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ORIGINAL PAPER

Mobile and Traditional Modes of Communication Among Male Latino Farmworkers: Implications for Health Communication and Dissemination

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Abstract This analysis describes (1) cell phone and smartphone ownership, (2) continuity of phone numbers, (3) use of specific technologies while inside and outside the U.S., and (4) perceived adequacy of specific formats to receive health research results among Latino farmworkers. Telecommunications questionnaires were administered to 165 and 102 farmworkers in North Carolina in 2012 and 2013, respectively. Univariate and bivariate analyses were completed. Increasing numbers of Latino farmworkers own cell phones and smartphones. Talk and text functions are used frequently. Relatively few farmworkers maintain consistent phone numbers. They prefer to receive study results through low technology formats. Strategies to use cell phones to improve health or to share research findings will face obstacles in this population. Public health officials who identify and implement effective strategies to overcome these barriers may be able to harness mobile technologies to address the needs of Latino farmworkers.

Keywords Health communication · Mobile phone · Dissemination · Latino · Farmworker

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Introduction

Access to mobile technology has increased substantially over the past few years, and access to the internet has remained high [1, 2]. Use of cell phones and smartphones (cell phones that have advanced functions including internet access) has become extensive, and diverse strategies to harness them to improve health have been identified [3–8]. Eighty-eight percent and 91 % of United States (U.S.) adults surveyed in 2012 and 2013, respectively, reported that they owned cell phones [1, 2], including 86 % of Latinos in 2012 [9]. Forty-nine percent and 60 % of Latinos in 2012 and 2013, respectively, owned smartphones [2, 9]. This is a higher proportion than the 46 and 56 % of all adults in the U.S. who owned smartphones in 2012 and 2013, respectively [2]. Furthermore, mobile devices, cell phones, tablets, and other handheld devices, are increasingly used to access the internet. Among Latinos who access the internet, 76 % accessed it at least occasionally through a cell phone, tablet, or other handheld device [9]. However, among Latino adults, being born outside the U.S., being non-English-dominant, and having low income and formal education were associated with lower rates of both cell phone and smartphone ownership [9].

Widespread ownership of cell phones and smartphones among Latinos has been reported [9]. However, limited information exists about the availability, use, or attitudes about different communication technologies among Latinos residing in the U.S. who were born in Mexico or Central America, including farmworkers [8, 10]. Among a 2011–2012 sample of Latinos who were predominantly foreign-born, had limited formal education, and were in Baltimore, 92 and 74 % reported using cell phones and text messaging, respectively [8]. Eighty-one percent and 39 % of a sample of 80 Latino migrant farmworkers in South

Carolina reported mobile phone access and smartphone ownership, respectively, in 2011 and 2012 [10].

According to the communication-persuasion model, it is crucial to select a "channel" or type of communication device that is appropriate and well-liked by the target audience to convey health messages [11]. Knowledge about the use and preferences for different forms of communication among Latino farmworkers, a population that has limited income, education, and English-proficiency [12, 13], will therefore facilitate development of appropriate health communication strategies for this population, including dissemination of results from health studies. This analysis addresses the gap in knowledge by providing descriptive information about (1) cell phone and smartphone ownership among Latino farmworkers by individual characteristics, (2) continuity of cell phone and contact numbers by individual characteristics, (3) use of specific technologies while inside and outside the U.S., and (4) perceived adequacy of multiple formats to receive research study results.

Methods

Data for this analysis were drawn from questionnaires administered to male Latino farmworkers in North Carolina in 2012 and 2013 as part of a larger longitudinal study that examines the neurological outcomes of pesticide exposure [14]. The study was developed and implemented using a community-based participatory research approach. North Carolina Farmworkers Project (Benson, NC), a community partner, assisted with farmworker recruitment. Participants completed a baseline interview in May–July, 2012. The first to fourth follow-up contacts occurred in 2012; the fifth to eighth follow-up contacts occurred 2013. *All procedures were approved by the Wake Forest School of Medicine Institutional Review Board, and signed consent was provided by each participant.*

Sample

Men who had worked in agriculture for at least 3 years at the time of recruitment, were 30 years of age and older, and who self-identified as Latino were eligible to participate in the parent project on pesticide exposure. North Carolina Farmworkers Project staff spoke with Latino men living in farmworker camps about the aims of and requirements for participation in our project. Research study staff contacted and screened those who expressed interest in the project. A total of 235 male farmworkers completed the baseline interview [14]; 165 and 102 farmworkers completed the telecommunications module in 2012 and 2013, respectively. Eleven farmworkers completed the 2013 telecommunications module, but not 2012 module; 91 farmworkers completed both telecommunications modules.

