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# Improving Diabetes Health Literacy by Animation

## Purpose and Scope

To produce a Spanish/English animated video about diabetes; to qualitatively assess cultural and linguistic appropriateness; and to test effectiveness at improving diabetes health literacy among Latino/Hispanics.

## Methods

Participatory research and animation production methods guided development of the video. Cultural appropriateness was assessed through focused discussion group methods. A prospective randomized controlled trial tested the effectiveness of the Spanish version at improving diabetes health literacy, compared to “easy to read” diabetes information from the National Institute of Diabetes and Digestive and Kidney Diseases. Functional health literacy was measured by the Short Test of Functional Health Literacy in Adults. Diabetes health literacy was measured by the Diabetes Health Literacy Survey (DHLS).

## Results

No significant differences were recorded between experimental ( $n = 118$ ) and control groups ( $n = 122$ ) at baseline on demographic characteristics, Short Test of Functional Health Literacy in Adults score, or DHLS score. Fifty-eight percent of the study participants had inadequate functional health literacy. Mean DHLS score for all participants and those having adequate functional health literacy were 0.55 and 0.54, respectively (inadequate diabetes health literacy). When adjusting for baseline DHLS score, sex, age, and insurance status, DHLS scores improved significantly more in the experimental group than the control group (adjusted mean = 55% vs

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53%,  $F = 4.7$ ,  $df = 1$ ,  $P = .03$ ). Interaction between experimental group and health literacy level was significant ( $F = 6.37$ ,  $df = 2$ ,  $P = .002$ ), but the experimental effect was significant only for participants with inadequate health literacy ( $P = .009$ ).

## Conclusions

The positive effect on DHLS scores suggests that animation has great potential for improving diabetes health literacy among Latinos having limited functional health literacy. A study is needed that targets participants with inadequate health literacy and that uses the English and Spanish versions of the video.

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**M**itigating the type 2 diabetes (T2D) epidemic requires conveyance of comprehensible health information that may improve health literacy. The American Medical Association and the Institute of Medicine define *health literacy* as “the degree to which individuals have the capacity to obtain, process and understand basic health information needed to make appropriate health decisions.”<sup>1,2</sup> This definition underscores knowledge acquisition. World Health Organization policy states, “Health literacy implies the achievement of a level of knowledge, personal skills and confidence to take action to improve personal and community health by changing personal lifestyles and living conditions.”<sup>3</sup> This position considers the importance of positive health behavior and skills acquisition in attaining health literacy. Building on these, *diabetes health literacy* refers to acquiring diabetes knowledge and translating it into health behavior (ie, primary and secondary prevention) and self-management skills.

Having good health literacy is associated with good health outcomes.<sup>4</sup> However, common health information venues tend to rely on text (paper or electronically derived) and require higher reading skills than those possessed by the average American.<sup>5,6</sup> Obtaining, processing, and understanding basic health information that may improve health literacy challenges persons having marginal or inadequate literacy skills—about half the US population.<sup>7</sup> Latino/Hispanics are overrepresented among them. Immigrant Latinos/Hispanics constitute about 25%

of US residents having the lowest literacy skills, according to the National Assessment of Adult Literacy. The assessment also revealed that average prose and document literacy scores of Latino/Hispanics declined 18 and 14 points, respectively, between 1992 and 2003.<sup>8</sup>

This is linked to limited educational attainment and English-language proficiency and associated with unfavorable socioeconomic and built environments, which are also conducive to poor health. They are sociocultural and ecological barriers that limit health information access and utilization, thereby promoting poor health literacy.<sup>9-12</sup> In doing so, these barriers contribute to ongoing disparities in the prevalence of obesity, prediabetes, T2D, metabolic syndrome, and poor clinical outcomes that Latinos/Hispanics experience.<sup>13-16</sup> Poor health literacy represents a major public health problem for Latinos, who are the largest and fastest-growing minority population in the United States.<sup>17,18</sup> Latino/Hispanics are therefore a high-value target for developing culturally and linguistically appropriate T2D educational interventions for improving diabetes health literacy.<sup>19</sup>

The only systematic analysis of T2D interventions targeting Latinos/Hispanics included 80 reports, of which 8 were randomized controlled trials.<sup>20</sup> Community-based research was reported in most, and cultural competence meant the inclusion of community health workers of similar Latino/Hispanic heritage. Didactic and/or unstructured group sessions were the most commonly used educational venues. Several studies used videos and computer-based information for didactic sessions. Diabetes knowledge was the universal measure of educational outcomes, yet few studies provided details about instruments used in measuring it. None measured diabetes health literacy. None reported assessment of the cultural and linguistic appropriateness of health information included in interventions and instruments measuring outcomes. And none used animation.

