WILEY

PAPER

Mobile-based patient-provider communication in cancer survivors: The roles of health literacy and patient activation

Shaohai Jiang[1] | Y. Alicia Hong[2]

[1] Department of Communications and New Media, National University of Singapore, Singapore

[2] School of Public Health, Texas A&M University, College Station, TX, USA

Correspondence
Shaohai Jiang, Department of Communications and New Media, National University of Singapore, Blk AS6, #03-41, 11 Computing Drive, Singapore, 117416.
Email: cnmjs@nus.edu.sg

Abstract

Objective: Thanks to rapid penetration of mobile tools, more and more cancer survivors have adopted mobile-based patient-provider communication (MBPPC). The relationship between MBPPC and patients' health outcomes, however, remains unclear; how health literacy and patient activation interact with such relationship is unexplored.

Methods: Data were drawn from National Cancer Institute's Health Information National Trends Survey 4 Cycle 3. A sample of 459 cancer survivors were included in the analysis. Based on the 3-stage model of health promotion using interactive media, this study empirically tested a moderated mediation model.

Results: MBPPC (eg, patient use of email, text message, mobile app, and social media to communicate with providers) had no direct effect on cancer survivors' emotional health. Instead, health literacy completely mediated this path. Patient activation positively moderated the effect of health literacy on emotional health and further increased the indirect effect of MBPPC on emotional health.

Conclusions: MBPPC alone does not directly result in better emotional health outcomes; health literacy is the key to realize its health benefits; patient activation significantly strengthens the effects of MBPPC. As we embrace the mHealth movement, innovative programs are needed to promote MBPPC, and improve health literacy and activation of cancer survivors, particularly in underserved communities, to reduce health disparities.

KEYWORDS

cancer survivors, health literacy, mobile-based health communication, patient activation, patient-provider communication, quality of life

1 | INTRODUCTION

Communication is an essential component of cancer care. Traditionally, face-to-face communication has been the primary means for patients to interact with their health care providers. With rapid penetration of mobile technologies, mobile-based communication (eg, email, mobile apps, and social media) is emerging as another viable avenue for patient-provider communication.[1] Advantages of mobile-based patient-provider communication (MBPPC) have been widely documented, such as greater access to health care providers, rapid message transfer, and reduced cost associated with traveling for consultations.[2] The progressive development of mobile technologies is congruent with the growth in MBPPC in the United States. In 2014, 31.6% of

American adults have communicated with health care providers online, compared with 3% in 2003.[3] Cancer survivors who are Internet users are more likely to use it for health purposes.[4]

Thanks to the advancement in cancer treatment and screening, the number of cancer survivors has increased, and their life expectancy has been prolonged. More than 15.5 million Americans with a history of cancer were alive in 2016, and this number is projected to reach more than 20 million by 2026.[5] In the continuum of cancer care, it's increasingly important to improve cancer survivors' quality of life including their emotional health. In the efforts to improve cancer survivors' emotional well-being, patient-provider communication plays a critical role. Prior research indicated that when doctors provide useful health information and respond to patients' emotions, patients

would have stronger sense of control and hope, which leads to higher quality of life and better survivorship.[6-8]

Despite the growing popularity of MBPPC and its evident benefits, little is known about the mechanism of how MBPPC affects quality of life in cancer survivors. A systematic review of patient-provider communication via patient portals found that the evidence on the direct effect of MBPPC on patients' health outcomes was insufficient.[9] Other empirical studies also showed that social media and Internet information seeking failed to directly affect emotional health outcomes.[10,11] To investigate how media use can influence health, Street introduced the 3-stage model of health promotion using interactive media.[12] Street stated that in most cases, media use affects health through more indirect or mediated route through outcomes of the interaction with the media. Specifically, stage 1 focuses on factors influencing use of technologies, which in turn merges into stage 2, users' experiences within the media environment (eg, when using the computer, apps). The intermediate outcomes of media use (eg, increase in knowledge and skills) then can lead to post media use health improvement at stage 3. Also highlighted in the 3-stage model is the notion that the effectiveness of interactive media resources depends on the quality of the user's experience interacting with the media (eg, activation and ability to use health-related media resources), and whether this produces desired outcomes.