Data Collection

Data for this analysis were taken from the baseline, second, third, and sixth follow-up contacts. The baseline interview included items about individual characteristics; the second follow-up contact included wage information. The telecommunications modules were administered in July–September, 2012, and July–August, 2013, at the third and sixth follow-up contacts. Unless noted otherwise, telecommunications items were identical across both years. Questionnaires were developed in English, translated into Spanish, checked for meaning, and pre-tested. Interviews were administered by trained interviewers fluent in Spanish. Farmworkers were interviewed in farmworker camps and clinic sites. Study data were electronically entered into our database, managed, and downloaded to statistical packages using Research Electronic Data Capture (REDCap), an electronic data capture tool hosted at Wake Forest School of Medicine [15]. Additional recruitment and data information has been published elsewhere [14].

Measures

Both cell phone ownership and smartphone ownership (among those who owned a cell phone) are reported. Only farmworkers who affirmed they had access to a cell phone during non-work hours were asked if they owned a cell phone in 2012. Participants who denied access to a cell phone during non-work hours in 2012 were assumed not to own a cell phone; those who denied access to a cell phone in 2012 during non-work hours or denied cell phone ownership were assumed not to own a smartphone in 2012. Participants were asked about cell phone ownership regardless of their reported cell phone access during non-work hours in 2013. Participants were informed that "smartphones can download computer programs for use on the phone" and that "examples of smartphones include the iPhone, BlackBerry, and Android." Among the 2013 participants who reported cell phone ownership, all but two reported access to a working cell phone during non-work hours. Each of these participants reported they had access to a cell phone during the prior year and owned a cell phone.

Consistency of cell phone number was obtained by asking cell phone owners if they had the same cell phone number as they did 12 months prior. Participants were asked if they had someone with a telephone number who took messages for them. Those who responded affirmatively were asked if the

message taker had the same phone number for the past 12 months.

Type of communication refers to seven modes through which individuals may have communicated with others through electronic devices: email message, text message, Facebook or other social networking tool, internet, landline telephone, cell phone, and Skype or other internet service. Values were obtained from items that asked how often participants had used each of the communication types in the U.S. during the past 2 months. Comparable questions were asked about type of communication while outside the U.S. among participants who had spent at least one month outside the U.S. during the previous year. Four response categories were provided in 2012: "at least once a day," "at least once a week," "at least once a month," and "less frequently than once a month." An additional response category, "never," was added in 2013. Responses to both sets of questions were dichotomized into "at least once a week" or "less than once a week."

Format refers to electronic and traditional formats through which group study health results could be provided to participants, including: email, a text message, a phone call to preferred number (leaving voice mail if no answer), a smartphone application, a website, an informational video, a typed letter mailed to their preferred address, an in-person conversation, or a toll-free number that participants could call. Participants were reminded that the research team planned to provide participants with group results from the main research study that examined numerous health issues. Participants stated whether it would be acceptable ("Yes" or "No") to receive group study results through each of the nine formats.

Participant characteristics include 2012 age (30–34, 35–44, and ≥45), education (0–6, 7–11, and ≥high school), marital status (married or living as married or not), whether born in Mexico, Central America, the U.S., or elsewhere, and visa status (having come to U.S. for current job under a work visa or not). Weekly 2012 income was categorized into ≤$500, $501–$850, and >$850. The two lowest weekly income categories both fell below the median weekly earnings of $865 for U.S. men ages 16 and older in 2012 [16]. Participants were asked how well they read English and Spanish, "not at all," "somewhat," "a little," or "well." The first three response categories and "Don't know" were recoded as "not well".

Statistical Analyses

Descriptive statistics (counts, percentages) were calculated for the participant characteristics of interest for the sample of Latino farmworkers who completed the telecommunications modules in 2012 and 2013, respectively. No participants reported that they spoke English well or were born outside Mexico; only six and seven, respectively, reported they were not married or were not here on a guest worker visa in 2012. These four characteristics were therefore excluded from subsequent analyses. A series of Chi square or Fisher's exact tests were conducted as appropriate to analyze the association between individual characteristics and each of the following: (1) owning a cell phone, (2) owning a smartphone, (3) having a consistent phone number for the past 12 months (among cell phone owners only), (4) having a message number, and (5) having a consistent message number (among those who had a person who took messages for them) during the 12 months prior to administration of the 2012 and 2013 modules, respectively. Analyses also examined the frequency of type of communication separately for participants while within the U.S., and among the appropriate subsample, while outside the U.S., in both 2012 and 2013. Analyses were calculated to indicate the frequencies of acceptability of receipt of group study results through different formats by cell and smartphone ownership. Frequency of both type of communication and acceptability of group study results formats were examined separately among farmworkers who completed at least one telecommunications module and farmworkers who completed modules both years.

