A scoping review of the use of visual aids in health education materials for persons with low-literacy levels

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Highlights

- Visual aids in health-education materials may aid individuals with low-literacy.
- The design of visual aids needs to include stakeholders and be culturally specific.
- Consent procedures need to be adapted for low-literacy research participants.
- More research from non-western, low-and middle-income countries is required.

Abstract

Objective: To conduct a scoping review on the literature on visual aids in health education for persons with low-literacy.

Methods: A scoping review methodology was employed. Pre-defined selection criteria identified 47 studies for inclusion. Data were extracted in relation to: (a) definitions of low-literacy and health literacy, (b) population studied, (c) research country, (d) consent procedures, (e) visual aids used, (f) development of visual aids, and (g) targeted outcomes.

Results: Visual aids developed with persons with low-literacy demonstrated statistically significant improvements in health literacy outcomes, with benefits in medication adherence and comprehension also reported. Pictograms and videos were the most effective visual aids. Only one study adapted consent procedures for low-literacy participants.

Discussion: Visual aids in health education materials may benefit persons with low-literacy levels, but large gaps in the research base are evident. Experimental research in low- and middle-income countries, with a particular focus on consent for participants with low-literacy is needed.

Practice implications: Visual aid design needs to include stakeholders. Consent procedures and decision-making need to be specifically adapted for participants with low-literacy.

Keywords: Consent; Health Education; Low health literacy; Low-literacy; Scoping review; Visual aids

1. Introduction

Health literacy is a set of cognitive and social skills that determine one's ability and motivation to seek, understand, and use information to promote health and well-being [1]. Where health literacy is low, poor health outcomes [2,3], including, lower implementation of preventative behaviours, lower treatment adherence [4] and frequent hospitalisations [5,6] may result. The effect on adherence is greater when negative side effects to treatment are present [6–8].

An integral component of health literacy is low-literacy [8]. Literacy is a universal skill that allows one the ability to acquire knowledge or understanding [9,10]. For this review literacy is defined as the ability to read, write and use numbers [11, p. 185] at a level of proficiency which allows for functioning in society and the achievement of one's goals [12]. Low-literacy, which is often regarded as an ability to read below a sixth or seventh grade level [13], can limit patients' ability to acquire key information and skills related to maintaining their health and managing conditions [14,15]. Such challenges may be attributed to most health information being provided in written materials, for example, doctors' directions, preventative information to guide lifestyle choices, and dosage instructions on medication [16,17]. Additionally, persons with low-literacy may experience difficulty processing and recalling complex information [2,17,18]. With approximately 750 million adults worldwide reported as living with low-literacy levels [19], the effects of low-literacy and low health literacy create an ongoing challenge for health professionals [12,20].

Published guidelines for readability of health education materials, for persons with low-literacy, propose that health education materials should have a readability level of grade six or below [21,22]. However, even if the reading levels of materials are reduced, this alone has not been shown to yield significant effects on health literacy [11]. Hence, alternative

methods for providing health information to persons with low-literacy, are required. Visual aids have been proposed as one such an alternative [21,23].

Visual aids include black and white or colour pictograms, pictures, drawings, graphics, photographs (incl. photo novellas), videos, and multimedia presentations [22,24]. The use of visual aids is reported to facilitate the establishment of joint attention or understanding of a shared concept for persons with low-literacy levels [24,25], and increased recall as a result of the "pictorial superiority effect" [26], where combined auditory and visual channels of learning enable persons to hold both words and visual aids in their working memory, enhancing recall [22,27].

A systematic review conducted in October, 2015 by Park and Zuniga (2016) [21], considered the effectiveness of picture-based health education for adults with low-literacy. This review included studies published in English, related to health literacy, using picture-based health education with adults over 18 years, and excluded reviews or meta-analyses and dental literature. The authors reported that ten of the eleven studies showed improvements in understanding of health education materials when visual aids were included. Specifically, health literacy, attention, comprehension, recall, and adherence to verbal health communication, and the understanding of complex information, was reported to be enriched with the addition of visual aids [22].

Despite the benefits of visual aids for health literacy, Park and Zuniga, highlighted that both culture and literacy levels can impact the guessability of images (how visual aids are understood) [22,28–30]. For instance, different understanding of pictures was evident between cultural groups [31–34], and although visual aids may have a positive effect on persons with low-literacy [22,35,36], it was cautioned that they could over-simplify or distort information.

The role of culture in the guessability of images is particularly important in relation to the Park and Zuniga review, as the results from this review were only from three countries, the United States (n=7), Taiwan (n=1), and South Africa (n=3). The limited range of reporting countries may be linked to the number of electronic databases searched in the review (n=3), or a gap in the literature, specifically with regard to low- and middle- income countries (LMIC) and the limited number of visual aids. This is a concern because it is LMIC where the majority of people with low-literacy/ health literacy tend to reside [19]. In addition, the lack of diversity of source countries limits the amount of information from different cultures, thus impacting the generalisability of the results.

Due to the possible roles of culture and literacy in the understanding of visual aids, the involvement of persons within the community in which the visual aid will be used, has been highlighted as key for the development of effective visual aids [37]. However, a further gap identified by the authors was that in the review by Park and Zuniga there was a lack of information on how informed consent was obtained from participants who have low-literacy. Informed consent is vital in order to protect participants in studies while obtaining valid and reliable results [38]. Yet, procedures for obtaining consent for research are not well established [39], and may not be comprehensive enough to ensure that participants are able to obtain sufficient understanding in order for consent to be "informed" [25,40,41]. Low literacy, in particular, has been identified as a barrier to the provision of full and informed consent [42]. Hence, it is important to identify what measures and methods are being used in research with participants who have low-literacy.

Based on the limited number of articles and the gaps identified in the review by Park and Zuniga [21], the authors of this article felt it prudent to obtain an overview of existing research on health education materials, in a broader range of countries, and with wider search

terms that included all types of visual aids. Such a review would serve to not only highlight literature which may have been omitted by the Park and Zuniga review, but could also advance the theory related to consent and visual aids by providing insights that may not be apparent from Western or high-income country (HIC) populations. A scoping review methodology was considered to be suitable as this allowed for the inclusion of a broad range of methodologies and outcomes, while not being dependent on results being reported in a specific format as required for meta-analysis in a systematic review [43].

2. Aims ö

This scoping review aimed to identify the available research on the use of visual aids in health education materials for persons with low-literacy and extract data from them in order to:

1. Describe the populations and countries in the studies, and identify the consent procedures for participants who had low-literacy.
2. Describe the terminology and assessment of low-literacy and health literacy.
3. Describe the types of visual aids used, their development, and their effect on targeted outcomes.ö
4. Provide recommendations for the design of health education materials for persons with low-literacy.
5. Identify gaps in order to guide future research.

3. Methods

3.1 Design

A scoping review was selected, to provide a generalised overview of the studies which have been conducted on the use of visual aids in health education materials for persons with low-literacy. The authors used the scoping review methodological framework recommended by

Arksey and O'Malley [44].Per scoping review methodology, formal study quality assessment is not required and was therefore not conducted [45–48].

3.2 Search strategy

An electronic search was conducted on the following search databases: Africa Wide Information, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Education Resources Information Centre (ERIC), MEDLINE, PsychInfo, and PubMed. The databases were selected due to their inclusion of both health, and education/literacy publications. Six databases were selected as this broadened the search conducted by Park and Zuniga, which only searched three databases [21], and exceeds the recommendation for systematic reviews of four databases [49,50]. Africa-Wide Information, in particular, was included in order to encompass studies from LMIC. The search terms were aligned with the aims of the scoping review and followed the Population, Exposure and Outcomes format [50]. The databases were searched in October 2017 and the search was updated in March 2018. Included studies were published between February 2001 to March 2018.

The search terms were individualised by database for example : (low-literacy OR literac* OR illit* OR limited literacy OR functional literacy OR non-literate) AND (visual aid* OR pict* OR graphic symbol* OR photogra* OR image OR animat* OR communication support OR visualisation OR cartoon OR illustration) AND (health OR health-literacy OR health education OR health information OR HIV education OR AIDS education OR cancer education OR diabetes education) as used for AfricaWide Information, searched through EBSCOHost search platform.

3.3 Title, abstract and full text screening

The search identified 1299 articles. Articles were screened first at title and abstract level and then at full text level against the inclusion and exclusion criteria, following the PRISMA

Table 1

Inclusion and exclusion criteria for interventions using visual aids in health education programmes for persons with low-literacy

Criteria	*Motivation*	Inclusion	Exclusion
Population	*The target population of this study is individuals with low-literacy or low-health literacy.*	Participants who have inadequate or marginal literacy, or functionally illiteracy, low health-literacy or numeracy (as described by the authors of that study).	Literate adults
Age	*Adults with low-literacy present with challenges which are unique within healthcare and as such need to be addressed separately from children. For example, adults are expected to provide consent to health care and self-monitor many aspects of health care.*	Persons over the age of 18 years	Participants under the age of 18 years
Intervention	*Any intervention aimed at using visuals aids in health-education materials with individuals with low-literacy.*	Interventions using health education materials incorporating visual aids - Any pictorial, photographic, symbol or system that can facilitate the establishment of joint attention or understanding of a particular shared concept.	- Images used for diagnostics and screening e.g. x-ray or scans. - Readability: reading level assessments - Video conferencing - Audiotaped sessions - Art forms such as theatre, poetry or dance.
Design		Qualitative, quantitative or mixed methods quasi-experimental or experimental studies	Systematic/scoping/literature reviews
Publication Type	*The authors did not have the resources for translation.*	English, peer-reviewed studies	Peer-reviewed articles in languages other than English Grey literature
Year	*2001 marks the year in which the World Health Organisation began moving from a medical model of health care to a social model of health care with the introduction of the ICF (WHO, 2001).*	From 2001 – 2018	Articles published prior to 2001.

Scoping Review structure [48]. The inclusion and exclusion criteria are reported in Table 1. All screening was conducted by two reviewers independently using Covidence [51]. Disagreements were discussed until resolved.

The study selection process is described in the PRISMA flow chart presented in Figure 1 [52].

