

Willingness to Exchange Health Information via Mobile Devices: Findings From a Population-Based Survey

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ABSTRACT

PURPOSE The rapid proliferation of mobile devices offers unprecedented opportunities for patients and health care professionals to exchange health information electronically, but little is known about patients' willingness to exchange various types of health information using these devices. We examined willingness to exchange different types of health information via mobile devices, and assessed whether sociodemographic characteristics and trust in clinicians were associated with willingness in a nationally representative sample.

METHODS We analyzed data for 3,165 patients captured in the 2013 Health Information National Trends Survey. Multinomial logistic regression analysis was conducted to test differences in willingness. Ordinal logistic regression analysis assessed correlates of willingness to exchange 9 types of information separately.

RESULTS Participants were very willing to exchange appointment reminders (odds ratio [OR] = 6.66; 95% CI, 5.68-7.81), general health tips (OR = 2.03; 95% CI, 1.74-2.38), medication reminders (OR = 2.73; 95% CI, 2.35-3.19), laboratory/test results (OR = 1.76; 95% CI, 1.62-1.92), vital signs (OR = 1.63; 95% CI, 1.48-1.80), lifestyle behaviors (OR = 1.40; 95% CI, 1.24-1.58), and symptoms (OR = 1.62; 95% CI, 1.46-1.79) as compared with diagnostic information. Older adults had lower odds of being more willing to exchange any type of information. Education, income, and trust in health care professional information correlated with willingness to exchange certain types of information.

CONCLUSIONS Respondents were less willing to exchange via mobile devices information that may be considered sensitive or complex. Age, socioeconomic factors, and trust in professional information were associated with willingness to engage in mobile health information exchange. Both information type and demographic group should be considered when developing and tailoring mobile technologies for patient-clinician communication.

Ann Fam Med 2016;14:34-40. doi: 10.1370/afm.1888.

Conflicts of interest: authors report none.

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INTRODUCTION

The ownership of mobile devices and the use of these devices for health purposes have been increasing rapidly.¹⁻⁴ These increases transcend nearly all sociodemographic categories,^{2,4} providing new opportunities to deliver health information to hard-to-reach or underserved populations. Health information exchange (HIE) between health care professionals and patients, in particular, has been increasing, allowing both parties to access and communicate health information electronically. Others have noted that mobile technologies may be a solution to the growing demand for exchanging one's information electronically, and may be a promising strategy for cancer prevention and control.⁵⁻⁷

The studies that have examined HIE, however, have been primarily Internet based, with little focus on mobile devices. These Internet-based studies have found that sociodemographic characteristics and the type of information that is being shared influence attitudes toward HIE.⁸⁻¹⁶ An initial qualitative study examining patients' preferences and attitudes toward mobile technology use to communicate with health care profes-

sionals suggests that familiarity with technology and trust in professionals may influence willingness to use mobile devices to engage in HIE with health care professionals.¹⁷ Variability in willingness may depend on the particular type of health information that is being communicated. We therefore extend prior research by quantitatively examining in a nationally representative sample (1) the differences in patients' willingness to engage in mobile HIE with clinicians based on the type of information being exchanged, and (2) whether various factors, such as sociodemographics and trust in professionals, are associated with willingness to use mobile devices to exchange different types of health information.

METHODS

Data Source and Sample

We analyzed data from the Health Information National Trends Survey (HINTS) 4, cycle 3. The HINTS is a cross-sectional, mail-administered survey designed to collect nationally representative data about the US population's cancer-related communication practices. Data were collected from September through December 2013, and the response rate was 35.2%. More information about the data collection methods is available elsewhere.¹⁸ A total of 3,165 respondents completed the part of the survey that included the measures of interest.