To check for bias in the changes in definitions of cell ownership between 2012 and 2013, we applied the 2012 definition of cell phone ownership to the 2013 data and used a McNemar test to compare the 2013 cell phone ownership distribution using the two different definitions. There was not a significant difference in the distribution of cell phone ownership in 2013 using the 2012 definition compared to the 2013 definition. This suggests that the variation in definition of cell phone ownership across the 2 years did not substantially influence the results.

Farmworkers who completed the 2012 telecommunications module were more likely than farmworkers who completed the baseline questionnaire only to be married ($p < 0.05$) and in the U.S. on a worker's visa ($p < 0.01$). However, individual characteristics of farmworkers who completed the telecommunications modules both years were not significantly different than the characteristics of farmworkers who completed the 2012 module only.

McNemar tests calculated whether there were changes in, (1) reported frequency of type of communication use within the U.S. and, among those who spent time outside the U.S. both years, outside the U.S., and (2) acceptability of format for receipt of study results between 2012 and 2013 among participants who completed the telecommunications modules both years. All analyses were conducted using SAS 9.3 (SAS Institute, Cary, NC), and p values of <0.05 were considered statistically significant.

Results

Most participants were younger than age 45, had less than a 12th grade education, were married, read Spanish well, and were here on work visas (Table 1). In 2012, 86 and 26 % of participants reported owning cell phones and smartphones, respectively (Table 2). In 2013, 97 and 37 % reported owning cell phones and smartphones, respectively. No statistically significant association was found between participant characteristics and cell phone ownership in either 2012 or 2013.

Among cell phone owners, 38 and 17 % had the same telephone number they had 1 year prior to their 2012 and 2013 telecommunications interviews, respectively (Table 3); 28 and 27 % of farmworkers had a person who took telephone messages for them in 2012 and 2013, respectively. Of the 47 and 28 Latinos who reported that someone took a message number for them in 2012 and 2013, 55 and 25 %, respectively, reported that the message number was the same as 12 months prior. Farmworkers who had low 2012 incomes ($p < 0.05$) and very limited education ($p < 0.01$) were more likely than their more affluent and educated counterparts to have a message number in 2013.

Table 1 Characteristics of Latino farmworkers in 2012 and 2013

	2012		2013	
	n	%	n	%
Adult men	165	100	102	100
2012 Age				
30–34	63	38	37	36
35–44	60	36	37	36
45+	42	26	28	28
2012 Weekly individual income[a]				
≤$500	20	13	10	11
$501–$850	47	32	31	33
>$850	81	55	53	56
Education[a]				
0–6 Grade	69	42	43	42
7–11 Grade	80	49	50	49
12+	15	9	9	9
Marital status				
Married	159	96	100	98
Not married	6	4	2	2
Reads English well				
Yes	0	–	0	–
No	165	100	102	100
Reads Spanish well				
Yes	124	75	73	72
No	41	25	29	28
H2A status				
H2A worker	158	96	100	98
Not H2a worker	7	4	2	2
Nativity				
Mexico	165	100	102	100
Other	0	–	0	–

[a] Missing observations: 17 observations for income and 1 for education in 2012; 8 observations for income in 2013

Among the participants who completed the telecommunications modules both years, 81 and 86 % reported they had spoken on a cell phone, and 66 and 68 % had read a text message at least once a week during the previous 2 months while in the U.S. to communicate with others in 2012 and 2013, respectively (Table 4). A substantial minority of participants had spoken on a landline telephone in the U.S. in both 2012 and 2013. However, fewer than 25 % reported using each of the following types of communication at least once a week either year while in the U.S.: accessing the internet, using a social networking site, reading an email message, or using Skype. The percentage who used each format at least once a week did not vary significantly across years. Speaking by cell phone was the most common means to communicate with others while outside the U.S., followed by speaking on a landline, then reading a text message, in both 2012 and 2013. No more than 12 % reported accessing the internet, or using a social networking tool, email, or Skype at least once a week during either 2012 or 2013 while outside the U.S. Furthermore, among the 89 farmworkers who completed the telecommunications module both years and spent time outside the U.S. both years, the percentage who used each format at least once a week did not vary significantly across years. All participants were born in Mexico. It is therefore likely that all or most of them were in Mexico while outside the U.S. during each of the previous years.