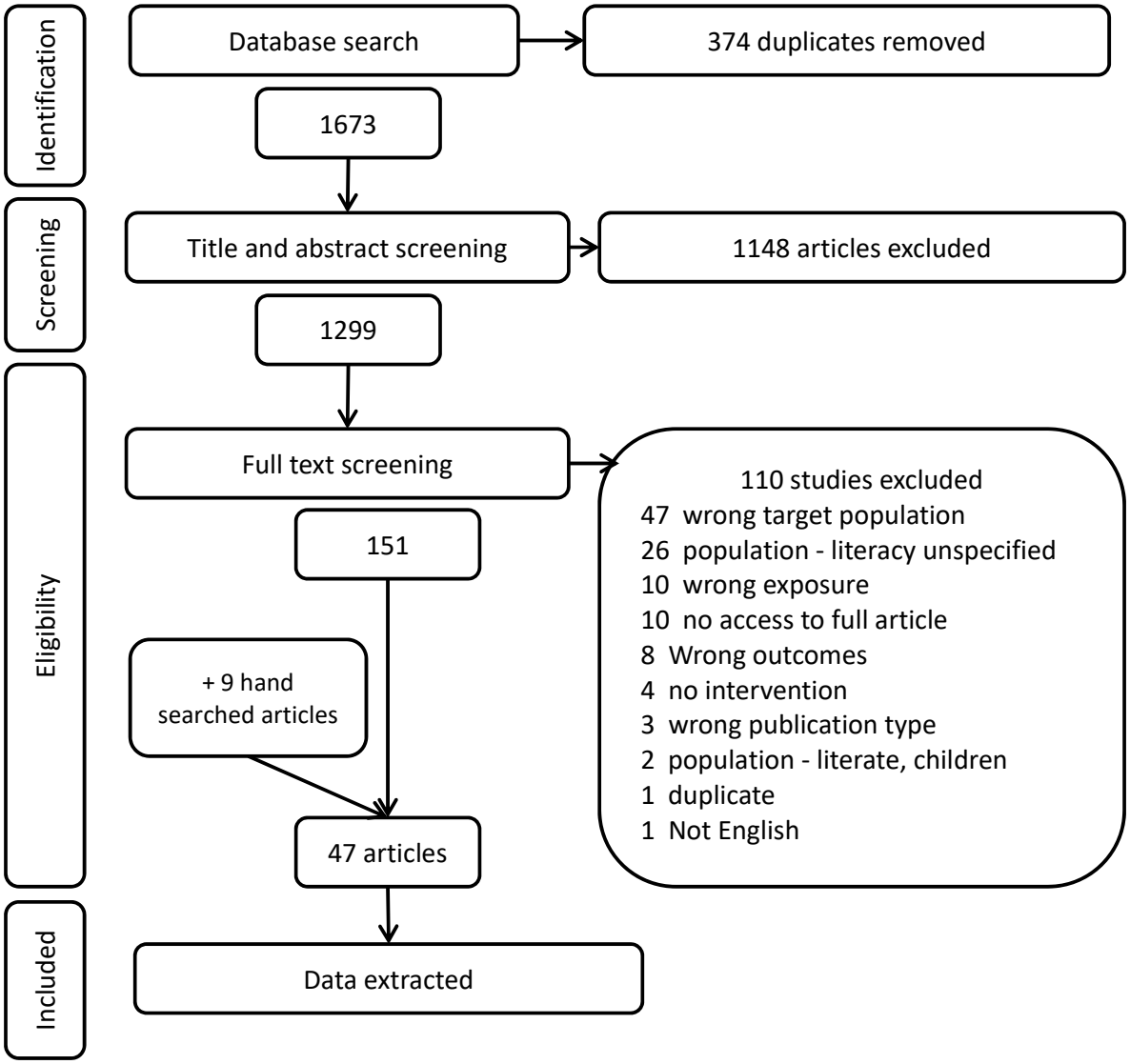


Figure 1. PRISMA [52] flow diagram of studies using visual aids for health education for persons with low-literacy levels.

3.4 Data extraction

Data extraction was conducted by the first author and reviewed by the second. Disagreements were discussed until resolved. Data from the studies were extracted into a predetermined form covering (a) author, (b) title, (c) research country, (d) population, (e) aims and design, (f) low-literacy definition and assessment, (g) health literacy definition and assessment, (h) measurement of consent; (i) visual aids, (j) visual aid development, and (k) targeted outcomes and results.

3.5 Data Analysis

The aims and design of the studies, definitions of low-literacy and health literacy were described. Participant data was analysed by collating the descriptive statistics presented in the identified studies. Age was presented as either mean age, or percentage of participants in an age grouping, based on how the study had reported this. Literacy levels were reported using means and percentages, grouped according to the measurement mechanism used within each study, for example years of schooling, the Test of Functional Health literacy for Adults (TOFHLA) [53] or the Rapid Estimate of Adult Literacy in Medicine (REALM) [54]. The countries in which studies were conducted were described according to their income category as defined by the World Bank, based on 2019 gross national per capita income, namely high-income (≥$12,536), upper-middle-income ($4,046 to $12,535), lower-middle-income ($1,036 to $4,045) and low-income (≤$1,036) [55]. Visual aids used in the studies were described and collated into groups according to common features of the visual aids. The design processes reported for the visual aids was described. The reported effects of each type of visual aid were described. The interventions and targeted outcomes from the studies were explored using thematic analysis [56]. Thematic analysis can be used across a wide variety of data collection methods, and allows for fluidity in the process of analysis [56]. The studies

included in each theme and their reported effects were described. In line with this being a scoping review, no attempt was made to calculate effect sizes or conduct meta-analysis on the data. Across this review some studies made use of multiple measurement mechanisms (e.g. years of schooling and the REALM [54]) or had multiple outcomes which were included in different themes (e.g. comprehension and recall). As a result the number of studies reported on may appear to exceed the total of 47.

4. Results

4.1 Summary

Forty-seven studies met the inclusion criteria for this review. Ten studies overlapped with Park and Zuniga's review [21]. The studies identified came primarily from HIC. The majority of participants were between 40 and 60 years of age, and had a primary/elementary level of schooling. Only two studies reported adapted informed consent procedures for individuals with low-literacy. When stakeholders with low-literacy were included in the development of visual aids, their efficacy appeared to be improved, however only 16 studies reported doing this. The goals of visual aid use in the studies related to improving comprehension, the development of health literacy, increasing recall, facilitating decision-making, increasing medication adherence, and evaluation of the visual aids. Overall pictograms were most frequently reported as being effective across a range of goals, while videos were reported as being effective for the development of health literacy. The results of this study are reported by country and referenced as high-income (HIC), middle-income (MIC), low-income (LIC) or low- and middle-income (LMIC).

4.2 Geographical context

Thirty of the studies in this review were conducted in HIC and seventeen in LMIC. The studies from HIC countries were published between 2004 and 2017, and were conducted in

Australia (HIC) (n=1) [57], Canada (HIC) (n=2) [58,59], the Netherlands (HIC) (n=4) [60–63], the United Kingdom (HIC) (n=1) [64], and the United States (HIC) (n=22) [65–85]. Studies from LMIC were published between 2001 and 2014, and were conducted in Benin (LIC) (n=1) [86], Nepal (LIC) and Bangladesh (MIC) (n=1) [87], Cameroon (MIC) (n=1) [88], India (MIC) and China (MIC) (n=1) [89], India (MIC) (n=1) [90], Iraq (MIC) (n=1) [91], Mexico (MIC) (n=1) [92], South Africa (MIC) (n=8) [93–100], and Taiwan (MIC) (n=1) [101]. One study was conducted in the UK (HIC) but participants were immigrants from Somalia (LIC) and Malaysia (MIC) [102], hence this study is reported as from a LMIC. Table 2 highlights the countries and their respective income levels included in this review.

4.3 Study design and sampling

Thirteen studies were randomised control trials [64,66,67,70,71,76,77,83,89,91,95,96], seven comparative group designs [60,69,72–74,81,84], three cross-sectional designs [63,80,88], two multistage designs [94,100], one explorative design [86], and one descriptive design [90]. Twenty studies did not specify their designs. The majority of the studies used convenience (n=22) or purposive (n=16) sampling. Random sampling was used in six studies and three studies did not specify sampling procedures. See Table 2 for the design and sampling procedures of the studies in the review.

4.4 Measurement of literacy and health literacy

Literacy or health literacy were determined through self-reports of schooling from participants (n=28), and the administration of standardised assessments of health literacy including the TOFHLA/ the Short-TOFHLA (s-TOFHLA) [53], (n=10) [57,68,69,72,79–81,83,91,103] or the REALM [54], (n=3) [59,63,70]. Two studies [66,75] relied only on the REALM [54], and four studies relied on self-reporting of schooling and comprehension questions related to a provided label [94], self-reporting of schooling and the Short

Table 2
Income levels, countries, study design, participants and literacy measures and levels reported in studies in the review.