Measures

The dependent variables were ascertained from the following question: "How willing would you be to exchange the following types of medical information with a health care provider electronically through your mobile phone or tablet?" Respondents were presented with 9 types of information—appointment reminders, general health tips, medication reminders, laboratory/test results, diagnostic information (eg, medical illnesses), vital signs (eg, heart rate), lifestyle behaviors (eg, physical activity), symptoms (eg, nausea), and digital images/video (eg, photos of skin lesions)—along with the response options of not at all, a little, somewhat, or very [willing]. Independent variables included self-reported sex, age, race/ethnicity, education, income, trust in professionals, and past use of a mobile telephone for health information exchange. Professional trust was assessed using the following 2 questions: (1) "In general, how much would you trust information about health or medical topics from a doctor?" which we labeled as professional trust information, and (2) "In the past 12 months, how often did you feel you could rely on your doctors, nurses, or other health care professionals to take care of your health care needs?"

which we labeled as professional trust care.¹⁹ Past use of text message or mobile applications (apps) for HIE was included in the models, and was ascertained from the question, "In the past 12 months, have you used any of the following to exchange medical information with a health care professional?" and "Mark all that apply: text message, application on a smart phone, or mobile device."

Statistical Analysis

We noted missing data for both the dependent and independent variables, with the percentages of respondents having missing ranging from 1.7% (professional trust information variable) to 19.1% (professional trust care variable). Percentages with missing data for the dependent variables were low, ranging from 3.8% (appointment reminders) to 5.9% (medication reminders). We assumed the data were missing at random.²⁰ This assumption is inherently not verifiable from the observed data. To make it more reasonable and realistic, for each variable with missing data, we included strong predictors of that variable and its missingness in the imputation model.²¹ Data were imputed via the sequential regression imputation method.²² The imputation model included all variables in this study.²³ We generated 5 imputed data sets using IVEware (Survey Research Center, Institute for Social Research, University of Michigan), and on diagnosis of the marginal distributions of missing variables before and after imputation, we concluded that this number was adequate for producing stable estimates.

A proportions test via multinomial logistic regression was first conducted to determine if there were differences in willingness to exchange various types of health information. For this analysis, the information types were grouped into a single categorical variable, and 9 levels represented each type of information. Ordered logistic regression analyses were then conducted for willingness to exchange each type of information separately. In all ordered logistic regression analyses, the results interpreted were for being in the "very willing" category vs lower willingness categories. All analyses were conducted with the weighted sample in SAS version 9.3 (SAS Institute, Inc).

RESULTS

Respondent characteristics are shown in Table 1. About 30% of the respondents were aged 35 to 49 years, 51% were female, and 67% were non-Hispanic white. The majority had some college or higher, and 32% reported a household income of \$75,000 or greater. Most respondents had not used a mobile device to exchange health information in the last year.

Willingness to exchange health information is shown in Table 2. Overall, 44% and 40% of respondents were not at all willing to exchange diagnostic information or digital images, respectively. Only 15% were not at all willing to exchange appointment reminders.

The proportions test showed significant differences in the types of information respondents were willing to exchange via mobile device (Table 3). Participants

were willing (a little, somewhat, and very) to exchange appointment reminders, general health tips, medication reminders, laboratory/test results, vital signs, lifestyle behaviors, and symptoms as compared with diagnostic information. The odds of those who were "a little" willing to exchange digital images/video vs diagnostic information were greater than those "not at all" willing; other response options were not statistically significant.

Regardless of the information type, older adults (those aged 50 or older) had lower odds of being more willing to exchange any information through mobile device compared with younger adults (those aged 18 to 34) (Table 4). Respondents with less than a bachelor's degree were less likely to be more willing to exchange most types of health information as compared with those with a bachelor's or higher. With respect to race/ethnicity, Hispanics were more likely to be more willing to exchange medication reminders as compared with non-Hispanic whites (odds ratio = 1.60; 95% CI, 1.09-2.35). Respondents with a household income of less than \$75,000 had lower odds of being more willing to exchange certain types of health information.

Respondents who trusted information from their professionals had higher odds of being more willing to exchange all type of health information except for digital images/video. Those who had used text messaging for HIE in the last year had higher odds of being more willing to exchange digital images/video (odds ratio = 1.59; 95% CI, 1.04-2.42). Respondents who had used a mobile app for HIE had higher odds of being more willing to exchange general health tips, medication reminders, laboratory/test results, vital signs, and symptoms than those who had not used HIE apps.