Participants reported varying degrees of acceptability of receiving study results through different formats (Table 5). Formats not dependent on new technologies were preferred. Among participants who completed the telecommunications modules both years, in-person communication was considered acceptable by the greatest percentage of participants overall (96 and 95 %), as well as the subsamples of cell phone owners (95 and 94 %) and smartphone owners (92 and 97 %) in 2012 and 2013, respectively. Receiving a text message was considered an acceptable format by fewer than 50 % of all participants and both cell and smartphone owners in 2012 and 2013. Twenty-one percent and 53 % indicated that informational videos were an acceptable format to receive group study results in 2012 and 2013, respectively. Fewer than 20 % of participants, including the subsamples of cell phone and smartphone owners, considered email, websites, or smartphone apps to be appropriate formats to receive study

Table 2 Number and percentage of Latino farmworkers who reported they owned cell phone, and owned smart phone within demographic group, 2012 and 2013

	2012				2013			
	Own cell phone, including smart phone[a]		Own smart phone[b]		Own cell phone, including smart phone[c]		Own smart phone[b]	
	(n = 165)		(n = 165)		(n = 102)		(n = 102)	
	n	%	n	%	n	%	n	%
All adult men	142	86	43	26	99	97	38	37
2012 Age								
30–34	57	90	20	32	36	97	17	46
35–44	48	80	17	28	36	97	14	38
45+	37	88	6	14	27	96	7	25
2012 weekly individual income[d]								
≤$500	16	80	4[e]	20	10	100	5	50
$501–$850	42	89	18	38	31	100	10	32
>$850	73	90	17	21	51	96	20	38
Education[d]								
0–6 grade	55[e]	80	18	26	41	95	15	35
7–11 grade	73	91	19	24	49	98	17	34
12+	14	93	6	40	9	100	6	67
Reads Spanish well								
Yes	109	88	32	26	71	97	25	34
No	33	80	11	27	28	97	13	45

[a] Those who denied access to cell phones during non-work hours in 2012 assumed not to own cell phone

[b] Those who denied cell phone ownership assumed not to own smart phone

[c] For participants who have reported cell phone ownership regardless of reported access during non-work hours

[d] Missing observations: 17 observations for income and 1 for education in 2012; 8 observations for income in 2013

[e] $P < 0.10$, value from Chi square test of differences in reporting a measured value by demographic category

results in either year. The acceptability of receiving study results through an informational video significantly increased between 2012 and 2013 from 21 to 53 % ($p < 0.001$). The acceptability of receiving study results by email significantly decreased between 2012 and 2013 from 17 % to 2 %, respectively ($p < 0.001$); the acceptability of receiving study results through a website also decreased between 2012 and 2013 from 13 to 3 %, respectively ($p < 0.05$). Frequencies of types of communications and preferred format for receiving study results among farmworkers who completed telecommunications module both years were similar to the frequencies among farmworkers who completed the telecommunications module either one or 2 years.

Discussion

Cell phone ownership is widespread among Latino farmworkers in North Carolina. At 97 %, cell phone ownership in 2013 was more widespread among study participants than among the total U.S. adult population [2]. Although the percentage of study participants owning smartphones increased to 37 % in 2013, it was substantially less than ownership levels among the U.S. Latino population or the U.S. population more generally [2].

Strategies designed to distribute health information or return health research findings to vulnerable Latino men by drawing upon the high penetration of cell phones will face obstacles. Although cell phone ownership is widespread, some farmworkers do not read text messages. In 2014, 47, and 26 % of U.S. adults ages 30–49 and 50–64, respectively, reported that they used the text messaging "a lot" the previous day [17]. More than 65 % of farmworkers reported they read text messages at least once a week while in the U.S., indicating that many farmworkers use text messaging frequently, although not necessarily "a lot" each day.

Research results are frequently returned to participants; however, the format in which they are returned is frequently omitted from research articles [18]. A review article noted that the most common strategy to disseminate

Table 3 Consistency of cell phone number and message number during past 12 months within demographic group, 2012, 2013

	Same cell phone number				Have message number				Same message number			
	2012[a] (n = 142)		2013[b] (n = 99)		2012[c] (n = 165)		2013[c] (n = 102)		2012[d] (n = 47)		2013[d] (n = 28)	
	n	%	n	%	n	%	n	%	n	%	n	%
Adult men	54	38	17	17	47	28	28	27	26	55	7	25
2012 Age												
30–34	14[g]	25	8	22	23[f]	37	6	16	12	52	1	17
35–44	23	48	6	17	11	18	12	32	7	64	4	33
45+	17	46	3	11	13	31	10	36	7	54	2	20
2012 weekly individual income[e]												
≤$500	8	50	3	3	5	25	6[g]	60	4	80	1	17
$501–$850	19	45	5	16	15	32	8	26	6	40	2	25
>$850	23	32	8	16	21	26	10	19	12	57	3	30
Education[e]												
0–6 Grade	23	42	10	24	19	28	19[h]	44	9	47	4	21
7–11 Grade	27	37	7	14	22	28	7	14	13	59	2	29
12^{+} Grade	4	29	0	0	5	33	2	22	3	60	1	50
Reads Spanish well												
Yes	38	35	13	18	35	28	17	23	20	57	6	36
No	16	48	4	14	12	29	11	38	6	50	1	9

[a] For participants who have access to a cell phone during non-work hours and own a cell phone

[b] For participants who have reported cell phone ownership regardless of reported access during non-work hours