Therefore, in line with the 3-stage model that suggests an indirect relationship between MBPPC and health outcomes, we speculate that a number of potential mediation and moderation effects exist between MBPPC and health outcomes, depending on the outcome of interest and the processes affecting health status. Specifically, we propose that the effect of MBPPC on cancer survivors' emotional well-being is mediated by health literacy and moderated by patient activation, reasoned as following.

Health literacy is one's ability to obtain, process, and understand health information and services.[13] The Internet and mobile tools have offered many opportunities for patients to receive information and build medical knowledge.[14] Most Internet users have searched health information online, especially in cancer survivors.[4] But better access to health information is not equivalent to better health literacy.[14] When patients have less satisfactory online health information seeking experiences (eg, information overload, inaccurate information, and obscure medical jargons), access to Internet health information might not lead to better health-related outcomes.[10] In this case, patients would turn to direct conversations with doctors for better quality health-related resources. Timely communication with health care providers, especially via mobile-based tools, could mitigate the negative experiences patients encounter while searching health information online.[15] Patients with good level of health literacy are less likely to encounter difficulty in interpreting online health information and more capable of utilizing online health resources for optimal health outcomes, including improving their emotional well-being.[10] Thus, health literacy mediates the effect of MBPPC on patients' health outcomes.

Patient activation is defined as one's motivation and engagement in managing health-related needs.[16] According to Esptein and Street,[17] patient activation serves as an important intrinsic moderator in the relationships between patient-provider communication and health

outcomes in cancer care. Literature suggests that when patients are able to obtain and understand health information by themselves, and become empowered and actively engaged in the course of care, the effects of health-related Internet use on health outcomes would be strengthened.[10,18] Thus, patient activation moderates the effect of MBPPC on health outcomes.

In light of the above, we hypothesize that MBPPC does not have direct effect on patients' emotional health outcomes; its effect only exists when health literacy is present with positive mediating effect. The relationship of MBPPC on emotional health is also moderated by patient activation, with higher level of activation indicating stronger effect of MBPPC on emotional health (see Figure 1).

2 | METHODS

2.1 | Sample

The Health Information National Trends Survey (HINTS) 4 Cycle 3 was used to test the above hypotheses. HINTS was conducted by the National Cancer Institute with the aim to examine American adults' health information use and health behavior. The HINTS 4 Cycle 3 was collected in 2013 with a stratified sampling scheme detailed elsewhere.[10] Briefly, a stratified sample of 12 010 addresses was chosen from a database of random samples of addresses that include areas with high and low concentration of minority populations. Questionnaires were mailed to the selected participants. A total of 3185 American adults completed the survey, with the completion rate of 26.5%. Given that we focus on cancer survivors, defined as people who have been diagnosed with cancer, only respondents who reported "Yes" to the question "Have you ever been diagnosed as having cancer?" were included into this study. Thus, our final sample consists of 459 cancer survivors, a sub-sample of the 3185 respondents in the HINTS. HINTS are approved public datasets and considered as exempt from institutional review board oversight. Ethical approval was not required for HINTS, because it was a survey of the general population that included no vulnerable populations; it obtained no individual respondents' identifiers; the information collected was not sensitive.[19] Informed written consent was obtained, as respondents signed and returned consent form before the survey started.

2.2 | Measurement

Mobile-based patient-provider communication (MBPPC) was measured by 4 items, drawn from prior research of similar measure.[2] Respondents were asked to identify in the past 12 months whether they have used the following 4 mobile-based platforms to communicate with their health care providers: (1) Email; (2) Text message; (3) Mobile apps; and (4) Social media. Their responses to these 4 dichotomous items (0 = no, 1 = yes) were summed up to create 1 index for analysis.