Table 1. Characteristics of Respondents (N = 3,165)

Characteristic	Respondents	
	No.	Weighted % (95% CI)
Sex		
Male	1,241	48.7 (46.8-50.6)
Female	1,924	51.3 (49.4-53.2)
Age-group, y		
18-34	435	26.8 (25.3-28.3)
35-49	727	30.3 (28.7-31.9)
50-64	1,102	25.3 (24.7-25.9)
≥65	901	17.5 (17.0-18.0)
Race/ethnicity		
Hispanic	584	15.4 (14.4-16.3)
Non-Hispanic black	501	10.9 (9.8-12.0)
Non-Hispanic other ^a	243	7.2 (6.7-7.6)
Non-Hispanic white	1,836	66.6 (65.0-68.1)
Education level		
Less than high school	303	9.7 (8.5-10.9)
High school graduate	715	24.5 (22.6-26.5)
Some college	953	32.6 (30.8-34.3)
College graduate or more	1,194	33.2 (32.7-33.6)
Income group		
<\$20,000	796	21.0 (19.0-23.0)
\$20,000 to <\$35,000	470	14.3 (12.3-16.3)
\$35,000 to <\$50,000	460	14.7 (12.3-17.1)
\$50,000 to <\$75,000	523	17.8 (15.7-20.0)
≥\$75,000	916	32.2 (29.8-34.5)
Professional trust information		
Low/no trust	352	16.7 (16.3-17.1)
High trust	2,813	83.3 (82.9-83.7)
Professional trust care		
Low/no reliance	988	31.3 (28.7-33.9)
High reliance	2,177	68.7 (66.1-71.3)
Used text messaging for health information exchange in past year		
No	395	14.0 (11.5-16.4)
Yes	2,770	86.0 (83.6-88.5)
Used mobile application for health information exchange in past year		
No	2,974	93.6 (92.1-95.1)
Yes	191	6.4 (4.9-7.9)

^a Aggregated because of small sample sizes in the Asian, Native Hawaiian/Pacific Islander, American Indian, and multiple races categories.

DISCUSSION

We examined a nationally representative sample to assess differences in patient/consumer willingness to engage in mobile HIE. Factors associated with willingness to use mobile devices to exchange 9 types of health information were also examined. Overall, few respondents (no more than 6%) had actually exchanged health information via their mobile devices. Despite these low rates, willingness rates were much higher, and well more than one-half were willing to exchange certain types of information via mobile devices. There were also differences in the types of information respondents were willing to exchange using mobile devices, with respondents less willing to exchange diagnostic information or digital images/videos vs other types of information. It is possible that willingness to engage in mobile HIE may be determined by the sensitivity or complexity of the health information being communicated, or both.

Table 2. Frequency of Willingness to Exchange Health Information via Mobile Device According to Health Information Type

Type of Health Information	Willingness to Exchange, Weighted % (95% CI)			
	Not at All	A Little	Somewhat	Very
Appointment reminders	15.1 (13.3-16.9)	8.6 (6.8-10.3)	19.2 (16.7-21.7)	57.2 (54.1-60.2)
General health tips	26.5 (24.2-28.8)	17.7 (15.3-20.2)	25.1 (22.8-27.4)	30.6 (28.0-33.3)
Medication reminders	24.2 (22.1-26.3)	14.6 (12.1-17.1)	23.6 (20.8-26.5)	37.6 (34.3-40.8)
Laboratory/test results	33.4 (30.0-36.8)	12.2 (10.0-14.4)	20.9 (18.8-23.1)	33.5 (30.7-36.3)
Diagnostic information	43.6 (40.3-46.9)	12.1 (10.0-14.2)	19.5 (17.0-22.1)	24.8 (22.3-27.3)
Vital signs ^a	33.0 (29.8-36.1)	13.2 (11.4-15.0)	23.3 (20.3-26.2)	30.6 (27.0-34.1)
Lifestyle behaviors	31.5 (28.8-34.2)	20.2 (17.9-22.4)	23.3 (20.7-25.8)	25.1 (22.4-27.8)
Symptoms	30.8 (28.1-33.5)	16.4 (13.9-18.8)	24.5 (22.1-26.9)	28.4 (25.4-31.3)
Digital images/video	39.8 (37.0-42.6)	16.8 (14.6-19.1)	19.4 (16.9-21.8)	24.0 (20.8-27.2)

^a Heart rate, blood pressure, glucose levels, etcetera.