[c] For all participants

[d] For participants who reported there is someone who takes messages for them

[e] Missing observations: In 2012, 11,17, and 6 for income in "Cell phone," "Have message number," and "Same message number" columns, respectively; and 1 for education in "Have message number" and "Same message number" columns, respectively. In 2013, 7, 8, and 4 for income in "Cell Phone," "Have message number," and "Same message number" columns, respectively

[f] $P < 0.10$, value from Chi square or Fisher's exact test, as appropriate, of differences in reporting a measured value by demographic category

[g] $P < 0.05$, value from Chi square or Fisher's exact test, as appropriate, of differences in reporting a measured value by demographic category

[h] $P < 0.01$, value from Chi square or Fisher's exact test, as appropriate, of differences in reporting a measured value by demographic category

study results was to organize a meeting with participant members; the least common format was to call participants by telephone [19]. Some researchers report using in-person contact or printed materials to convey results [20, 21]. One state's Department of Health publicized two public meetings at which biomonitoring levels of environmental chemicals would be discussed. They also mailed the research findings to the study participants and invited them to the meeting [22]. Researchers who examined farmworkers' pesticide urinary metabolites provided each farmworker with the pesticide metabolites detected in their urine and metabolite information about the farmworker participants as a whole. This was followed by the development of an educational program on pesticide safety that was delivered to farmworker camps [23].

Limited research has examined participants' preferences for receiving research results. Most (69 %) mothers in a Midwestern state preferred to receive individual biomarker results in a letter that included a phone number they could call with questions rather than in-person contact [24]. Other researchers recruited participants from the Yukon Kuskokwim Delta (YK) in southwestern Alaska and Seattle to examine the two populations' thoughts about how findings from genetic testing conducted in their communities should be presented to them [25]. Many participants expressed a preference to have genetic test results reviewed during a series of in-person discussions. However, participants at both sites indicated that newsletters, posters, web-based reference sources, and secure email or social media could be used to convey the information. Some participants

Table 4 Frequency of type of communication of Latino farmworkers while within and outside of U.S. among farmworkers who completed both the 2012 and 2013 telecommunications modules

	2012				2013			
	Communication within U.S.		Communication outside of U.S.		Communication within U.S.		Communication outside of U.S.	
	≥Once a week		≥Once a week		≥Once a week		≥Once a week	
	(n = 91)		(n = 90)		(n = 91)		(n = 90)	
	n	%	n	%	n	%	n	%
Spoke—cell phone	74	81	66	73	78	86	69	77
Read a text message[a]	60	66	43	48	62	68	51	57
Spoke—landline[a]	36	40	62	70	44	48	56	62
Accessed internet[a]	19	21	11	12	17	19	8	9
Used Facebook/other social networking tool	13	14	9	10	11	12	6	7
Read an email message	8	9	7	8	2	2	5	6
Spoke— Skype/other internet	3	3	2	2	3	3	1	1

[a] Missing observations: 1 for speaking on landline outside the U.S. in 2012; 1 for accessing internet outside U.S. in 2013

Table 5 Number and percentage of Latino farmworkers who report specific formats acceptable for receipt of study results among farmworkers who completed both the 2012 and 2013 telecommunications modules

	2012						2013					
	All participants (n = 91)		Cell phone owners (n = 86)[a]		Smartphone owners (n = 25)[b]		All participants (n = 91)		Cell phone owners (n = 90)[c]		Smart phone owners (n = 35)[c]	
	n	%	n	%	n	%	n	%	n	%	n	%
In-person conversation	87	96	82	95	23	92	86	95	85	94	34	97
Typed letter[d]	69	77	67	79	18	72	76	84	75	83	28	80
Toll-free number[d]	59	66	58	68	15	63	64	70	63	70	26	74
Phone call, voice mail[d]	45	51	42	50	15	63	36	40	36	40	18	51
Text message[d]	40	44	40	47	9	38	37	41	37	41	15	43
Informational video[d]	19[f]	21	19	22	2	8	48	53	48	53	14	40
Email[d]	15[f]	17	15	18	3	13	2	2	2	2	2	6
Website[d]	12[e]	13	12	14	2	8	3	3	3	3	3	9
Smart phone app[c]	2	2	2	2	0	–	4	4	4	4	4	11

[a] For participants who have access to a working cell phone during non-work hours

[b] For participants who have access to a working cell phone during non-work hours and own a cell phone

[c] For participants who reported cell phone ownership, even if they did not report access to a cell phone during non-work hours

[d] Missing observations: 1 for typed letter, toll free number, text message, informational video, email, website, smartphone app, and 2 for phone call in 2012; 1 for smartphone app in 2013

[e] $P < 0.05$, value from McNemar's test; testing the 2012 and 2013 difference in the proportion who indicated acceptability of receiving test results through specified format among the 91 participants who completed the telecommunications module both years

[f] $P < 0.001$, value from McNemar's test; testing the 2012 and 2013 difference in the proportion who indicated acceptability of receiving test results through specified format among the 91 participants who completed the telecommunications module both years

in YK thought that text messages could convey information effectively to youth. Other populations appear positive about the use of text messaging. Among a sample of Latinos in Baltimore City with a median age of 33, most of whom were foreign-born, 68.8 % reported that it would be acceptable to receive HIV test result by text messaging [8].