Income level[a] Country (population[b])	Articles	Study design (Sampling)	Participants (n) age: years(y)/mean ($\bar{x}$)	*Literacy measures*/ levels reported
Low Benin	Bello-Bravo et al., 2013 [86]	Explorative Random	n=26 Age < 40y n=19 ≤ 40y n=7	*Schooling* Illiterate: n=10 Primary school n=5 Secondary school n=3 University n=8
Low Nepal Lower-middle Bangladesh Researchers from Quatar	Kheir et al., 2013* [87]	RCT Purposeful	n=123 Age$\bar{x}$ =32y	*Schooling* $\bar{x}$=6.1 years school
Lower-middle Cameroon	Mbuagbaw & Ndongmanji, 2012 [88]	Cross sectional/ cohort Convenience	n=204 Age 0–20y n=26 21–30y n=93 31–40y n=34 41–50y n=9 51–60y n=30 60+y n=12	*Schooling* None n=12 Primary n=39 Secondary n=98 University n=55
Lower-middle-India	Gupta et al., 2009 [90]	Descriptive Convenience	n=1000 Age $\bar{x}$ =30y	*Schooling* None n=100 Primary school n=140 Middle school n=670 High school n=90
Lower-middle India Upper-middle China Researchers from Canada	Poureslami et al., 2012 [89]	RCT Purposeful	n=85 Age $\bar{x}$=63y	*Schooling* None n=15 Elementary school n=21 High school n=29 Post high school n=20
Upper-middle Iraq	Negarandeh et al., 2012 [91]	RCT Purposeful	n=127 Exp. 1 n=44 Exp. 2 n=43 Ctrl n=40 Age $\bar{x}$=51y $\bar{x}$=*51y* $\bar{x}$= 49y	*Schooling* (n) Exp. 1 Exp. 2 Ctrl Primary school 34 33 34 Secondary school 4 6 8 College 2 4 2 *TOFHLA* $\bar{x}$= 27.27 $\bar{x}$= 26.71 $\bar{x}$= 27.57

Upper-middle Mexico	Bacardi-Gascon, Jimenez-Cruz & Jones, 2002 [92]	Convenience	n=97				*Schooling*				
			Age	25-45y			<10 years school (n not reported)				
							>10 years school (n not reported)				
Upper-middle South Africa	Carstens, Maes, & Gangla-Birir, 2006 [93]	Convenience	n=54	LL	Lit		*Schooling*	LL	Lit		
			Age	$\bar{x}$ =43y	$\bar{x}$ Lit =33y		Years school	$\bar{x}$=3.7	$\bar{x}$=12.6		
Upper-middle South Africa	Dowse & Ehlers, 2001* [94]	Multistage Purposeful	n=46				*Schooling*	(n)	Comprehension of label		
			Age	21-40y	n=17				None (n)	Partial (n)	Full (n)
				41-65y	n=26		None	9	9	0	0
				>65y	n=3		1-4 years school	12	12	0	0
							5-7 years school	25	5	17	3
Upper-middle South Africa	Dowse & Ehlers, 2005* [95]	RCT Convenience	n=78	Exp. n=46	Ctrl n=41		*Schooling*	Exp.	Ctrl		
			Age <21	5	3		None	6	11		
			21-40	21	25		1-4 years school	10	4		
			41-65	13	12		5-7 years school	19	15		
			>65	7	1		8-10 years school	11	11		
Upper-middle South Africa	Dowse, Barford & Browne, 2014 [96]	RCT Random	n=64	$\bar{x}$=39y			*Schooling*	$\bar{x}$=7.3 years school			
Upper-middle South Africa	Dowse, Ramela & Browne, 2011 [97]	Convenience	n=39				*Schooling*				
			Age	<50y	n=35		< 7 years school	n=19			
				>50y	n=4		>7 years school	n=20			
Upper-middle South Africa	Dowse, Ramela, Barford & Browne, 2010 [98]	Purposeful	n=52				*Schooling*				
			Age	<40y	7%		<4 years school	30%			
				>40y	93%		4-7 years school	48%			
							8-10 years school	22%			
Upper-middle South Africa	Hoogwegt, 2009 [99]	Purposeful	n=46	Age $\bar{x}$=32y			*Schooling*	$\bar{x}$=7.37 years school			
Upper-middle South Africa	Mansoor & Dowse, 2003 * [100]	Multistage Purposeful	n=60				*Schooling*				
			Age:	<21y	n=9		1-4 years school	n=20			
				21-40y	n=41		5-7 years school	n=40			
				41-65y	n=10						
Upper-middle Taiwan[b]	Chuang et al., 2010 [101]	Convenience	n=500	LL n= 250	Lit n=250		*Schooling*	LL	Lit		
			Age <60y	n=108	n=250		No School	n=154			
			61-70y	n=66			< 6 years school	n=96			
			>71y	n=76			High School		n=24		
							College degree		n=215		
							Postgraduate		n=11		

Low-income Somalia Upper-middle Malaysia *This research was conducted in the UK but with immigrant populations from Somalia and Malaysia.*	Roberts et al., 2008 [103]	Purposeful	n=79 Age	Somalia n=10 $\bar{x}$=44y	Malaysia n=19 $\bar{x}$=49y	Ctrl (UK) n=50 $\bar{x}$=48y	*Schooling* No School until age 14 Left school age 14-16 Left school age 17-20 Post school No information	Somalia n=5 n=5	Malaysia n=7 n=2 n=9 n=1	Ctrl (UK) n=13 n=11 n=26
High-income Australia	Smith et al., 2009 [57]	Convenience	n=108 Age	Exp. 1 n=33 45-74y		Exp. 2 n=75	*Schooling* No/minimal school Degree *TOFHLA*	Exp. 1 n=17 n=16	Exp. 2 LL Lit	 $\bar{x}$=91 $\bar{x}$=98
High-income Canada	Berthenet, Vaillancourt & Pouliot, 2017 [58]	Purposeful	n=135	Age $\bar{x}$=79y			*Schooling* No school/ primary school High school or higher	n=74 n=61		
High-income Canada	Hwang, Tram & Knarr, 2005 [59]	Random	n=130 Age	<25y 25-39y 40-64y ≥65y	n=25 n=40 n=51 n=14		*Schooling* < high school Some high school Completed high school Post-secondary *REALM* Grade 0-6 Grade 7-8 ≥ grade 9	 n=5 n=8 n=35 n=82 n=6 n=29 n=95		
High-income The Netherlands	Koops van 't Jagt et al., 2017 [60]	Group Designs Purposeful	n=202 LL Lit	n=89 n=113	$\bar{x}$=48y $\bar{x}$=41y		*Schooling* LL only primary or lower vocational schooling. Lit Secondary, higher vocational or higher schooling.			
High-income The Netherlands	Meppelink & Bol, 2015 [61]	Random	n=61 Age	LL n=31 $\bar{x}$=59y		Lit n=30 $\bar{x}$=54y	*Schooling* (n) Low Middle High *SAHL-D*	LL 11 12 8 $\bar{x}$=46.48		Lit 2 8 20 $\bar{x}$=57.47
High-income The Netherlands	Meppelink et al., 2015 [62]	Other Random	n=231 LL n=123 HL n=108	Age $\bar{x}$=68y			*Schooling* LL: Primary or lower vocational schooling only. Lit: Higher education or a university degree.			
High-income	van Beusekom,	Cross	n=191	LL n=30		Lit n=161	*Schooling*	LL		Lit

The Netherlands	Bos, Wolterbeek, Guchelaar, & van den Broek, 2015 [63]	sectional /cohort Convenience	Age	$\bar{x}$=59y	$\bar{x}$=59y	Low Middle High *REALM Dutch*		23 3 4 <61 n=30	57 54 50 ≥61 n=161
High-income UK	Bickmore et al., 2010 [64]	RCT Convenience	n=29	Age $\bar{x}$=60y		*Schooling* LL ≤ grade 8 Lit ≥ grade 9	13 16		
High-income US	Borrayo, 2004 [65]		n=174 Age	Exp. 1 n=34 $\bar{x}$=62y	Exp. 2 n=58 $\bar{x}$=70y	*Schooling* Years School		Exp. 1 $\bar{x}$=8	Exp. 2 $\bar{x}$=7
High-income US	Bryant et al., 2009 [66]	RCT Purposeful	n=222 Exp. Ctrl.	 n=110 n=112	 Age $\bar{x}$=57y Age $\bar{x}$=60y	*REALM* < high school (<61) ≥ high school (≥61)		Exp. 33 77	Ctrl 29 83
High-income US	Calderon et al., 2014 [77]	RCT Purposeful	n=240 18-39y 40-60y >60y	Exp. (n=118) n=23 n=70 n=23	Ctrl (n=122) n=26 n=69 n=26	*Schooling* < high school ≥ high school *s-TOFHLA* Inadequate Marginal Adequate *DHLS* Inadequate Marginal		Exp. n=84 n=12 n=64 n=8 n-32 n=101 n=16	Ctrl n=85 n=14 n=61 n=10 n=43 n=102 n=20
High-income US	Choi, 2012* [79]		n=6	Age 37-55y		*Schooling* Most had a high school diploma ≤22 on the *s-TOFHLA*			
High-income US	Choi, 2013* [80]	Cross sectional study Convenience	n=15	Age $\bar{x}$ =68 yrs		*Schooling* 80% had a high school diploma ≤22 on the *s-TOFHLA*			
High-income US	Choi, 2015* [81]	Group Design Convenience	n=42 Age	Exp. n=21 $\bar{x}$=68y	Ctrl n=21 $\bar{x}$=67y	*Schooling* ≤ high school College Missing *s-TOFHLA*		Exp. n=16 n=2 n=3 $\bar{x}$=15.95	Ctrl n=19 n=2 $\bar{x}$=18.1

High-income US	DeWalt et al., 2004* [82]	Convenience	n=23	Age $\bar{x}$=60y			*Schooling*	$\bar{x}$= 9.6 years school			
							REALM	$\bar{x}$=5th grade			
							<18 (3rd grade)	32%			
							19–44 (4th–6th grade)	32%			
							45–60 (7th–8th grade)	36%			
							s-TOFHLA				
							Inadequate	52%			
							Adequate	48%			
High-income US	Gerber et al., 2005 [83]	RCT Purposeful	n=244	Exp. (n=122)	Ctrl (n=122)		*Schooling*	Exp.	Ctrl		
			LL (n) Age	n=68	n=67		≤ high school	LL: n=48	LL: n=45		
			Lit (n) Age	$\bar{x}$=58y	$\bar{x}$=60y			Lit: n-9	Lit: n=9		
				n=54	n=55		*s-TOFHLA*				
				$\bar{x}$=50y	$\bar{x}$=52y		< 22 = LL	56%	55%		
							≥ 23 = Lit	44%	45%		
High-income US	Hill et al., 2016 [84]	Group Design Convenience	n=144	Exp.	Ctrl		*Schooling*	Exp.	Ctrl		
				n=72	n=72		< 12th grade	37%	18%		
			Age	$\bar{x}$=59y	$\bar{x}$=61y		≥ 12th grade	63%	82%		
High-income US	Kalichman et al., 2005 [85]	Purposeful	n=81				*Schooling*	$\bar{x}$= 12.3 years			
High-income US	Kalichman et al., 2013* [103]	Convenience	n=446	Exp.	Ctrl 1	Ctrl 2		Exp.	Ctrl 1	Ctrl 2	
				n=148	n=157	n=141	*Years Schooling*	$\bar{x}$=12	$\bar{x}$=12	$\bar{x}$=11.9	
			Age	$\bar{x}$=57y	$\bar{x}$=47y	$\bar{x}$=48y	*TOFHLA reading*	$\bar{x}$=72.2%	$\bar{x}$=73.9%	$\bar{x}$=72.4%	
							TOFHLA numeracy	$\bar{x}$=64.1%	$\bar{x}$=67.7%	$\bar{x}$=62.4%	
High-income US	Kalichman, Cherry & Cain, 2005 [67]	RCT Random	n=30	Age $\bar{x}$=45y			*Schooling*	$\bar{x}$= 10.4 years			
							≤ 11 years school		n=19		
							12 years school		n=8		
							13 years school		n=2		
							Reported difficulty reading		n=26		
							Take someone with for reading assistance			n=13	