Table 3. Odds of Willingness to Exchange Health Information via Mobile Device According to Health Information Type

Type of Health Information	Willingness to Exchange, Odds Ratio (95% CI) ^a		
	A Little	Somewhat	Very
Diagnostic information (ref)	1.00	1.00	1.00
Appointment reminders	2.05 (1.52-2.78)	2.83 (2.28-3.52)	6.66 (5.68-7.81)
General health tips	2.42 (1.87-3.14)	2.11 (1.70-2.63)	2.03 (1.74-2.38)
Medication reminders	2.18 (1.64-2.91)	2.18 (1.79-2.65)	2.73 (2.35-3.19)
Laboratory/test results	1.32 (1.06-1.64)	1.40 (1.23-1.58)	1.76 (1.62-1.92)
Vital signs	1.45 (1.17-1.80)	1.58 (1.37-1.81)	1.63 (1.48-1.80)
Lifestyle behaviors	2.31 (1.92-2.79)	1.65 (1.37-1.98)	1.40 (1.24-1.58)
Symptoms	1.92 (1.53-2.40)	1.77 (1.55-2.03)	1.62 (1.46-1.79)
Digital images/video	1.53 (1.20-1.93)	1.09 (0.90-1.31)	1.06 (0.96-1.18)

ref = reference group.

^a Reference group was "not at all" willing.

Sociodemographics such as age, education, and income, as well as trust in the information received from a professional, were correlated with willingness to exchange certain types of information. Those who were older were less willing to engage in mobile HIE. In contrast, O'Donnell and colleagues¹² found that older adults were more likely to be interested in HIE via the Internet. These data collectively suggest that there may be generational differences in attitudes toward using different technology platforms for HIE, mobile vs Internet. Future research should further explore age vs cohort differences in perceptions of technology use and mobile HIE.

In general, neither race/ethnicity nor sex was significantly associated with willingness to use mobile HIE, with the exception of Hispanics being more willing to exchange medication reminders than non-Hispanic whites. The variability in willingness to engage in mobile HIE was mostly related to socio-

economic status, more consistently for education than income level. Having a college education was associated with greater willingness to use mobile devices to communicate with health care professionals about health information across the board. As analyses accounted for the significant effects of prior use of text messaging/mobile apps for HIE, it is less likely that the differences in educational attainment noted were due to familiarity with mobile health technology. Given the low prevalence of past engagement in mobile HIE in the current sample, however, the significant findings between past engagement

in mobile HIE and willingness may not be reliable. Health literacy and patient engagement/activation may play a role, as more educated individuals tend to have higher health literacy and also greater levels of patient engagement/activation.²⁴⁻²⁷ Studies examining the role of health literacy, patient engagement, and mobile HIE are needed.

Patients who trusted the information received from their professionals were more willing to exchange most types of information through a mobile device. Interestingly, ratings of trusting professional information were not associated with willingness to exchange digital images/videos, suggesting that the sensitivity or complexity of this type of information supersedes the influence of professional trust in patients' willingness to exchange such information. In contrast, whether respondents felt that they could rely on professionals to care for their health needs was not associated with willingness to engage in mobile HIE. Future research

Table 4. Odds of Willingness to Exchange Different Types of Health Information via Mobile Devices According to Respondent Characteristics