Taken together, these findings suggest that in-person discussions and letters are not the only means to convey research findings to communities that participate in research.

Most farmworkers reported it would be unacceptable to receive group study results through text messages. Furthermore, most farmworkers interviewed in 2013 indicated that they would find it unacceptable to be called at their preferred number to receive study findings. Low acceptance of these formats may be influenced, in part, by limited literacy and the cost associated with receiving text messaging and phone calls on their cell phones. Furthermore, the high instability of phone numbers may be due to high reliance on low cost pay-as-you-go or prepaid cell phones [26]. Challenges associated with maintaining consistent cell phone coverage are not unique to farmworkers. Almost half (48 %) of smartphone-dependent residents living in the US have had to cancel or shut off cell phone services, at least temporarily, due to cost [27]. Efforts to continually update current phone numbers and address the cost of receiving messages would be required to effectively use cell phone technology to provide health information or return research findings within this population.

Our findings are in marked contrast to a sample of urban-dwelling Latinos, most of whom had limited education and were born in Mexico or Central America, who reported high levels of interest in receiving HIV education and HIV test results via text messaging [8], and to a study of migrant farmworkers in S.C. who reported high willingness to use mobile technology provided to them to transmit personal health information to health care providers [10]. However, we asked farmworkers in our study about receipt of findings from a study in which they were currently participating, not a potential future study or medical test. The concreteness of our request and variations across non-U.S.-born Latino communities may both have contributed to the disparate findings. An increasing level of acceptance of informational videos among participants, combined with documented effectiveness of videos and telenovelas for health communication [28–31], indicates that videos may be an appropriate format to convey information and disseminate group level results. This suggests that videos accessible through smartphones may become a viable format to transmit information and disseminate results. Individuals can view YouTube videos, for example, by accessing the internet from their smartphones. However, challenges caused by changing phone numbers and the high cost associated with accessing the internet on a smartphone will need to be addressed. Both training and technology support may be required as users become familiar with new technology [10, 32, 33]. Other research suggests that increased use of smartphones will lead to an increased use of health apps for personal use [34]. If the current trend continues, increasing numbers of vulnerable Latinos will have access to a smartphone. This opens up the possibility, but not certainty, that health information can be shared with vulnerable Latino communities through mobile devices.

Strategies based on communication practices of Latinos while they are in the U.S. may be less effective when they return to their country of origin. Cell phone-based communication was lower when the participants were outside of the U.S. than within it. Given that all study participants were born in Mexico, the reduced reliance on cell phones may reflect the lower cell phone penetration in Mexico compared to the U.S. [35].

The communication-persuasion model posits that it is crucial to select a "channel" or type of communication device that is appropriate and well-liked by the target audience to convey health messages [11]. In-person communication, typed letters, and telephone calls were most favored by farmworkers in our sample to receive research results. Although acceptability of receipt of group research results by text messages was <50 %, use of text messaging while in the U.S. exceeded 65 %.

The Technology Acceptance Model [36] and the Unified Theory of Acceptance and Use of Technology [37] posit that people who expect that a technological device will address their needs have the greatest likelihood of using it. Therefore, if farmworkers perceive that text messaging on cell phones or, among smartphone owners, viewing videos to receive group study results, would be valuable to them, they will have an increased likelihood of learning to use those functions if they are taught how to use them and have the means to pay for cell phone or smartphone service.

There are limitations to this study. This study does not enable us to evaluate how patterns of actual or preferred forms of communication will change in the future. However, evidence from this and other studies indicates that penetration of cell and smartphone ownership continues to grow, including among Latinos [2, 9]. Although only 70 and 43 % of farmworkers who completed the baseline interview also completed the first and second telecommunications modules, respectively, this completion rate is notable considering the geographical mobility and structural vulnerability of this population. The sample used for this analysis was restricted to male Latino farmworkers. Findings from this study therefore should not be generalized to Latinas or Latinos more generally. Furthermore, our study did not include Latinos younger than 30. Smartphone penetration and acceptance of forms of communication that rely upon cell phones, smartphone, and internet capabilities are likely to be greater among younger Latinos than those recruited for this study. Finally, the relatively small sample size did not enable us to conduct multivariate analyses.