High-income US	Kandula et al., 2009 [68]	Convenience	n=190	Age $\bar{x}$=60y	*Schooling* < high school n=18 High school graduate n=27 Some college n=30 College graduate n=25 *s-TOFHLA* $\bar{x}$=28.8 Inadequate n=16 Marginal n=24 Adequate n=150
High-income US	Kandula et al., 2011 [69]	Group Design Convenience	Exp. 1 n=113 Age $\bar{x}$=56y	Exp. 2 n=58 Age $\bar{x}$=53y	*Schooling* Exp. 1 / Exp. 2 < high school n=13 / n=36 High school graduate n=24 / n=31 Some college n=33 / n=17 College graduate n=30 / n=16 *s-TOFHLA* $\bar{x}$=29.6 / $\bar{x}$=27.8 Inadequate n=9 / n=10 Marginal n=12 / n=5 Adequate n=92 / n=43
High-income US	Kripalani et al., 2007* [70]	RCT Convenience	n=209	Age $\bar{x}$=64y	*Schooling* < grade 12 n=99 ≥ grade 12 n=110 *REALM* Inadequate (≤6th grade) n=87 Marginal (7–8th grade) n=77 Adequate (≥9th grade) n=45
High-income US	Kripalani, Schmotze & Jacobson, 2012 [71]	RCT Purposeful	n=435	Exp. A / Exp. B / Exp.AB / Ctrl n=102 / n=121 / n=116 / n=96 $\bar{x}$=65y / $\bar{x}$=64y / $\bar{x}$=63y / $\bar{x}$=64y	*Schooling* A / B / AB / Ctrl years school $\bar{x}$=10.8 / $\bar{x}$=10.8 / $\bar{x}$=11.1 / $\bar{x}$=10.9 ≤6th grade n=53 / n=51 / n=49 / n=43 ≥7th grade n=49 / n=70 / n=67 / n=53
High-income US	Shea et al., 2008 [72]	Group Design	N=2015	AE AS BE BS CE CS	*Schooling (n)* AE AS BE BS CE CS

		Convenience	Age (n)							≤ 8th grade	4	26	6	27	4	27
			<30y	30	22	26	25	30	12	Some high school	34	31	38	27	42	26
			30–39y	20	28	28	27	28	36	High school/	42	27	37	30	33	25
			40–49y	22	18	22	20	20	14	GED	6	4	6	4	7	9
			≥50y	28	32	25	27	21	38	Vocational	14	10	12	12	14	12
										≥ College						
										s-TOFHLA (n)	19	27	22	37	20	32
										Low literacy	80	62	79	63	80	68
										Functional						
High-income US	Terndrup et al., 2012 [73]	Group design	n=142							*Schooling*						
			< 60y			n=4				< high school	n=3					
			60 to 69y			n=40				High school	n=43					
			70 to 79y			n=59				Some college	n=35					
			≥ 80y			n=39				College degree	n=30					
										Graduate degree	n=29					
High-income US	Tsahakis, et al., 2014 [74]	Group design	n=299		Exp. n=153			Ctrl n=146		*Schooling*		Exp.			Ctrl	
			Age		$\bar{x}$=43y			$\bar{x}$=43y		≤ high school		n=85			n=95	
										≥ college		n=58			n=51	
High-income US	Volandes, Barry, Chang & Paasche-Orlow, 2009 [75]	Other Convenience	n=146		Age $\bar{x}$=57y					*REALM*						
										Low	n=27					
										Marginal	n=30					
										Adequate	n=89					
High-income US	Volk et al., 2008 [76]	RCT Convenience	n=450			Exp. n=149		Ctrl n=301		*Schooling* (%)		Exp.$_1$	Exp.$_0$	Ctrl$_1$	Ctrl$_0$	
			Completed$_1$			n=89		n=263		< high school		27	30.5	3.4	2.6	
			Age			$\bar{x}$=56y		$\bar{x}$=57y		High school graduate		43.9	42.4	6.5	10.5	
			Lost to follow up$_0$			n=60		n=38		≥ college		29.2	27.1	90.1	86.8	
			Age			$\bar{x}$=52y		$\bar{x}$=55y								
High-income US	Webb et al., 2008 [78]	Convenience	n=85		Age $\bar{x}$=49y					*Schooling* (%)						
										Grades 1-8		17%				
										Grades 9-11		19%				
										≥ High school graduate		61%				

Notes

[a] [42]

[b] Where studies from a country reported on a sub-population from a different background/ nationality/ income level, this is indicated in (brackets) and described according to the income level of the sub-population.

[c] This study was reported on as conducted in Taiwan. Currently the World Bank does not report data on Taiwan due to the political climate with China. Due to the economic relationship between China and Taiwan, the Chinese classification of upper-middle-income was used.

[*] Studies included in the review by Park and Zuniga (2010) [17]

LL= Low literate Lit=literate Exp.=experimental Ctrl=control $\bar{x}$ = mean RCT = randomised controlled trial

NS = not specified

TOFHLA/ s-TOFHLA [53] REALM [54] SAHL-D [104] DHLS [77]

Assessment of Health literacy in Dutch (SAHL-D) [104], [61], the self-reporting of schooling, the s-TOFHLA [53] and the REALM [54], [82], and the self-reporting of school, the s-TOFHLA [53] and the Diabetes Health literacy Survey (DHLS) [77].

4.5 Participant descriptions

Participants in the studies ranged from 18 to 95 years of age with 9492 participants in total. The mean age of participants for studies which reported this was 55 years (n=35), and for studies which reported age ranges (n=12), 44% of the participants were 40-60 years old, 35% were younger than 40, and 21% were older than 60 (percentages may not add up to 100 due to rounding). Of the studies which reported mean years of schooling (n=10), a mean of 9.64 years of schooling was reported. While for studies which reported schooling in ranges (n=33), 4% of participants were reported to have no formal schooling, 22% of participants had some or completed primary schooling, 13% had some high school but did not graduate, 8% graduated high school and 18% had higher education qualifications (percentages may not add up to 100 due to rounding). Health literacy scores varied greatly between studies, using the TOFHLA/ s-TOFHLA [53] (n=11). Some studies applied a score of below 22 or 23 as a benchmark for low-literacy [79,80,83], while others reported scores of 27 [91], 72% [103] or 91% [57] to determine low-literacy. For studies which reported TOFHLA [53] scores in ranges (n=6), 67.4% of participants scored adequate, 5% marginal and 27.6% inadequate health literacy scores [68,69,72,77,82]. For studies using the REALM [54] (n=6) 40% of participants were reported as having low-literacy (less than high school) and 60% as having adequate literacy (high school or greater) (n=6) [59,63,66,70,75,82].

4.6 Consent

Thirty-three studies did not provide details of how consent was obtained. One study from South Africa (MIC), provided information on the study and obtained consent verbally from

their participants [93]. Written consent was adapted for participants with low-literacy in one study from the United States (HIC) [67] and written consent (no adaptation reported) was obtained for seven studies in HIC, namely the United States (HIC) (n=5) [71,79,81,85,103], Canada (HIC) [59] and the Netherlands (HIC) [61], and 4 studies in MIC, namely South Africa (MIC) (n=3) [96–98] and India (MIC) and China (MIC) (n=1) [89].

4.7 Participants included in visual aid development

Participants with low-literacy were included in the development of visual aids in 16 studies, eight from high income countries namely the United States (HIC), the UK (HIC) and the Netherlands (HIC) [60,64,66,70,73,79,80,82], and eight from LMIC namely Mexico (MIC), Taiwan (MIC), South Africa (MIC), India (MIC), China (MIC) and Cameroon (MIC) [88–90,92,96,98,100,101]. Professionals or persons with high-literacy were included in eight studies, in HIC [57,58,62,71,72,75,80,84], community stakeholders from the research area in studies from the US (HIC) [83] and the Netherlands (HIC) [63], Cameroon (LIC) [88], India and China (MIC) [89], and other informants in studies from the United States (HIC) (n=4) [68,69,76,85], Benin (LIC) [86] and Iraq (MIC) [91]. No description of the development of the visual aids was provided in 13 studies.