The US Army used animation to teach soldiers in basic training during World War II.<sup>21</sup> Animation is a vital public health tool in the United Nations Children’s Fund (UNICEF) campaign to convey social and health messages in developing nations.<sup>22</sup> UNICEF first used animation for advocacy purposes in the 1960s and to get vital health information across to people in Nepal in the 1980s.<sup>23</sup> In the 1990s, the Meena and Sara communication initiatives used animated adolescent girl icons to convey information about the dangers of gender discrimination in Central Asia and Africa, respectively, and

to promote the rights and well-being of adolescent girls.<sup>24,25</sup> The Maximo project used an animated toucan as the icon in a series of short films for disseminating and conveying information about vaccination that helped eradicate measles in Ecuador. The success of Maximo promulgated the icon's use to convey UNICEF messages about oral rehydration, iodine deficiency disorder, vitamin A deficiency, and sanitation throughout Central and South America.<sup>26</sup> In each case, the challenge of communicating with populations having limited literacy was a driving force for using animation.

Animation is used widely to convey health messages and is highly accessible through the Internet. BrainPop is an animated educational Internet site for school-age youth that teaches how the body works.<sup>27</sup> The Starlight Children's Foundation uses animation to teach about chemotherapy.<sup>28</sup> Video-oriented social media websites allow access to scores of animated health messages and medical animation is commonly used in health professions education.<sup>29,30</sup> Animated videos are a logical venue for health education and a useful tool for health care provider conveyance of self-management information to patients. This has implications for undergraduate and graduate medical education.<sup>31</sup>

In general, video-based programs are a successful strategy to improve communication with patients and increase short-term knowledge, and they have consistently outperformed written materials.<sup>32</sup> Animated videos are non-threatening and have the advantage of being entertaining as well as educational.<sup>33,34</sup> Animation is a powerful social marketing tool that is seen in television, video games, slot machines, movies, and cell phones. The cost-effectiveness of animation lies in its long shelf life, ease of use, adaptability to multiple languages, and universal acceptance as a media venue. This is in contrast to the cost of developing and implementing strategies to improve reading proficiency for millions of persons with limited reading skills, especially in multicultural populations.

Moreover, social attitude changes about health may be most effectively obtained in a multicultural society if educational interventions are based on imagery rather than dependant on text.<sup>35</sup> The London School of Hygiene and Tropical Medicine developed CHIDSPLA, a program that uses animation rather than written surveys to query children about their health preferences.<sup>36</sup> The Philadelphia Collaborative Violence Prevention Center recently used animation as a method to translate research findings from a study on youth violence to communities.<sup>37</sup> However, reports on the use of animation in health

research are sparse. Only 1 research study reported testing the effectiveness of an animated video at improving health knowledge. A Spanish/English animated video about polio vaccination was compared to the same information conveyed by text.<sup>38</sup> However, this report did not provide detailed information about animation production, cultural adaptation, language translation, or the measure of knowledge. There are no studies reporting use of animation to improve health literacy.

The objectives of this study were to (1) produce an animated video about diabetes in Spanish and English, (2) qualitatively assess its cultural appropriateness for use among Latino/Hispanics and African Americans, and (3) conduct a randomized controlled trial to test the effectiveness of the Spanish version at improving diabetes health literacy among immigrant Latinos.

## Methods

### Community-Academic Partnership

The South Central Family Health Center (SCFHC) and the Charles Drew University of Medicine and Science Center for Health Services Research (Drew) established a community-based research partnership to address chronic disease health disparities in South Los Angeles. The SCFHC-Drew partnership agreed to a memorandum of understanding that promoted shared facilities, human resources, information technology, recruitment efforts, data gathering, and institutional oversight to bring the study to completion. SCFHC is a federally qualified health center with more than 140 staff members, of which 25 are clinical staff who provide direct medical services, treatment, and care to patients. SCFHC has provided comprehensive health services in the historically underserved and uninsured population of South Los Angeles for more than 30 years. The services provided directly address health care issues prevalent among geographically and economically disadvantaged individuals and families. SCFHC identified poor clinical outcomes from T2D as a high-priority target.