Further research is needed to understand better how different technologies are currently being used and to identify how they may be used effectively to provide health information and study results to Latino farmworkers. Studies that have larger sample sizes will enable researchers to conduct multivariate analyses to assess for independent associations after controlling for relevant covariates. Furthermore, studies that recruit farmworkers from different regions of the U.S. and that solicit information about participants' cell phone plans and reasons they change numbers frequently will be particularly valuable. Although use of a technology "channel" that is appropriate to Latino farmworkers is not itself sufficient to ensure that information or test results will be communicated effectively to a targeted community, it is necessary [11].

Conclusion

Most vulnerable Latino farmworkers living in North Carolina own cell phones and a substantial minority own smartphones. However, strategies to harness these devices to improve health or to share research findings must adapt to obstacles including farmworkers' high turnover of cell phone numbers, preferences for receiving study results through traditional formats, possibly due to cost, and limited use of the multiple functions available on cell and smartphones. Efforts to convey health information and health study results to members of this community may be further hampered by the reduced use of cell phone capabilities when living or working outside the U.S. Researchers and public health officials who identify and implement effective strategies to overcome these barriers may be able to harness mobile technologies to address the needs of vulnerable Latino farmworkers.

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References

1. Smith A. 17 % of cell phone users do most of their online browing on their phone, rather than a computer or other device. Washington: Pew Research Center; 2012. http://www.pewinternet.org/~/media/Files/Reports/2012/PIP_Cell_Phone_Internet_Access.pdf.
2. Smith A. Smartphone ownership—2013 update. Washington: Pew Research Center; 2013. http://www.pewinternet.org/2013/06/05/smartphone-ownership-2013/.
3. Direito A, Dale LP, Shields E, Dobson R, Whittaker R, Maddison R. Do physical activity and dietary smartphone applications incorporate evidence-based behaviour change techniques? BMC Public Health. 2014;14:646.
4. Gazmararian JA, Elon L, Yang B, Graham M, Parker R. Text4baby program: an opportunity to reach underserved pregnant and postpartum women? Matern Child Health J. 2014;18(1):223–32.
5. Free C, Phillips G, Galli L, Watson L, Felix L, Edwards P, Patel V, Haines A. The effectiveness of mobile-health technology-based health behaviour change or disease management interventions for health care consumers: a systematic review. PLoS Med. 2013;10(1):e1001362.
6. Burner ER, Menchine MD, Kubicek K, Robles M, Arora S. Perceptions of successful cues to action and opportunities to augment behavioral triggers in diabetes self-management: qualitative analysis of a mobile intervention for low-income Latinos with diabetes. J Med Internet Res. 2014;16(1):e25.
7. Quinn CC, Shardell MD, Terrin ML, Barr EA, Ballew SH, Gruber-Baldini AL. Cluster-randomized trial of a mobile phone personalized behavioral intervention for blood glucose control. Diabetes Care. 2011;34(9):1934–42.
8. Leite L, Buresh M, Rios N, Conley A, Flys T, Page K. Cell phone utilization among foreign-born Latinos: a promising tool for dissemination of health and HIV information. J Immigr Minor Health. 2014;16(4):661–9.
9. Lopez HM, Gonzalez-Barrera A, Patten E. Closing the digital divide: Latinos and technology adoption. Washington: Pew Research Center; 2013. http://www.pewhispanic.org/files/2013/03/Latinos_Social_Media_and_Mobile_Tech_03-2013_final.pdf.
10. Price M, Williamson D, McCandless R, Mueller M, Gregoski M, Brunner-Jackson B, Treiber F. Hispanic migrant farm workers' attitudes toward mobile phone-based telehealth for management of chronic health conditions. J Med Internet Res. 2013;15(4):e76.
11. Elder JP, Ayala GX, Parra-Medina D, Talavera GA. Health communication in the Latino community: issues and approaches. Annu Rev Public Health. 2009;30:227–51.
12. Bauer M, Stewart M. Close to slavery: guestworker Programs in the United States. Montgomery: Southern Poverty Law Center; 2013. http://www.splcenter.org/sites/default/files/downloads/publication/SPLC-Close-to-Slavery-2013.pdf.
13. Arcury TA, Weir M, Chen HY, Summers P, Pelletier LE, Galvan L, Bischoff WE, Mirabelli MC, Quandt SA. Migrant farmworker housing regulation violations in North Carolina. A J Ind Med. 2012;55(3):191–204.
14. Arcury TA, Nguyen HT, Summers P, Talton JW, Holbrook LC, Walker FO, Chen H, Howard TD, Galvan L, Quandt SA. Lifetime and current pesticide exposure among Latino farmworkers in comparison to other Latino immigrants. Am J Ind Med. 2014;57(7):776–87.
15. Harris RA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research information informatics support. J Biomed Inform. 2009;42(2):377–81.
16. Bureau of Labor Statistics. News release: weekly earnings of full-time workers by age and sex, second quarter 2012. Washington, D.C. Report No: USDL-12-1419. U.S. Department of Labor; 2012. www.bls.gov/news.release/archives/wkyeng_07182012.pdf.
17. Newport F. The new era of communications among Americans. Nov 10, 2014. Gallup. http://www.gallup.com/poll/179288/new-era-communication-americans.aspx.
18. Darbyshire JL, Price JC. Disseminating results to clinical trial participants: a qualitative review of patient understanding in a post-trial population. BMJ Open. 2012;2(5):e001252.