4.8 Types of visual aids used

For this review, visual aids were identified and classified into groups based on their inherent characteristics. Graphic symbols were defined as any image presented on paper. As the results of the studies were collated it was noticed that pictograms formed a large proportion of the studies using graphic symbols. Because a number of these studies presented statistically significant results, pictograms were categorized into a separate group. Multimedia

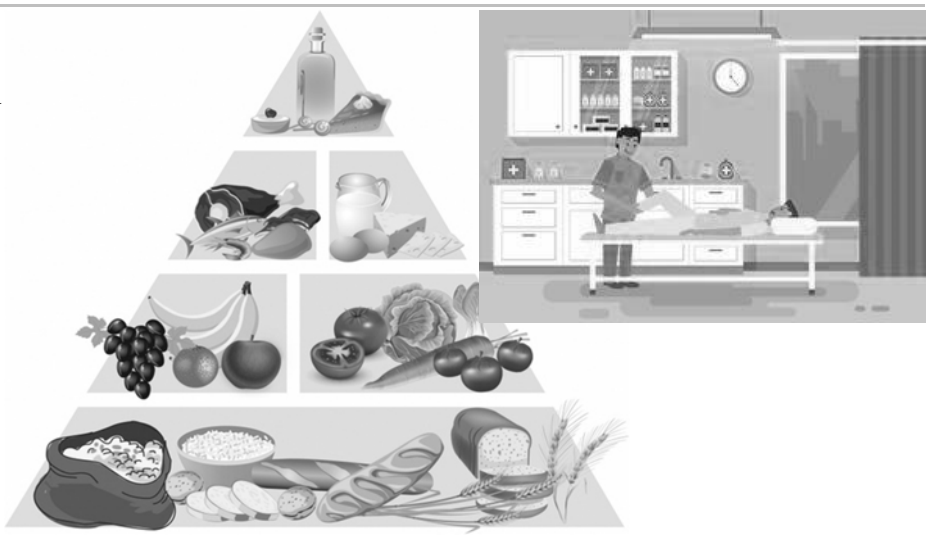
Graphic symbols (n=15) Images which may be in black and white or colour and may include combinations of images and additional information, not specific to the core meaning [101]. *Types of graphic symbols in this review: A food pyramid; images from pharmaceutical labels; black and white, and colour pictures; graphs and charts; a photonovella; photographs; pictures of clinical scenarios.* [57,59,60,63,70-72,74,78,79, 91,92,99,103,104]	
Pictograms (n=17) Black and white or colour, icons and symbols that have clear pictorial similarities with the object or meaning they represent. Additional contextual information is kept to a minimum [100]. [58,61,67,80,81,84,85,87,88, 94,-98,100,101,103]	
Multimedia (n=15) Combining multiple mediums of expression or communication [103]. *Types of multimedia visual aids used in this review: videos; video and pamphlet/ chart support; computer programmes with sounds, text and images; a telenovella; Computer programmes using animation.* [62,64,65,66,68,69,73,75,76, 77,83,86,89,90,93]	

Figure 2. Types of visual aids

Table 3
Visual aids used, targeted outcomes, description and effects of the visual aids.

	Authors and year	Targeted Outcomes	Visual aid description	Effect
Graphic symbols (n=15)	Bacardi-Gascon, Jimenez-Cruz & Jones, 2002 [92]	Comprehension; Satisfaction and suitability	Colour graphic of an apple containing various food types and a food pyramid.	NSS
	Hwang, Tram & Knarr, 2005 [59]	Comprehension	Black and white images from existing pharmaceutical labels.	NR
	Smith et al., 2009 [57]	Comprehension; Decision making; Satisfaction and suitability	Colour illustrations and graphs on a chart.	NSS
	Tsahakis, et al., 2014 [74]	Comprehension	Image of a skeleton on which a fractured bone would be circled.	NSS
	Webb et al., 2008 [78]	Comprehension	Black and white commonly used medication warning labels.	NC
	Choi, 2012 [79]	Visual aid evaluation	Black and white, different visual aids, humans, analogous objects and abstract objects.	NSS
	DeWalt et al., 2004 [82]	Health literacy	Not described.	**SSD**
	Hoogwegt, 2009 [99]	Visual aid evaluation	Colour pictures from a multimedia health promotion and social change project. Each picture highlighted an action by zooming in.	NSS
	Koops van 't Jagt et al., 2017 [60]	Health literacy	Photonovella: A dramatic story using photographs, captions, realistic characters, and simple text.	NSS
	Kripalani et al., 2007 [70]	Medication adherence	Colour digital photographs of medicine instructions and labelling.	NSS
	Kripalani, Schmotze & Jacobson, 2012 [71]	Medication adherence	Colour images or icons of medications.	NSS
	Negarandeh et al., 2012 [91]	Health literacy; Medication adherence	Not described.	NSS
	Roberts et al., 2008 [103]	Visual aid evaluation	Colour pictorial representations of clinical scenarios.	NSS
	Shea et al., 2008 [72]	Satisfaction and suitability	Not described.	NC
	van Beusekom, Bos, Wolterbeek, Guchelaar, & van den Broek, 2015 [63]	Visual aid evaluation	Black and white visuals, not described.	NC
Multimedia (n=5)	Bickmore et al., 2010 [64]	Satisfaction and suitability	Animated conversational agents that stimulate face-to-face conversation with patients using synthetic speech.	NC
	Gupta et al., 2009 [90]	Health literacy	A Short educational film and flipcharts presented on a camp.	NSS
	Kandula et al., 2009 [68]	Health literacy	A programme combining text, sound, graphics and video.	NSS
	Kandula et al., 2011 [69]	Health knowledge recall	Computer based programme with 7 modules combining graphics, animation and spoken audio.	NC
	Meppelink et al., 2015 [62]	Health knowledge recall	Colorectal cancer screening illustrations and animations.	NSS

	Authors and year	Targeted Outcomes	Visual aid description	Effect
	Poureslami et al., 2012 [89]	Health literacy; Medication adherence	Educational videos and a pictorial pamphlet.	**SSD**
	Volk et al., 2008 [76]	Decision making; Satisfaction and suitability	An entertainment based decision aid for prostate cancer screening.	NSS
	Bello-Bravo et al., 2013 [86]	Satisfaction and suitability	3 prevention videos shown on a cell-phone.	NSS
	Borrayo, 2004 [65]	Decision making	An 8 minute telenovela in soap opera format.	NA
	Bryant et al., 2009 [66]	Comprehension	A multi-media computer version of the AUA and additional videos for the experimental group.	NSS
	Calderon et al., 2014 [77]	Health literacy	A colour animated video of a character's story of diabetes.	**SSD**
	Carstens, Maes, & Gangla-Birir, 2006 [93]	Visual aid evaluation	Black and white, images, humans, analogous objects and abstract objects.	NSS
	Gerber et al., 2005 [83]	Health literacy	A sequence of 19 audio and video health information lessons..	**SSD**
	Terndrup et al., 2012 [73]	Health literacy	A brief video.	**SSD**
	Volandes, Barry, Chang & Paasche-Orlow, 2010 [75]	Decision making	Video of a patient with advanced dementia.	NSS
Pictogram (n=17)	Berthenet, Vaillancourt & Pouliot, 2017 [58]	Comprehension; Visual aid evaluation	Black and white International Pharmaceutical Federation picture set.	NC
	Choi, 2013 [80]	Satisfaction and suitability	Pictograms drawn by a professional illustrator.	NSS
	Choi, 2015 [81]	Comprehension; Health knowledge recall	Simple line drawings of stick figures showing explicit care actions.	**SSD**
	Chuang et al., 2010 [101]	Comprehension; Satisfaction and suitability	Black and white simple line drawings	**SSD**
	Dowse & Ehlers, 2001 [94]	Visual aid evaluation, Health knowledge recall, Satisfaction and suitability	Black and white, 23 pictograms from the USP-DI and 23 locally developed pictograms for medication instructions.	NSS
	Dowse & Ehlers, 2005 [95]	Comprehension; Medication adherence	Black and white pictogram labels for medicine bottles	NSS
	Dowse, Ramela, & Browne, 2011 [97]	Comprehension	Black and white. Not described.	NSS
	Dowse, Ramela, Barford, & Browne, 2010 [98]	Comprehension; Health knowledge recall	Black and white line drawings created for the purpose of quick, clear communication without words.	NC

Authors and year	Targeted Outcomes	Visual aid description	Effect
Hill et al., 2016 [84]	Health knowledge recall; Satisfaction and suitability	Colour pictogram enhanced discharge instructions.	NSS
Kalichman et al., 2005 [85]	Medication adherence	Colour simple line drawings depicting individuals of ambiguous ethnic backgrounds.	**SSD**
Kalichman et al., 2013 [103]	Health literacy; Medication adherence	Realistic colour stickers of pills on a chart of dosing times and instructions.	NSS
Kalichman, Cherry, & Cain, 2005 [67]	Health literacy; Medication adherence	Colour humans, analogous objects and abstract objects.	NSS
Kheir et al., 2014 [87]	Comprehension	Colour pictograms illustrating medication labels.	NSS
Mansoor & Dowse, 2003 [100]	Comprehension; Satisfaction and suitability	Black and white United States Pharmocopeia pictogram set.	**SSD**
Mbuagbaw & Ndongmanji, 2012 [88]	Comprehension	Colour prescription label pictures.	NSS
Meppelink & Bol, 2015 [61]	Health knowledge recall	Colour radio frequency ablation treatment illustrations.	NSS
Dowse, Barford, & Browne, 2014 [96]	Health literacy; Medication adherence	Black and white. Not described.	**SSD**

Notes: PLL: Participants with low-literacy; PHL: Participants with high-literacy; PML: Participants with marginal literacy; VA: Visual Aid
SSD: Statistically significant difference in results; NSS: No statistical significance in results; NC: No difference between groups
NR: A negative difference in results was evident (not statistically significant)

visual aids were defined as any type of image combined with additional media such as sound or movement. See Figure 2 for examples of the visual aids used.

Although not all studies provided a description of the visual aids used, this review identified 15 studies incorporating graphic symbols (10 from high-income countries and 5 from LMIC), 15 studies using multimedia (11 from high-income countries and 4 from LMIC) and 17 using pictograms (8 from high-income countries and 9 from LMIC). The types and descriptions of visual aids used in each study are reported in Table 3.

4.9 Efficacy of the types of visual aids

Graphic symbols (n=15) were reported by the authors of the studies to produce statistically significant improvements in information comprehension (n=1) relating to heart failure [82] in the United States (HIC). Multimedia visual aids (n=15) were reported by the authors of the studies to produce statistically significant improvements in knowledge, understanding and knowledge application (n=4), relating to asthma (video and picture pamphlet) [89] in China (MIC) and India (MIC) (n=1), knowledge of the emergency department (video) [73] in the United States (HIC), and diabetes (video) [77,83] in the United States (HIC). Pictograms (n=17) were reported by the authors of the studies to produce statistically significant improvements (n=5) in relation to the comprehension of, information relating to medication in Taiwan (MIC) [101] and South Africa (MIC) [100], and discharge instructions [81] in the United States (HIC), the recall of health information [81] in the United States (HIC), and adherence to medication regimes in South Africa (MIC) [96] and the United States (HIC) [85]. Studies using pictograms produced the most significant effects (n=7), followed by multimedia visual aids (n=4). Of the multimedia visual aids, all studies which reported significant effects made use of video [73,77,83] or video combined with pictograms [89]. The types of visual aids and their effects on the theme areas can be seen in Table 5.

