this reason participants wished to live in homes without steps. For example, participants who live in level home were happier than those who live in a home that has many steps and stairs. "a unit on the ground floor with a bus stop at the gate & that has been a wonderful modification of my living conditions" "I'm very fortunate, I live in a very nice home that's level, all on one level, and I don't have steps to worry about, and I'm very fortunate that". There is a need for research on whether this fear of falling is itself debilitating in people including with AMD, as it is a major and, perhaps, our of proportion concern. If this fear is not debilitating, having a fear of accidents and falling may have a beneficial and protective effect if it causes a behavioural adaptation to take greater care to avoid accidents by using strategies such as home modification, assistive devices, low vision aids and memory.

### ***Assistive devices***

Participants of this study reported a positive impact of assistive devices on their performance of daily activities in agreement with previous studies (Becker *et al.*, 2005; Horowitz *et al.*, 2006; Leat *et al.*, 1994; Leat and Woodhouse, 1993; Mann *et al.*, 1997; Margrain, 2000). Use of a large screen TV was only reported by a few participants as most reported that they were unaffordable. There were not many reports regarding the use of large print clocks or large magnifying mirrors, despite the fact that there is a wide range of assistive devices (Horowitz *et al.*, 2006). Participants reported use only of a few items, mainly use of a cane for the purpose of mobility. Only one participant had information about an easy threading needle (Riazi *et al.*, 2011) and reported that she was more functional using this type of needle. Participants gave similar responses with regards to information on rehabilitation, for example in this study 97 per cent of participants had never been informed about easy threading needles. None of the participants reported that they had any information about advanced low vision aids for magnification such as bioptic telescopes; auto-focus telescopes or head-mounted video magnification systems. Participants had little information about non-optical aids such as those for reading and writing, different types of lamps and screen reading software; they had no idea about personal guide systems (PGS); and they were not well informed about household products to assist with sewing, cooking, bathing and personal care, etc.

### **Conclusion**

The results of these individual interviews provide evidence that the majority of environmental modifications generally recommended in checklists and guidelines are useful in the perspective of participants of this study with AMD. This indicates their usefulness for people

with AMD, although participants had not had experience all of those recommendations. The current checklists and guidelines have no solutions for difficulty with reading small print size materials on the remote controls or controls of home appliances or their visual displays. Perhaps changes in design of such appliances or the use of low vision aids such as bioptic spectacles would be useful in such instances.

Although the participants were recruited from a university low vision clinic and the MD Foundation database and were in the care of ophthalmologists, the participants lacked knowledge about assistive devices and home modification services. This indicates that the delivery of information to people who need such information requires improvement. This finding indicates that there might be a lack of knowledge about the benefits of home modification among ophthalmologists and optometrists caring for these people. It seems that it is not typically included in their management plans. Continuing education for these professional about home modification needs, solutions and referral criteria need to be developed and delivered to these two groups of eye care professionals so that people with visual impairment can better access home modification strategies.

Given the expressed benefits of home modifications for this group of participants with AMD, it is likely that people with visual impairment due to other causes may also have discovered home modification strategies that reduce the difficulties they are encountering in their home environment. Further research is required to determine whether the perceived benefits of home modification strategies differ according to the cause of visual impairment so that advice can be appropriately targeted.

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