19. Chen PG, Diaz N, Lucas G, Rosenthal MS. Dissemination of results in community-based participatory research. Am J Prev Med. 2010;39(4):372–8.
20. Brody J, Dunagan S, Morello-Frosch R, Brown P, Patton S, Rudel R. Reporting individual results for biomonitoring and environmental exposures: lessons learned from environmental communication case studies. Environ Health. 2014;13(1):40.
21. Adams C, Brown P, Morello-Frosch R, Brody JC, Rudel R, Zota A, Dunagan S, Tovar J, Patton S. Disentangling the exposure experience: the roles of community context and report-back of environmental exposure data. J Health Soc Behav. 2011;52(2):180–96.
22. Vousden CL, Johnson JE. Communicating about biomonitoring and the results of a community-based project: a case study on one state's experience. J Environ Health. 2014;77(5):20–6.
23. Arcury TA, Quandt SA. Community-based participatory research and occupational health disparities: pesticide exposure among immigrant farmworkers. In: Leong F, Eggerth D, Flynn M, editors. Occupational health disparities among racial and ethnic minorities: formulating research needs and directions. American Psychological Association; 2015.
24. Wilson SE, Baker ER, Leonard AC, Eckman MH, Lanphear BP. Understanding preferences for disclosure of individual biomarker results among participants in a longitudinal birth cohort. J Med Ethics. 2010;36(12):736–40.
25. Trinidad SB, Ludman EJ, Hopkins S, James RD, Hoeft TJ, Kinegak A, Lupie H, Kinegak R, Boyer BB, Burke W. Community dissemination and genetic research: moving beyond results reporting. Am J Med Genet A. 2015;167(7):1542–50.
26. Latin America—mobile voice, data and forecasts. P.R. Newswire; 12 June 2013. http://finance.yahoo.com/news/latin-america-mobile-voice-data-182900833.html.
27. Smith A. U.S. Smartphone use in 2015. Washington D.C.: Pew Research Center. 1 Apr 2015. http://www.pewinternet.org/2015/04/01/us-smartphone-use-in-2015/.
28. Byrd TL, Wilson KM, Smith JL, et al. AMIGAS: a multicity, multicomponent cervical cancer prevention trial among Mexican American women. Cancer. 2013;119(7):1365–72.
29. Kelly NR, Huffman LC, Mendoza FS, Robinson TN. Effects of a videotape to increase use of poison control centers by low-income and Spanish-speaking families: a randomized, controlled trial. Pediatrics. 2003;111(1):21–6.
30. Wilkin HA, Valente TW, Murphy S, Cody MJ, Huang G, Beck V. Does entertainment-education work with Latinos in the United States? Identification and the effects of a telenovela breast cancer storyline. J Health Commun. 2007;12(5):455–69.
31. Tuong W, Larsen ER, Armstrong AW. Videos to influence: a systematic review of effectiveness of video-based education in modifying health behaviors. J Behav Med. 2014;37(2):218–33.
32. Nagler RH, Ramanadhan S, Minsky S, Viswanath K. Recruitment and retention for community-based ehealth interventions with populations of low socioeconomic position: strategies and challenges. J Commun. 2013;63(1):201–20.
33. Lyles CR, Harris LT, Le T, et al. Qualitative evaluation of a mobile phone and web-based collaborative care intervention for patients with type 2 diabetes. Diabetes Technol Ther. 2011;13(5):563–9.
34. Fox S, Duggan M. Tracking for health. Washington, D.C: Pew Research Center; 2013. http://www.pewinternet.org/~/media//Files/Reports/2013/PIP_TrackingforHealth%20with%20appendix.pdf.
35. mHealth: new horizons for health through mobile technologies based on the findings of the second global survey on ehealth, vol 3. Switzerland: World Health Organization; 2011. http://www.who.int/goe/publications/goe_mhealth_web.pdf?ua=1.
36. Davis FD, Bagozzi RP, Warshaw PR. User acceptance of computer technology—a comparison of 2 theoretical-models. Manage Sci. 1989;5(8):982–1003.
37. Venkatesh V, Morris MG, Davis GB, Davis FD. User acceptance of information technology: toward a unified view. MIS Q. 2003;27(3):425–78.