Table 4

Areas in which the different types of visual aids showed significant differences between low- and high-literacy participants

	Graphic Symbol (n=15)	Pictogram (n=17)	Multimedia (n=15)
Comprehension or understanding (n=15*)		4 [67,81,100,101]	
Health-literacy (n=12*)	1 [82]		4 [73,77,83,89]
Health Information Recall (n=7*)		1 [81]	
Decision-making supports (n=4*)			
Adherence to medication regimes (n=9*)		2 [96,85]	1 [89]
Visual aid evaluation (n=7*)			
Satisfaction or suitability (n=11*)		2 [100,101]	

Note: *Some studies measured multiple targeted outcomes

2 Studies reporting statistically significant differences between low- and high-literacy participants (number signifies the number of studies)

Table 5

Themes of studies included in the review, area and effect of intervention and results

Targeted outcome	Studies	Aims	Area	Effect of IV	Results
Comprehension or understanding (n=15)	Bacardi-Gascon, Jimenez-Cruz & Jones, 2002 [92]	To evaluate and compare the graphical impact, and overall understanding.	Nutrition	NSS	• PLL and PHL preferred more familiar VA with simple and specific text, to more technical VA's.
	Berthenet, Vaillancourt & Pouliot, 2017 [58]	To validate a set of pictograms depicting medication instructions for use among the elderly to support health-literacy.	Medication	NC	• No difference in overall comprehension between PHL and PLL.
	Bryant et al., 2009 [66]	To develop a multimedia version of the AUA-SS to improve patient understanding and decrease symptom score errors	Urology symptoms	NSS	• Increased comprehension with the addition of VA for PLL and PHL. • Improved comprehension for PLL using VA in a multimedia presentation even when verbal input was also received.
	Choi, 2015 [81]	To examine the effect of pictograph based discharge instructions on comprehension and recall of older adults with low-literacy.	Discharge instructions	SSD	• Lower comprehension of written materials without VA for PLL. • Increased comprehension with the addition of VA for PLL.
	Chuang et al., 2010 [101]	To compare preference and comprehension of pictographs between medical staff and persons with low-literacy.	Medication	SSD	• Significant differences in the selection of pictographs between PHL and PLL and increased comprehension of pictograms for PHL.
	Dowse & Ehlers, 2005 [95]	To design labels incorporating pictograms for medicines, to compare the understanding of these with conventional labels, and to assess the influence of pictogram labels on adherence to therapy.	Medication	NSS	• Lower comprehension of written materials without VA for PLL. • Increased comprehension with the addition of VA for PLL.
	Dowse, Ramela, Barford & Browne, 2010 [98]	To develop materials to facilitate the communication and recall of medicine-related information to South African HIV/AIDS patients	Medication, HIV/AIDS	NC	• Comprehension of the information presented varied according to the concrete or abstract nature of the information.
	Dowse, Ramela, & Browne, 2011 [97]	To develop and evaluate a medicine information leaflet with pictograms for low-literate HIV/AIDS patients.	HIV/ AIDS Medication	NSS	• 60% understanding of PIL, but 71.8% understanding of pictograms.

	Hwang, Tram & Knarr, 2005 [59]	To determine whether the addition of illustrations to prescription medication instruction labels affects patients' comprehension of the accompanying written information.	Medication	NR	• Current VA on medication labels do not aid comprehension.
	Kheir et al., 2013 [87]	To compare comprehension of medicine label instructions in text and pictorial formats among foreign workers with low-literacy skills in Quatar	Medication	NSS	• Lower comprehension of written materials without VA for PLL. • Increased comprehension with the addition of VA for PLL. • Improved comprehension for PLL using VA in a written format even when verbal input was also received. • VA in isolation the most difficult source to comprehend
	Mansoor & Dowse, 2003 [100]	To design, develop, and evaluate an understandable medicine label and patient information leaflet for nystatin suspension, for low-literate participants.	Medication	SSD	• Lower comprehension of written materials without VA for PLL.
	Mbuagbaw & Ndongmanji, 2012 [88]	To investigates patient comprehension of frequently used prescription patterns and explore preferences for the various methods.	Medication	NSS	• Lower comprehension of written materials without VA for PLL. • Increased comprehension with the addition of VA for PLL.
	Smith et al., 2009 [57]	The development and evaluation of a bowel cancer screening decision aid for persons with lower education and literacy	Bowel cancer	NSS	• Some PLL felt the tool promoted bowel cancer screening rather than presenting balanced information.
	Tsahakis et al., 2014 [74]	To evaluate the change in comprehension, treatment plans, and discharge instructions after orthopaedic trauma patients are given pictorial discharge instructions.	Discharge instructions	NSS	• Increased patient questionnaire scores when the VA was used.
	Webb et al., 2008 [78]	To refine warning labels promoting the safe use of prescription drugs among patients, regardless of literacy level.	Medication	NC	• Existing VA on medication labels did not aid comprehension.
Health-literacy (n=12)	Calderon et al., 2014 [77]	To determine if the effectiveness of standard diabetes screening tool may be improved using a multimedia format.	Diabetes	SSD	• Health-literacy scores improved with the addition of the VA.
	Dewalt et al., 2004 [82]	To develop and pilot a disease management program for low literacy patients with heart failure.	Heart failure	SSD	• No change in heart-failure related knowledge but a SSD in daily measurement weight.

	Dowse, Barford, & Browne, 2014 [96]	To develop a patient information leaflet on HIV- and ARV-related knowledge and self-efficacy in a low-literacy South African population.	HIV/ AIDS	SSD	• Increased knowledge and self-efficacy with VA.
	Gerber et al.,2005 [83]	To evaluate a multimedia intervention for diabetes education targeting individuals with low-health-literacy levels.	Diabetes	SSD	• Increased knowledge and self-efficacy with VA.
	Gupta et al., 2009 [90]	To assess the impact of a health education intervention program among women in India	Breast cancer	NSS	• Improvement in mean score
	Kalichman, Cherry, & Cain, 2005 [67]	To develop and pilot an HIV treatment adherence improvement counselling intervention for people with lower health-literacy who were taking antiretroviral medications.	HIV/ AIDS Medication	NSS	• Increased knowledge and self-efficacy with VA.
	Kalichman et al., 2013 [103]	To test the efficacy of a pictograph-guided adherence skills building counselling intervention for limited literacy adults living with HIV.	HIV/ AIDS Medication	NSS	• General counselling showed greater improvement than VA guided counselling for PHL. • For PLL VA guided counselling greater use of adherence strategies was reported than for general health improvement counselling.
	Kandula et al., 2009 [68]	To examine the effect of a multimedia diabetes education programme for patients with low-literacy. To assess the association between literacy and knowledge improvement using the multimedia programme.	Diabetes	NSS	• Increased knowledge with VA, but PLL had lower increases than PHL.
	Koops van 't Jagt et al., 2017 [60]	To test the effects of a Dutch version of a photonovela across participants with varying levels of literacy.	Diabetes	NSS	• Increased knowledge with VA.
	Negarandeh et al., 2012 [91]	To explore the impact of pictorial image and teach back educational strategies on knowledge, adherence to medication and diet among patients with type 2 diabetes and low-health-literacy	Diabetes	NSS	• Increased knowledge and self-efficacy with VA.
	Poureslami et al., 2012 [89]	To explore the effectiveness of different formats of culturally relevant information and its impact on asthma patients' self-management.	Asthma	**SSD**	• Increased knowledge and self-efficacy with VA.
	Terndrup et al., 2012 [73]	To evaluate a multi-media education intervention to inform elderly patients about emergency department care.	Emergency department	**SSD**	• Increases in knowledge resulted in increases in the participants ability to cope in the ED.

Health Information recall (n=7)	Choi, 2015 [81]	To examine the effect of pictograph based discharge instructions on comprehension and recall of older adults with low-literacy.	Discharge instructions	**SSD**	• Improvement in recall of discharge instructions with VA.
	Dowse & Ehlers, 2001 [94]	To evaluate and compare locally developed, pharmaceutical pictograms with pictograms appearing in from the USP-DI in a low- literate population. To investigate the effectiveness of pictograms in stimulating recall of medication instructions.	Medication	NSS	• Local pictograms were more easily understood and preferred by PLL.
	Dowse, Ramela, Barford & Browne, 2010 [98]	To develop materials to facilitate the communication and recall of medicine-related information to South African HIV/AIDS patients	Medication, HIV/AIDS	NC	• Comprehension of the information presented varied according to the concrete or abstract nature of the information.
	Hill et al., 2016 [84]	To evaluate the effect of standard vs pictograph-enhanced discharge instructions on patients' recall of and satisfaction with their discharge instructions.	Discharge instructions	NSS	• Improvement in recall of discharge instructions with VA.
	Kandula et al., 2011 [69]	To examine the stability of knowledge gains after viewing the multimedia diabetes education programme across literacy levels and to determine if a teach-back protocol, improved knowledge retention at 2 weeks.	Health-literacy	NC	• All participants, regardless of literacy level had trouble remembering large amounts of new information, even when a teach-back approach was used.
	Meppelink & Bol, 2015 [61]	To gain insight into how people with low- or adequate health-literacy attend to online health-information, and how this influences recall.	Online general health-literacy	NSS	• Improved recall with attention to VA spoken text included.
	Meppelink et al., 2015 [62]	To investigate what features of spoken health animations improve information recall and attitudes and whether there are differences between health-literacy groups.	Online general health-literacy	NSS	• Improved recall with attention to VA spoken text included. • PHL recalled more information in all conditions than PLL.
Decision-making supports (n=4)	Borrayo, 2004 [65]	To evaluate the efficacy of an educational video on breast cancer.	Breast cancer screening	NA	• Results not reported
	Smith et al., 2009 [57]	The development and evaluation of a bowel cancer screening decision aid for persons with lower education and literacy	Bowel cancer screening	NSS	• PLL indicated that the VA promoted screening rather than presenting a choice.