Variable	Willingness to Exchange, Odds Ratio (95% CI)				
	Appointment Reminders	General Health Tips	Medication Reminders	Laboratory/ Test Results	Diagnostic Information
Sex					
Male (ref)	1.00	1.00	1.00	1.00	1.00
Female	1.02 (0.79-1.32)	0.98 (0.78-1.24)	0.87 (0.71-1.08)	0.98 (0.79-1.22)	0.84 (0.68-1.04)
Age-group, y					
18-34 (ref)	1.00	1.00	1.00	1.00	1.00
35-49	0.84 (0.56-1.27)	0.88 (0.66-1.16)	0.84 (0.63-1.13)	0.82 (0.61-1.09)	0.81 (0.61-1.09)
50-64	0.44 ^a (0.30-0.63)	0.51 ^a (0.39-0.67)	0.55 ^a (0.42-0.72)	0.63 ^a (0.44-0.91)	0.64 ^a (0.46-0.90)
≥65	0.23 ^a (0.15-0.36)	0.29 ^a (0.22-0.40)	0.35 ^a (0.25-0.48)	0.54 ^a (0.38-0.78)	0.54 ^a (0.38-0.78)
Race/ethnicity					
Hispanic	1.05 (0.72-1.54)	1.33 (0.94-1.87)	1.60 ^a (1.09-2.35)	1.38 (0.98-1.94)	1.33 (0.95-1.87)
Non-Hispanic black	0.85 (0.54-1.34)	1.14 (0.79-1.66)	1.37 (0.89-2.10)	0.81 (0.60-1.10)	0.79 (0.58-1.07)
Non-Hispanic other	0.68 (0.40-1.17)	0.92 (0.57-1.49)	0.92 (0.57-1.50)	1.02 (0.60-1.71)	1.01 (0.57-1.78)
Non-Hispanic white (ref)	1.00	1.00	1.00	1.00	1.00
Education level					
Less than high school	0.46 ^a (0.31-0.67)	0.48 ^a (0.31-0.75)	0.52 ^a (0.35-0.77)	0.75 (0.50-1.13)	0.70 (0.46-1.07)
High school graduate	0.37 ^a (0.26-0.52)	0.53 ^a (0.38-0.74)	0.55 ^a (0.40-0.76)	0.61 ^a (0.46-0.81)	0.66 ^a (0.50-0.88)
Some college	0.64 ^a (0.46-0.88)	0.88 (0.66-1.18)	0.83 (0.63-1.10)	0.81 (0.64-1.03)	0.78 (0.61-1.01)
College graduate or more (ref)	1.00	1.00	1.00	1.00	1.00
Income group					
<\$20,000	0.64 (0.37-1.09)	0.64 ^a (0.42-0.97)	0.73 (0.50-1.07)	0.66 ^a (0.47-0.92)	0.92 (0.67-1.25)
\$20,000 to <\$35,000	0.68 (0.45-1.03)	0.70 (0.45-1.10)	0.60 ^a (0.41-0.89)	0.92 (0.62-1.38)	1.04 (0.72-1.50)
\$35,000 to <\$50,000	0.88 (0.53-1.47)	0.74 (0.48-1.15)	0.74 (0.53-1.04)	0.83 (0.60-1.15)	1.00 (0.71-1.41)
\$50,000 to <\$75,000	0.79 (0.51-1.21)	0.78 (0.56-1.09)	0.73 ^a (0.54-0.99)	0.67 ^a (0.50-0.88)	0.76 (0.56-1.01)
≥\$75,000 (ref)	1.00	1.00	1.00	1.00	1.00
Trust in health care professional					
Professional trust information	1.73 ^a (1.31-2.27)	1.71 ^a (1.42-2.06)	1.67 ^a (1.35-2.06)	1.53 ^a (1.18-2.00)	1.33 ^a (1.00-1.76)
Professional trust care	0.89 (0.59-1.35)	0.87 (0.63-1.20)	0.81 (0.59-1.10)	0.83 (0.57-1.21)	0.76 (0.52-1.11)
Use of HIE in past year					
Used text messaging for HIE	1.46 (0.87-2.44)	1.27 (0.83-1.93)	1.16 (0.74-1.84)	1.24 (0.76-2.01)	1.09 (0.67-1.76)
Used mobile app for HIE	1.41 (0.62-3.22)	2.64 ^a (1.22-5.71)	2.29 ^a (1.17-4.48)	2.27 ^a (1.14-4.52)	1.98 (0.98-3.99)

app = application; HIE = health information exchange; ref = reference group.

^a Statistically significant.

Note: Odds ratios (95% CIs) from proportional odds models. Odds ratios are for being in the "very willing" category vs lower willingness categories.

should explore constructs of patients' trust in physicians and mobile HIE.

The study had several limitations. First, the data that we analyzed were from a cross-sectional survey, limiting the ability to make causal inferences with respect to professional trust. Second, only 2 items were used to measure trust, and others have noted that there are different measures of patients' trust in physicians.^{28,29} Third, the data were self-reported and therefore may be prone to bias. Fourth, the survey response rate was low at 35%; however, the survey weights applied take into account the nonresponse rate.³⁰ A fifth limitation is related to multiple comparisons and type I error. To examine this factor, we applied the Bonferroni correction, with a new $\alpha = .0056$ to indicate

statistical significance. The results were very similar despite the new α : age, education, and professional trust information remained significant, whereas race/ethnicity and past use of mobile HIE became nonsignificant. A final limitation is related to issues regarding privacy and security, which was not assessed in HINTS 4, cycle 3, and may influence willingness to engage in mobile HIE.¹⁷