### Study Design

#### Randomized Controlled Trial

A prospective randomized controlled design was used to evaluate the effect of animation or text interventions on diabetes health literacy. Participants who completed baseline surveys (see description in Study Measures section) were randomly assigned to either the experimental

group (animated video) or the control group (easy-to-read text). Random assignment was done via numbers concealed in sealed envelopes that were generated by the study statistician through randomization software. Neither the SCFHC diabetes nurse educator who recruited patients nor Drew's health navigator/promotora who tested participants knew the content of the envelopes (allocation concealment). Therefore, neither knew the group (animation or text) to which participants would be assigned (allocation status). Random assignment was designed to make intervention groups similar to each other in characteristics, such as educational attainment, diabetes health literacy, and functional health literacy at baseline, so that postintervention differences between groups were not be due to prior differences.<sup>39</sup>

### Study Participants and Recruitment

The SCFHC service community is predominantly Latino/Hispanic. A large proportion comprises unemployed, uninsured, and undocumented immigrants, who are therefore highly mobile. Latino/Hispanics in South Los Angeles often seek health care from more than one provider. Many seek care from traditional healers, and those of Mexican heritage often seek less costly health care in Mexico.<sup>40</sup> Self-medicating with imported drugs from countries of origin is a common practice among immigrant Latino/Hispanics.<sup>41</sup> Given the epidemic nature of T2D and the disparate incidence among Latino/Hispanics, the population is likely to have been exposed to media-driven information about T2D. This notwithstanding, previous studies have demonstrated that immigrant Latino/Hispanics are limited in educational attainment, reading skills, and chronic disease health literacy; they do not depend on text; and they tend to rely on word of mouth for health information.<sup>42-44</sup>

Participants included in the study sought health care at the SCFHC and were at least 18 years of age and diagnosed with T2D; they self-identified as Latino/Hispanic and were Spanish speaking; and they had not received diabetes education or counseling from the diabetes nurse at the SCFHC. Recruitment was multifaceted. The first line of recruitment was through SCFHC's certified diabetes nurse, who met with all new patients diagnosed with T2D, scheduled group education sessions, followed up on adherence, and maintained the clinic's diabetes registry. The nurse screened information for new T2D patients for study inclusion criteria. The second line of

recruitment was through a health navigator/promotora, who met with patients referred by the diabetes nurse and who provided more information about the study. The health navigator/promotora was trained in health services research methods at Drew and was from the community, which helped build trust to promote successful recruitment and retention.<sup>45</sup> Recruitment was also passive, based on flyers distributed at the clinic by front office personnel and posted on billboard in waiting areas.

### Study Interventions

#### Control Group: Easy-to-Read Information About Diabetes

Control group participants were provided with easy-to-read diabetes information available from the National Diabetes Information Clearinghouse of the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). Information about diabetes definition, cause and risk factors, clinical management, and self-management was accessed from the Spanish version of *Your Guide to Diabetes: Type 1 and Type 2*.<sup>46</sup> The information was presented on 5 pages with Times New Roman 14-point font, and it contained 1969 words. Readability of Spanish text was assessed by the Fernandez-Huerta Readability Formula: the preferred instrument for assessing reading difficulty of Spanish text for US government health publications.<sup>47</sup> The Fernandez-Huerta formula is a modification of Flesch Reading Ease Index.<sup>48</sup> Both formulas provide a score between 0 and 100, with higher scores meaning that the text is easier to read and comprehend. Text used in this study had a mean score of 75 (range = 74-78), considered "fairly easy" to read and comprehend and requiring about a fifth-grade reading level for native Spanish speakers. After completing baseline surveys, including the Diabetes Health Literacy Survey (DHLS), control group participants were allowed 30 minutes to read the information. The DHLS was administered again 1 hour later. Control group participants were given a copy of the animated video *¿Que es la Diabetes? / What Is Diabetes?* to take home and encouraged to view with their families.