	Volandes, Barry, Chang & Paasche-Orlow, 2010 [75]	To examine whether a video of a patient with advanced dementia could improve decision-making.	End of life decision	NSS	• The VA decreased uncertainty for PLL, thus assisting decision-making.
	Volk et al., 2008 [76]	To evaluate an entertainment-based patient decision aid for prostate cancer screening among patients with low or high health-literacy.	Prostate cancer screening	NSS	• The use of the VA was associated with lower decisional conflict and greater self-advocacy than an audio booklet.
Medication Adherence (n=9)	Dowse & Ehlers, 2005 [95]	To design labels incorporating pictograms for medicines, to compare the understanding of these with conventional labels, and to assess the influence of pictogram labels on adherence to therapy.	Medication	NSS	• Positive changes in the adherence of participants to medication regimes when VA included in the health-education materials or instructions.
	Dowse, Barford & Browne, 2014 [96]	To develop a patient information leaflet on HIV- and ARV-related knowledge and self-efficacy in a low-literacy South African population.	HIV/ AIDS Medication	**SSD**	• Knowledge of the need for ARV's, and the effects of these increased following the introduction of health-education materials with VA.
	Kalichman et al., 2005 [85]	To test the pictographic and colour visual analogue scale for assessing self-efficacy for medication adherence.	HIV/ AIDS Medication	**SSD**	• The self-efficacy scale used was associated with significant differences in adherence to medication regimes.
	Kalichman et al., 2013 [103]	To test the efficacy of a pictograph-guided adherence skills building counselling intervention for limited literacy adults living with HIV.	HIV/ AIDS Medication	NR	• PML demonstrated greater adherence in the VA condition. • PLL demonstrated greater adherence in the general health improvement condition than in the VA condition.
	Kalichman, Cherry, & Cain, 2005 [67]	To develop and pilot an HIV treatment adherence improvement counselling intervention for people with lower health-literacy who were taking antiretroviral medications.	HIV/ AIDS Medication	NSS	• The use of VA increase participants adherence to medication regimes.
	Kripalani et al., 2007 [70]	Development, implementation and preliminary evaluation of an illustrated medication schedule for low-literacy patients.	Medication	NSS	• Improvements in self-efficacy were identified using the VA.
	Kripalani, Schmotze & Jacobson, 2012 [71]	To test the effect of two low-literacy interventions on medication adherence	Medication	NSS	• Improvements in self-efficacy were identified using the VA.
	Negarandeh et al., 2012 [91]	To explore the impact of pictorial image and teach back educational strategies on knowledge, adherence to medication and diet among patients with type 2 diabetes and low-health-literacy	Diabetes	NSS	• Improvements in self-efficacy were identified using the VA.

	Poureslami et al., 2012 [89]	To explore the effectiveness of different formats of culturally relevant information and its impact on asthma patients' self-management.	Asthma	**SSD**	• Improvements in self-efficacy were identified using 2 educational videos compared to the pamphlet.
Visual aid evaluation (n=7)	Berthenet, Vaillancourt & Pouliot, 2017 [58]	To validate a set of pictograms depicting medication instructions for use among the elderly to support health-literacy.	Medication	**SSD**	• Differences in translucency between PLL and PHL (>12y education)
	Carstens, Maes, & Gangla-Birir. 2006 [93]	To determine differences in picture comprehension between literate and low-literate audiences in the context of HIV and AIDS	HIV/ AIDS	NSS	• Human are more easily recognised than non-human VA. • The identification of abstract objects was difficult for PHL and PLL although more difficult for the PLL.
	Choi, 2012 [79]	To develop and pilot breast health-care instructions enhanced by pictographs for persons with low-literacy.	Breast health-literacy	NSS	• The pictograms were considered useful and easy to identify.
	Dowse & Ehlers, 2001 [94]	To evaluate and compare locally developed, pharmaceutical pictograms with pictograms appearing in from the USP-DI in a low- literate population. To investigate the effectiveness of pictograms in stimulating recall of medication instructions.	Medication	NSS	• Local pictograms were more easily understood and preferred by PLL.
	Hoogwegt, 2009 [99]	To investigate the effect of motion suggesting elements (arrows) in health related pictures aimed at low-literate audiences in South Africa.	General health-literacy	NSS	• Arrows can indicate motion for PHL, but has only a very low effect for PLL.
	Roberts et al., 2008 [103]	To produce an understandable pictorial asthma action plan.	Asthma	NSS	• Guessability and translucency were reported to be good for the pictures used.
	van Beusekom, Bos, Wolterbeek, Guchelaar, & van den Broek, 2015 [63]	To evaluate graphics of organs to provide directions for the development of pictograms that support patient leaflets for a low-literate audience.	General health-literacy	NC	• PLL identified organs in isolation more easily than organs within the context of the body.
Satisfaction and suitability (n=11)	Bacardi-Gascon, Jimenez-Cruz & Jones, 2002 [92]	To evaluate and compare the graphical impact, and overall understanding.	Nutrition	NSS	• PLL and PHL preferred a familiar object (apple) to a diagram (pyramid) with simple and specific text.
	Bello-Bravo et al., 2013 [86]	To assess the reaction of local populations to the use of animated videos.	General Health-literacy	NSS	• Positively received by participants

	Bickmore et al., 2010 [64]	To evaluate an animated computer agent to explain research consent forms to potential participants.	General Health-literacy	NC	• Overall patients were satisfied with the VA and its ease of use. No difference between PHL and PLL.
	Choi, 2013 [80]	To examine the acceptability and comprehensibility of pictograph based discharge instructions in low-literate older adults.	Discharge instructions	NSS	• A focus group reported that the pictograms were acceptable and useful to older patients on discharge.
	Chuang et al. 2010 [101]	To compare preference and comprehension of pictographs between medical staff and persons with low-literacy.	Medication	**SSD**	• Preferences for pictograms differed between PLL and PHL.
	Dowse & Ehlers, 2001 [94]	To evaluate and compare locally developed, pharmaceutical pictograms with pictograms appearing in from the USP-DI in a low- literate population. To investigate the effectiveness of pictograms in stimulating recall of medication instructions.	Medication	NSS	• Local pictograms were preferred by PLL.
	Hill et al., 2016 [84]	To evaluate the effect of standard vs pictograph-enhanced discharge instructions on patients' recall of and satisfaction with their discharge instructions.	Discharge instructions	NSS	• Participants who were provided VA enhanced instructions were more satisfied with these post discharge.
	Mansoor & Dowse, 2003 [100]	To design, develop, and evaluate an understandable medicine label and patient information leaflet for nystatin suspension, for low-literate participants.	Medication	**SSD**	• A clear preference for materials including VA was identified.
	Shea et al. 2008 [72]	To compare responses on a printed patient satisfaction instrument with responses to an illustration enhanced format and a telephone based format.	Patient satisfaction	NC	• Written survey and those with accompanying VA's were preferred by PLL over an interactive voice format, although they included more invalid responses.
	Smith et al., 2009 [57]	The development and evaluation of a bowel cancer screening decision aid for persons with lower education and literacy	Bowel cancer screening	NSS	• VA positively reviewed by PLL and PHL
	Volk et al., 2008 [76]	To evaluate an entertainment-based patient decision aid for prostate cancer screening among patients with low or high health-literacy.	Prostate cancer screening	NSS	• PLL showed greater engagement with the VA than PHL.

TOFHLA [53] REALM [54] DHLS [77] SAHL-D [104]
PLL: Participants with low-literacy; PHL: Participants with high-literacy; PML: Participants with marginal literacy; VA: Visual Aid
SSD: Authors reported statistically significant difference in results; NSS: No statistical significance in results reported;
NC: No difference between groups reported NR: A negative difference in results

The attributes reported by the studies in this review to be associated with the efficacy, or lack thereof of the visual aids included (a) characteristics of the visual aids such as level of abstractness (guessability) in Canada (HIC) [58,59]and South Africa (MIC) [93], the (b) position of images portraying human anatomy in Canada (HIC) [59] and the Netherlands (HIC) [63], and the (c) simplicity or complexity of the visual aids in Taiwan (MIC) [101]. Other studies explored and expanded on the importance of the (d) familiarity of images in Mexico (MIC) [92] and South Africa (MIC) [98] and (e) cultural appropriateness in India (MIC) and China (MIC) [89] and the United States (HIC) [71], as facilitators of efficacy.

4.10 Aims targeted and outcomes of the studies

The studies reviewed were grouped into themes based on their targeted outcomes. The number of studies across the themes may exceed the total (n=47) as some studies had multiple outcomes. Seven themes were identified. Studies which reported statistically significant results as reported by the authors of that paper are highlighted. The full results of all studies in the review according to themes are presented in Table 5.

The first theme is *comprehension or understanding* of health education materials (n=15) [57–59,66,74,78,81,87,88,92,95,97,98,100,101]. The authors of three studies reported results with statistical significance relating to the use of pictograms, for improved comprehension of health education materials for individuals with low-literacy in the United States (HIC) [81] and South Africa (MIC) [100], and relating to differences in the comprehension of pictograms between participants with high and low-literacy in the United States (HIC) [101]. The remaining studies (n=12) did not report statistically significant effects relating to comprehension in Cameroon (MIC) [88], Nepal (LIC) and Bangladesh (MIC) [87], Mexico (MIC) [92], South Africa (MIC) [95,97,98], Australia (HIC) [57], Canada (HIC) [58,59] and the United States (HIC) [66,74,78].