Despite these limitations, this study sheds some light on the US population's attitudes toward mobile HIE by quantitatively examining differences in and correlates of willingness to exchange health information via mobile technology. Our results from this study suggest that both information type and education level should be considered when developing and tailoring

Vital Signs	Lifestyle Behaviors	Symptoms	Digital Images/Video
1.00 0.93 (0.75-1.15)	1.00 0.90 (0.71-1.14)	1.00 0.92 (0.72-1.17)	1.00 0.91 (0.73-1.12)
1.00 0.79 (0.60-1.04) 0.52 ^a (0.38-0.73) 0.41 ^a (0.29-0.59)	1.00 0.82 (0.60-1.12) 0.49 ^a (0.36-0.65) 0.35 ^a (0.26-0.47)	1.00 0.83 (0.63-1.08) 0.51 ^a (0.39-0.66) 0.34 ^a (0.25-0.47)	1.00 0.79 (0.59-1.04) 0.42 ^a (0.31-0.57) 0.29 ^a (0.20-0.40)
1.19 (0.91-1.55) 0.93 (0.66-1.29) 0.95 (0.57-1.56) 1.00	1.33 (0.95-1.86) 1.12 (0.76-1.65) 1.11 (0.66-1.87) 1.00	1.34 (0.98-1.83) 1.07 (0.72-1.59) 0.83 (0.46-1.49) 1.00	1.17 (0.86-1.59) 1.02 (0.73-1.44) 0.91 (0.54-1.55) 1.00
0.62 ^a (0.42-0.92) 0.61 ^a (0.46-0.81) 0.79 (0.61-1.04) 1.00	0.41 ^a (0.26-0.64) 0.42 ^a (0.30-0.59) 0.70 ^a (0.54-0.92) 1.00	0.57 ^a (0.38-0.84) 0.53 ^a (0.39-0.72) 0.83 (0.64-1.09) 1.00	0.49 ^a (0.31-0.78) 0.55 ^a (0.39-0.78) 0.78 (0.60-1.02) 1.00
0.72 (0.51-1.03) 0.76 (0.53-1.08) 0.85 (0.59-1.22) 0.68 ^a (0.51-0.90) 1.00	0.70 (0.47-1.06) 0.88 (0.58-1.33) 0.79 (0.55-1.15) 0.75 (0.54-1.03) 1.00	0.73 (0.49-1.11) 0.90 (0.60-1.36) 0.94 (0.61-1.46) 0.74 (0.55-1.00) 1.00	0.63 ^a (0.44-0.90) 0.77 (0.49-1.21) 0.87 (0.59-1.28) 0.69 ^a (0.51-0.95) 1.00
1.43 ^a (1.13-1.80) 0.87 (0.62-1.23)	1.37 ^a (1.09-1.71) 0.99 (0.71-1.39)	1.42 ^a (1.16-1.73) 0.90 (0.65-1.25)	1.19 (0.93-1.53) 0.80 (0.58-1.11)
1.27 (0.71-2.24) 2.24 ^a (1.13-4.46)	1.34 (0.85-2.14) 1.62 (0.75-3.46)	1.45 (0.96-2.19) 2.04 ^a (1.02-4.07)	1.59 ^a (1.04-2.42) 1.62 (0.81-3.23)

mobile HIE for patients and clinicians. For example, less educated patients may be more skeptical of engaging in mobile HIE and may need to be made aware of its benefits and efficiencies, such as the ability to track and monitor their own health. Health care professionals should provide patients with information related to the benefits of mobile HIE. In addition, physicians should partner with technologists to ensure mobile technologies related to HIE take into account their patient population and patients' comfort level with these technologies. More in-depth research is needed, however, to determine whether the sensitivity or complexity of the health information, or both, matter when considering patients' willingness to use mobile technology to exchange various types of information.

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Key words: mobile health; health information exchange; patient/consumer attitudes; cell phones; electronic mail

Submitted April 28, 2015; submitted, revised, August 19, 2015; accepted November 5, 2015.

Prior presentation: This work was presented at the Society of Behavioral Medicine Annual Meeting, April 22-25, 2015, San Antonio, Texas.

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