#### Experimental Group: Animated Video about Diabetes

*¿Que es la Diabetes? / What Is Diabetes?* is a Spanish/English 13-minute animated video written and directed by the study's principal investigator (J.L.C.). Animation production was provided by Animax (Burbank, California,





**Figure 1.** Corazón Quelate / Lotta Hart (center) with daughter (Athena) and grandson (Isaiah).  
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USA), an Emmy Award–winning animation company. The video features an animated icon named “Corazón Quelate” (heart that beats; Spanish version) / “Lotta Hart” (English version). Corazón/Lotta’s anthropomorphic features are characteristic of many Latina/Hispanic/African American middle-aged women who tend to be centrally obese. Corazón/Lotta engages viewers with an invitation into her home and emphatically shares her experience with diabetes. The animated video targets persons with T2D but is also meant to be viewed by significant others, whose support is emphasized in scenes that include Corazón/Lotta’s daughter and grandson (Figure 1).

### **Animated Video Content and Conveyance**

The video conveys content from 3 main areas that are consistent with the information provided as written text to control group participants: general information about diabetes (glucose intolerance, obesity, signs and symptoms, risk factors, comorbidities), clinical management (doctor visits, A1C, blood pressure and cholesterol

checks, treatment), and self-management (self-monitoring of blood glucose, nutrition, physical activity, foot care). Animated analogies explain technical, uncommon, and difficult-to-understand concepts. For example, information about microvascular disease and retinopathy is conveyed by the animated video panning into an eye and into a blood vessel “highway” traveled by sugar cubes (glucose) and red blood cells. Having too many sugar cubes in the bloodstream causes damage to blood vessel walls, which in turn blocks red blood cell traffic to tissues beyond, causing damage to the eyes. Images are also used to emphasize comorbidity to kidneys, heart, and feet. Clinical management information is conveyed through imagery that represents the ABCs of diabetes care: A1C, blood pressure, and cholesterol.

### **Qualitative Assessment**

#### **Focused Discussion Groups**

Before the randomized controlled design was implemented, Spanish and English versions of the animated

video were assessed for cultural appropriateness to ensure acceptance by Latino/Hispanics and African Americans, respectively, via focused discussion group (FDG) methods. FDGs are qualitative and based on participant-observer methodology.<sup>49</sup> FDGs are different from focus groups that were originally intended to provide data for marketing strategists before being adopted by health researchers. FDGs collect qualitative data but are also intended to improve health literacy by correcting misinformation and dispelling myths about the health topic under discussion. Furthermore, focus group moderators traditionally lead group discussions using a script, from which they do not veer. In contrast, in FDGs, a participant/observer leads group discussions and may digress from scripts to probe emerging themes in a conversational manner. The educational premise underlying FDGs is that word of mouth is a very important source of health information in many cultures and that conversational approaches facilitate richer and more in-depth discussion about health beliefs and perceptions. FDGs have been shown to be an effective method for collecting qualitative data and as an educational intervention.<sup>42,50</sup>

### **Animated Video Cultural Appropriateness**

Before commencing each FDG, participants self-administered the DHLS. Five FDGs were convened at the Drew HSRC: 2 in Spanish (1 with 11 women; 1 with 9 men) and 3 in English with African American participants (1 with 13 women; 1 with 7 men; 1 with 8 men and women). Participants were at least 18 years of age and were recruited passively through flyers posted at a local hospital and proactively by research assistants at a shopping area in Watts, Los Angeles. The FDGs were guided via a script with introductory, transition, key, and summary questions. The FDG introductory question sought perceptions about the DHLS to assess its face validity: the health topic it queried and the ease of reading and comprehension of items. Transition questions sought to promote discussion of diabetes beliefs and perceptions, available health information, and preferred information sources.

After FDG transition questions, participants viewed a preproduction version of the animated video: an *animatic*. Animatics contain a series of partially animated images covering the full complement of themes and information that would be included in the final production. After the animated video, key FDG questions engaged participants in discussion about information in the video, information conveyance, the video's icon (Corazón Quelate / Lotta

Hart), other images, and the use of animation as an educational tool. The summary question asked participants to fill in any gaps in the discussion summary. The FDGs lasted between 70 and 90 minutes.