The second theme is the use of visual aids for the development of *health literacy* (moving knowledge into actions) (n=12) [60,67,68,73,77,82,83,89–91,96,103]. Multimedia videos were reported by the authors to produce statistically significant effects relating to improvements in knowledge and self-efficacy in studies relating to the self-management of diabetes [77,83] in the United States (HIC), asthma in India (MIC) and China (MIC) [89], and understanding of the emergency department care in the United States (HIC) [73]. Similarly, illustrated graphs were reported by the authors to produce statistically significant effects for heart failure interventions [82] in the United States (HIC), whilst pictograms were reported by the authors to produce statistically significant improvements in HIV/AIDS knowledge and self-efficacy [96] in South Africa (MIC). The authors of the remaining studies (n=6) did not report statistically significant results relating to health literacy in India (MIC) [90], Iraq (MIC) [91], the Netherlands (HIC) [60], and the United States (HIC) [67,68,103].

The third theme is the use of visual aids to aid *health information recall* (n=7) [61,62,69,81,84,94,98]. The authors of one study reported a statistically significant improvement in the recall of discharge instructions by older-adults with the inclusion of pictographs in the United States (HIC) [81]. The remaining studies from South Africa (MIC) [94,98], the Netherlands (HIC) [61,62] and the United States (HIC) [69,81,84] did not report significant differences in recall when visual aids were used.

The fourth theme is the use of visual aids as *decision-making supports*. Four studies included either illustrations (graphic symbols), audio or videos, but no significant differences in decision-making were reported by the authors of the studies which were conducted in Australia (HIC) [57] and the US (HIC) [65,75,76].

The fifth theme is the use of visual aids in health education materials as a tool to improve *medication adherence* (n=9) [67,70,71,85,89,91,95,96,103]. Medication adherence was targeted through the enhancement of medication labels with pictograms in South Africa

(MIC) [95] and the United States (HIC) [70], and information materials with pictograms related to HIV/AIDS in South Africa (MIC) [96], and the United States (HIC) [67,85,103], diabetes in Iraq (MIC) [91], heart disease in the United States (HIC) [71], and asthma in India (MIC) and China (MIC) [89]. The authors of three studies reported statistically significant improvements in medication adherence when visual aids were included for participants with HIV/AIDS in South Africa (MIC) and the United States (HIC) [85,96], and asthma in India (MIC) [89]. The remaining studies (n=6) did not report statistically significant differences in medication adherence with the inclusion of pictograms in medication labels or information materials.

The sixth theme is *visual aid evaluation* (n=7) [58,63,79,93,94,99,102]. A statistically significant difference in the guessability of pictograms was identified by the authors of one study for participants with high-literacy when compared to participants with low-literacy in Canada (HIC) [58]. The remaining authors of studies did not present statistical differences in the evaluation of visual aids, but qualitatively described the preferred attributes of visual aids for persons with low-literacy. Guessability, familiarity, and position were described as important in South Africa (MIC) [93,99], the UK (HIC) (with immigrant populations from LMIC countries) [102], the Netherlands (HIC) [63] and the United States (HIC) [79] and cultural acceptability was described as important in South Africa (MIC) [94].

The seventh and final theme identified is the satisfaction and suitability of visual aids to their target population (n=11) [57,64,72,76,80,84,86,92,94,100,101]. The authors of one studies highlighted statistically significant differences in the preferences of participants with low- and high-literacy, with regards to the specific pictogram chosen for each concept in Taiwan (MIC) [101], while the authors of a second study reported a statistically significant preference for medication labels including pictograms compared to those without in South Africa (MIC) [100]. The authors of the remaining studies did not report significant

differences in either the satisfaction with or suitability of graphic symbols in Mexico (MIC) [92], Australia (HIC), [57] and the United States (HIC) [72], pictograms in South Africa (MIC) [94] and the United States (HIC) [80,84], or multimedia visual aids in Benin (LIC) [86], the UK (HIC) [64] and the United States (HIC) [76].

5. Discussion and conclusion

5.1 Discussion

This scoping review of the use of visual aids in health education materials for persons with low-literacy identified significantly more studies than the previous review by Park and Zuniga (2016) [21], including more studies from LMIC (n=17 compared to n=4). However, a disparity in the number of studies from high- versus LMIC still exists. This is concerning, as it is in LMIC that the greatest diversity in culture is seen and where the majority of low-literate individuals reside [19]. In addition, no new studies published in the past five years from LMIC were identified. A lack of research in LMIC since 2014 is troubling as this is the period, post-millennium development goals, in which a shift from poverty alleviation, to human rights, equality and sustainability, has been proposed [105]. Yet, without research to guide the way forward, specifically from the countries in need, any interventions re-iterate current divides by applying knowledge from primarily high-income, western countries into LMIC, with non-western cultures [106].

The studies included in this review focused on visual aids for persons with low-literacy, yet, most studies (n=29) relied on self-reporting of years of school attended by participants, rather than standardised assessments of literacy. The self-reporting of literacy levels however, may not be a reliable measure of literacy due to the shame experienced by individuals who have low-literacy, this may result in over-reporting of actual literacy levels [107]. A lack of use of standardised measures of health literacy may be indicative of the

paucity of health literacy measures which are available for LMIC [106,108], which is highlighted by the fact that only one study from a LMIC made use of a standardised measure of literacy, and that tool had not been validated for use within the population [91].

A specific concern identified in this review is that of consent. Low health literacy impacts not only the ability to obtain information but also the ability to make use of this information in decisions regarding one's health. Hence low-literacy and/or low health literacy may limit a person's understanding of their rights and responsibilities, including the implications of participation in (or exclusion from) a research study. The majority of studies with individuals with low-literacy, did not report on how consent was obtained, and the remainder obtained written consent. Even a study which investigated using a visual aid to explain research consent forms, and indicated that understanding was a challenge for participants with low-literacy, did not describe consent procedures for their own study [64].

The mechanisms followed in the development and evaluation of visual aids provided the strongest indication of the efficacy of the visual aid across this review. This can be seen when the efficacy of studies which included individuals with low-literacy in the development of visual aids (n=16) is compared to those which did not include/report inclusion of individuals with low-literacy in development (n=37). Ten studies which included individuals with low-literacy reported significant improvements in various areas when using visual aids (62.5%), while no studies which did not include individuals with low-literacy reported improvements when visual aids were used. A final factor relating to the efficacy of visual aids, highlighted in this review is the need to limit the use of abstract concepts for persons with low-literacy [93,94]. In addition, different patterns of preferences with regards to visual aids were highlighted between persons of low-literacy and those with higher literacy.

This review highlighted health literacy (translating knowledge into actions) as the theme in which the greatest proportion of studies which reported significant improvements was seen. Forty-one percent of studies (n=7) considering health literacy reported statistically significant improvements. Thirty-three percent of studies measuring medication adherence and 20% measuring comprehension also benefitted from the use of visual aids. The use of visual aids in decision-making supports did not show significant results.

For individuals with low-literacy, pictograms were the type of visual aid which was most likely to produce statistically significant results (n=5) relating to comprehension of health education materials and adherence to medication regimes, followed by multimedia videos (n=4) relating to health literacy around diabetes and asthma. The use of generalised graphic symbols did not significantly impact health literacy, nor did the use of computer programmes. Overall, the descriptions of visual aids provided by studies was poor, limiting the possibility of further comparisons. Furthermore, studies using pictograms (n=17) contained a higher percentage of randomised control trials, thus increasing the likelihood of statistically significant differences being reported.

Overall, the response of persons with low-literacy to the incorporation of visual aids into health education materials shows promise for increasing health literacy particularly in relation to medication adherence. However, increased clarity on the types of visual aids used, the development of these visual aids, and the reporting of literacy is recommended for future studies.

Guidelines for the development and use of visual aids

Guidelines for the development of visual aids include the need for persons from the target population to be involved in the development of the visual aids, and to make use of both quantitative and qualitative measures. For the use of abstract concepts to be limited

where possible [93,94], and when required, to include culturally and contextually appropriate, facial expression and posture to aid the comprehension of abstract concepts [93].

Gaps in the research

As identified within this review, the field would benefit from guidelines for obtaining consent from low-literate and low-health literate participants. A gap in the literature exists in evidence of the effect of visual aids for persons with low-literacy from LMIC, particularly since 2014, and there is a need for health literacy tools to be validated in languages other than English and cultures other than those affiliated with Western HICs. A lack of experimental designs and definition of variables is evident which hampers the determination of efficacy and replicability of results.

Limitations

Limitations of this review include an inability to perform more in-depth analysis of the effects of the type of visual aid due primarily to a lack of detail in many of the descriptions provided by authors of the original reports. Hence, this is more of a limitation in the data set rather than this review per se. Secondly, both publication and language bias cannot be ruled out as factors impacting this review [109]. Only peer-reviewed publications were included, which may have impacted the number of studies obtained from LMIC, as researchers from such countries do not often have the training, mentoring, and supervision needed to publish in reputable peer-reviewed journals [110], and hence are more likely to have reported on their findings in the grey literature which was excluded. Secondly, although only one study was omitted at the full text level for not being reported in English, more studies may have been omitted at the title and abstract level, and the process of publication in English for non-English speakers is reported to be longer and more difficult than for first-language English speakers, thus making it less likely that that studies reach publication [111].

A third limitation of this review may be the search terminology used. Terminology relating specifically to graphic displays was not included, and a focus on high-prevalence conditions such as HIV/AIDS, cancer and diabetes, in the search criteria may have resulted in studies on other conditions being excluded.

5.2 Conclusions

This review provides preliminary support for the use of visual aids for persons with low-literacy in health education materials. However, visual aids need to be designed using feedback from the target population involved in the study. This review suggested that pictograms or videos may be the most effective visual aids, and that abstract concepts are more difficult to understand than concrete concepts.

Large gaps in the literature are evident for studies from LMIC in general and consent procedures for low-literate or low-health-literate participants from LMIC in particular, and for studies using experimental designs. Also, the need for validated tools for the measurement of health literacy were highlighted.

5.3 Practice Implications

Consent procedures need to be adapted for persons with low-literacy. Visual aids developed with the population under consideration could be included in health education materials within health education programmes. Pictograms and videos may be the best suited visual aids for health education materials.

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Declaration of interest

The authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest, or non-financial interest in the subject matter or materials discussed in this manuscript.

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