### **Study Measures**

Before randomization to experimental or control groups, participants completed the Spanish version of a demographic questionnaire, the Short Test of Functional Health Literacy in Adults (STOFHLA), and the DHLS. As required, the STOFHLA was self-administered.<sup>51</sup> The DHLS and demographic surveys were interviewer administered to minimize item nonresponse among poor readers. To facilitate accurate responses, show cards were used to display response options for the demographic questionnaire and DHLS as the interviewer read survey questions.

#### **Short Test of Functional Health Literacy in Adults**

The Test of Functional Health Literacy in Adults (TOFHLA) is a reading comprehension and numerical ability test developed with actual hospital materials. The TOFHLA was developed via the cloze method, whereby a paragraph is mutilated by deleting, for example, every fifth word.<sup>52</sup> Participants fill in blanks with multiple-choice response options. The text ranges from 4th to 12th-grade reading difficulty and was developed with actual hospital-related information. The 14-point-font version of the STOFHLA was used to promote reading ease. TOFHLA has demonstrated concurrent validity with the Wide Range Achievement Test-Revised and the Rapid Estimate of Adult Literacy in Medicine and has been administered to racial/ethnic minorities with diabetes in public hospital settings.<sup>9,51</sup> STOFHLA scores are classified into 3 functional health literacy categories: 0-16 = inadequate (unable to read and interpret health texts), 17-21 = marginal (has difficulty reading and interpreting health texts), or  $\geq 22$  = adequate (can read and interpret most health texts).

#### **Diabetes Health Literacy Survey**

The DHLS was developed for this study, and it includes 37 items measuring 4 constructs related to T2D: general T2D information (16 items), clinical management information (5 items), self-management (6 items), and ethnomedical (cultural) beliefs (10 items). Items in the general information, clinical management



information, and self-management constructs measure themes conveyed in the animated video and the NIDDK's easy-to-read information. Items in the ethnomedical construct measure information not conveyed in the animated video or the NIDDK information (ie, insulin causes blindness, traditional medicines cure T2D, alcohol helps treat diabetes in men). The general information and clinical management information constructs measure T2D knowledge (21 items combined). The self-management and ethnomedical belief constructs measure knowledge application and cultural perceptions about diabetes management (16 items combined). Inclusion of the latter distinguishes the DHLS from diabetes knowledge surveys by measuring knowledge application toward self-management and culture-based health beliefs that may be barriers to attaining good health literacy.<sup>41,43,53,54</sup>

Twelve items in the DHLS were derived from the Spanish version of the Starr County Diabetes Knowledge Questionnaire.<sup>55</sup> Twenty-five items were developed de novo in Spanish by a bilingual committee of 4 Drew CHSR staff and faculty to derive the 37-item DHLS. This committee also translated the DHLS into English. To test accuracy of language translation, the forward translation (English) was back-translated into Spanish by an independent translator.<sup>56</sup> Items from the 2 Spanish versions (original and translated) were correlated to identify discordance in wording and meaning that arose from back translation. Discordance between Spanish versions was disambiguated, and modifications were made to the English version accordingly to produce the consensus Spanish and English versions.

The readability of single items in the DHLS Spanish and English versions was assessed with the Fernandez-Huerta Readability Formula and Flesch Reading Ease Index, respectively.<sup>57</sup> To ensure inclusion of items representative of the range of topics measurable in each of the 4 constructs of the DHLS (content validity), the translation committee, a bilingual survey research expert, and a diabetologist evaluated the survey's subject matter.

## Data Analysis

This study employed the univariate analysis of variance procedure per the generalized linear model to estimate the effect of group (experimental vs control) on diabetes health literacy score (dependent variable), controlling for the following independent variables: baseline diabetes health literacy score, sex (male/female), age in years, and health insurance (insured vs not insured). We

also evaluated whether change in DHLS scores varied by STOFHLA level (inadequate vs marginal and adequate) by including an interaction term in the model. In addition, we estimated the analysis of variance model separately for the 2 levels of STOFHLA noted above. Adjusted means, standard errors, and *F* statistics are presented for the univariate models. The 3 ordinal categories of the DHLS and STOFHLA (inadequate, marginal, and adequate) were cross-tabulated and Spearman rank-order correlations estimated. The product-moment correlation between educational attainment (years in school) and DHLS scores was also estimated. Coefficient alpha was used to estimate the internal consistency reliability of the DHLS. Data analyses were conducted with SPSS 20.0. The significance level for statistical tests was set at  $P < .05$ . The study was approved by Drew institutional review board (7-07-008-06).

## Results

### Sample Characteristics

A total of 118 participants were randomly assigned to the experimental group (animated video) and 122 to the control group (NIDDK easy-to-read information). There were no significant differences in demographic characteristics between the groups at baseline ( $P > .05$ ). Eighty-two percent of participants were women; 87% had less than high school education; 83% had a family history of diabetes; 79% self-reported fair or poor general health status; 76% were of Mexican heritage; 76% had incomes of < \$10 000; and 69% were uninsured (Table 1).

### Focused Discussion Groups

The Spanish and English versions of the animated video were perceived to be culturally appropriate by Latino/Hispanic and African American FDG participants, respectively, by roll call and a show of hands. Nearly all Latino/Hispanics and African Americans agreed that the information conveyed by animation was educational (improved awareness about diabetes) and understandable (facilitated comprehension of complex topics such as T2D microvascular disease). The use of Spanish was perceived by Latino/Hispanics as being linguistically appropriate and understandable by roll call and a show of hands. There was consensus agreement across Latino/Hispanic and African American FDGs that animation is an appropriate and acceptable method for teaching and learning about diabetes. Moreover, 2 emerging themes were

Table 1

Participant Baseline Characteristics and Mean DHLS Scores<sup>a</sup>

	No. (%)			Mean ± SD
	Experimental	Control	All Participants	Score
Sex				
Male	25 (21.2)	19 (15.6)	44 (18.3)	0.49 ± 0.09
Female	93 (78.8)	103 (84.4)	196 (81.7)	0.51 ± 0.09
Age, y				
18-39	23 (19.8)	26 (21.5)	49 (20.7)	0.52 ± 0.08
40-60	70 (60.3)	69 (57.0)	139 (88.6)	0.50 ± 0.09
> 60	23 (19.8)	26 (21.5)	49 (20.7)	0.49 ± 0.09
Education				
< High school	84 (87.5)	85 (85.9)	169 (86.7)	0.50 ± 0.09
≥ High school	12 (12.5)	14 (14.1)	26 (13.3)	0.54 ± 0.09
Annual income				
< \$10 000	83 (76.9)	81 (74.3)	164 (75.6)	0.49 ± 0.09
≥ \$10 000	25 (22.2)	28 (25.7)	53 (24.4)	0.55 ± 0.09
Insurance status				
Insured	41 (35.7)	31 (27.0)	72 (31.3)	0.49 ± 0.10
Not insured	74 (64.3)	84 (73.0)	158 (68.7)	0.51 ± 0.09
STOFHLA score				
Inadequate	64 (62)	61 (54)	125 (58)	0.48 ± 0.09
Marginal	8 (8)	10 (8)	18 (8)	0.52 ± 0.06
Adequate	32 (30)	43 (38)	75 (34)	0.54 ± 1.00
DHLS score				
Inadequate, ≤ 59%	101 (86)	102 (84)	203 (85)	0.48 ± 0.08
Marginal, 60%-74%	16 (14)	20 (16)	36 (15)	0.65 ± 0.04
Adequate, ≥ 75%	—	—	—	—

Abbreviations: DHLS, Diabetes Health Literacy Survey; STOFHLA, Short Test of Functional Health Literacy in Adults.  
<sup>a</sup>No significant difference between the groups in the demographic characteristics and the baseline mean DHLS score ( $P > .05$ ).

common across both sets of groups. One was the need to modify the way that Corazon / Lotta's hands appeared; that is, in the preproduction animatic, the fingers appeared to be pointed. Second was the need for background music in the video. Both recommendations were incorporated into the final animated video production.

### Reliability and Validity of DHLS

Face validity of the DHLS was supported by responses to the FDG introductory questions "What is this questionnaire about?" and "How difficult was it to read and understand the questions?" Participants in each FDG correctly indicated that the DHLS asked questions about diabetes and diabetes care. The Latino/Hispanic and African American FDG participants also indicated that the questions about diabetes in

Spanish and English, respectively, were easy to read and understand. Content validity was confirmed by the translation committee and the survey and diabetes experts. Construct validity was supported by Spearman rank-order correlations of the DHLS category scores (inadequate, marginal, adequate) with STOFHLA of 0.33 and 0.20 for the experimental and control groups at baseline and 0.37 and 0.34 at posttest, respectively. Internal consistency reliability of the DHLS was very good (coefficient alpha = 0.79).

### DHLS and STOFHLA Scores

There was no significant difference between the intervention and control groups on STOFHLA and DHLS scores at baseline (Table 2). The mean DHLS score for all participants was  $0.55 \pm 0.06$ , consistent with inadequate diabetes

Table 2

## Univariate Analysis of Variance to Analyze the Effect of Group on Posttest Diabetes Health Literacy Score

Factor	Control (n = 109)	Intervention (n = 113)	F	P
Diabetes health literacy score				
Main effect				
Group (adjusted posttest 1) <sup>a</sup>	0.53	0.55	4.7	.03
Covariates				
Pretest knowledge			58.6	.0001
Sex			4.1	.04
Age, 18-39 y			0.18	.67
Age, 40-60 y			0.05	.82
Insurance			0.32	.57
Interaction: group × STOFHLA group			6.37	.002

Abbreviation: STOFHLA, Short Test of Functional Health Literacy in Adults.  
<sup>a</sup>Adjusting for pretest score and confounding variables for all participants.

health literacy. DHLS scores increased significantly from baseline to follow-up in both the experimental group (5%;  $t = 6.0$ ,  $P < .05$ ) and the control group (2%;  $t = 3.0$ ,  $P < .05$ ). Adjusting for baseline DHLS score, sex, age, and insurance status, DHLS scores improved significantly more in the experimental group than the control group (adjusted mean = 55% vs 53%;  $F = 4.7$ ,  $df = 1$ ,  $P = .03$ ; Table 2).

Of all participants 58% had inadequate functional health literacy as measured by STOFHLA; 8% had marginal and 34% had adequate. This concurs with results from a previous study that Latino/Hispanics have poor functional health literacy and that last grade completed is a predictor of TOFHLA scores.<sup>58,59</sup> Change in DHLS scores depended on STOFHLA level ( $F$  for the interaction term = 6.4,  $df = 2$ ,  $p = .002$ ). Intervention group participants with STOFHLA scores < 17 (inadequate functional health literacy) had significantly greater improvement in DHLS scores than control group participants with similar STOFHLA scores (53% vs 50%;  $F = 7.12$ ,  $P = .009$ ; Table 3). However, change in DHLS scores did not differ between experimental and control group participants with marginal or adequate functional health literacy (STOFHLA scores  $\geq 17$ ; 58% and 57%, respectively;  $F = 0.82$ ,  $P = .37$ ; Table 4).

## Discussion

Inadequate functional health literacy is associated with poorer glycemic control and worse diabetic retinopathy than having adequate functional health literacy.<sup>4</sup> The

majority of Latino/Hispanics with clinically diagnosed T2D in this study had inadequate functional health literacy as measured by STOFHLA. The animated video *¿Que es La Diabetes?* improved diabetes health literacy in Latino/Hispanics with inadequate functional health literacy. Since the prevalence of diabetes is increasing in the face of growing Latino/Hispanic populations, the issue of addressing inadequate health literacy is particularly germane to public health efforts to mitigate the T2D epidemic.

Before this study, the use of a linguistically and culturally validated animated video as an educational intervention for improving diabetes health literacy had not been empirically and rigorously tested. Moreover, reliance on inclusion of ethnically matched community workers and certified educators alone as a measure of cultural competency in education falls short if there is no assurance of formative and summative evaluations of intervention content and conveyance. This report fills these gaps by providing details of animation production and formative rigorous qualitative evaluation for linguistic and cultural appropriateness.

It is important to note that none of the participants in the current study had adequate diabetes health literacy (assessed by DHLS) at baseline or follow-up. Although 58% of all participants had inadequate functional health literacy along with 8% marginal and 34% adequate, their mean DHLS scores were only 0.48, 0.52, and 0.54, respectively, consistent with inadequate diabetes health literacy. This underscores the fact that despite having

Table 3

## Univariate Analysis of Variance to Analyze the Effect of Group on Posttest 1 Diabetes Health Literacy Score

Factor	Control (n = 52)	Intervention (n = 61)	F	P
Diabetes health literacy score				
Main effect				
Group (adjusted postintervention) <sup>a</sup>	0.497	0.532	7.12	.009
Covariates				
Pretest knowledge			33.14	.0001
Sex			2.41	.12
Age, 18-39 y			0.03	.87
Age, 40-60 y			1.71	.19
Insurance			1.25	.27

<sup>a</sup>Adjusting for pretest knowledge score and confounding variables for participants with inadequate health literacy (n = 113).

Table 4

## Univariate Analysis of Variance to Analyze the Effect of Group on Posttest 1 Diabetes Knowledge Score

Factor	Control (n = 50)	Intervention (n = 37)	F	P
Diabetes health literacy score				
Main effect				
Group (adjusted postintervention) <sup>a</sup>	0.571	0.584	0.82	.37
Covariates				
Pretest knowledge			24.0	.0001
Sex			2.29	.14
Age, 18-39 y			1.66	.20
Age, 40-60 y			2.62	.11
Insurance			3.91	.05

<sup>a</sup>Adjusting for pretest knowledge score and confounding variables for participants with marginal or adequate health literacy (n = 87).

adequate functional health literacy skills, persons with diabetes may have poor diabetes health literacy, thereby placing them at risk for poor clinical outcomes.

Diabetes educational interventions developed for populations who tend to have inadequate health literacy may also benefit those with adequate health literacy. This was not demonstrated in the current study, because those with adequate health literacy did not improve in DHLS scores after viewing the animated video or reading the information in the control setting. Being newly diagnosed with T2D and being in a clinic setting may have affected concentration on viewing and reading. Future studies may benefit from assessing and controlling for number of views of the animated video and reads of the text.

Knowledge is universally measured in T2D interventional studies, and STOFHLA has been used with knowledge surveys. However, surveys measuring T2D knowledge are typically not described in detail nor correlated with the STOFHLA. This study found that DHLS scores correlated significantly with STOFHLA categorical scores as well as with respondents' level of educational attainment. The DHLS may be a useful instrument for measuring diabetes health literacy in future T2D interventional studies and may allow comparison of data across studies. Such a measure may also allow clinicians and health care delivery systems to assess the effectiveness of patient education and training for T2D. A larger population-based ethnomedical study that cross-culturally

compares performance of the Spanish and English versions of the DHLS would be beneficial in this regard.

Animation has been used in a variety of ways to communicate health information to patients and communities and may improve health literacy and promote disease management. Unlike any other medium, animation has universal appeal that crosses sex, age, and cultural barriers. As the animated icons Meena, Sara, and Maximo demonstrate, animated characters such as Corazón Quelate / Lotta Hart can provide role models that may alter behaviors by changing perceptions.<sup>22</sup> Although animation is not a new medium or field of inquiry, the innovative application of existing technologies may help improve diabetes health literacy in populations at greatest risk for T2D and inadequate health literacy. Moreover, there is a crucial need to develop venues for enhancing diabetes health literacy that do not depend on written text or access to information technology. Animation has been demonstrated to fit this bill. Animation's usefulness as an educational venue may be enhanced and health literacy reinforced by combining it with other educational venues.

## Conclusions

Animation is a valid venue for improving diabetes health literacy. This study demonstrates that a culturally and linguistically appropriate animated video can improve diabetes health literacy among populations with limited educational attainment and inadequate functional health literacy. This has important implications for the Latino/Hispanic population, which is estimated to become the majority population in the United States before the end of the 21st century. Should the current population and epidemiologic trends continue for Latino/Hispanics, a very high prevalence of T2D-related morbidity would lead to substantial increases in direct and indirect costs of T2D and likely stunt the growth of our national economy, which is already burdened by excess health disability costs: a burden that threatens to overwhelm the structure and process of health care as we know it. The imperative for developing innovative approaches to improve health literacy has never been greater, and cost-effective innovations such as animated learning tools should be aggressively pursued.

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