Health literacy was assessed with the HINTS Health Literacy Screening Measure.[20,21] Four items were selected for this measurement. The first 2 items asked respondents if they have heard of genetic tests and HPV shot, respectively. The third item asked if respondents agreed with Food and Drug Administration's regulation on tobacco products. Responses to these 3 items were dichotomous (0 = no,
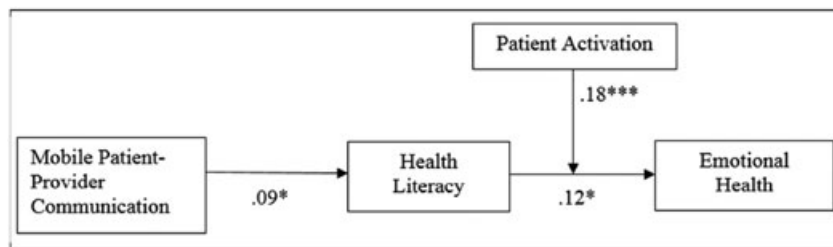
FIGURE 1 Conceptual framework

1 = yes). In the fourth item, respondents were first provided with an ice cream food label and then asked to calculate the calories from eating an entire container of ice cream. Correct answer was coded as 1, while others were scored as 0. An index was created based on the responses to the above 4 items. The use of the 4 dichotomous items aligns with the multi-dimensional nature of health literacy as proposed by Zarcadoolas and colleagues[22]: scientific literacy (eg, knowledge of genetic testing and HPV vaccine), civic literacy (eg, knowledge of Food and Drug Administration), and fundamental literacy (eg, calculation of calories).

Patient activation was measured by 6 items, drawn from Hibbard and colleagues' Patient Activation Measure.[16] Respondents were asked how often they (1) asked doctors to explain a test, treatment, or procedure in detail; (2) read information about a new prescription, such as side effects and precautions; (3) did research on a health or medical topic after seeing a doctor; (4) took with them to doctor's visit a list of questions or concerns they wanted to cover; (5) took a list of all of their prescribed medicines to doctors; and (6) took with them to doctor's visit any kind of health information they had found. A 4-point Likert scale was used, ranging from 1 = never to 4 = always. The Cronbach's alpha was .73. The mean score of the 6 responses were calculated.

Emotional health outcome was assessed with 3 items, adapted from the Center for Epidemiologic Studies Depression Scale.[23] Respondents were asked to rate the frequency when they (1) feel anxious, (2) feel sad, and (3) feel hopeful in the past 30 days with a 5-point Likert scale ranging from 1 = all of the time to 5 = none of the time. Item (3) was reverse coded. The Cronbach's alpha of the scale was .75. An average score was calculated for analysis.

Demographic variables were controlled to reduce confounding effects. These variables included age, gender (0 = female, 1 = male), education (ranging from 1 = less than 8 years to 7 = postgraduate), household income (ranging from 1 = less than $10 000 to 9 = $200 000 or more), and race (1 = non-Hispanic White, 0 = other).

2.3 | Statistical analysis

Structural equation modeling (SEM) was performed to examine the mediation pathway from MBPPC to health literacy and finally to emotional health (see Figure 1). Sobel test was used to test the mediation effect of health literacy more closely.

Hierarchical regression was conducted to examine the moderating effect of patient activation. An interaction term between health literacy and patient activation (after mean centered) was created and entered into the regression model. The inclusion of this interaction term provided test for the moderation effect.

To further explore the moderated mediation effects, a normal theory-based approach was adopted.[24] This method tested the significance levels of conditional indirect effects at 3 different values of the moderator, patient activation: 1 standard deviation above the mean, the mean, and 1 standard deviation below the mean.

To calculate the statistical power of this study, we conducted a post-hoc statistical power test. With 8 predictors (3 main predictors and 5 control variables) in the regression analysis, an observed R^2 of 0.25, a sample size of 459, and alpha = 0.05, the test results indicated an observed power of 1.0.

3 | RESULTS

Characteristics of the study participants were illustrated in Table 1. The mean age was 66.12 years (SD = 13.59); 36.60% were male, and more than half (54.9%) had at least some college education. Over half (55.77%) had annual household income over $50 000, and 80.61% were non-Hispanic White. The mean score of MBPPC was .35. MBPPC was associated with younger age and higher education. Among the 459 respondents, 133 have used at least 1 mobile-based tool to communicate with health care providers. Specifically, the most common mode of MBPPC was via email with 20.7% participants having used email to exchange medical information with doctors in the past 12 months, followed by text message (5.88%), and mobile apps (4.36%). The least popular form of MBPPC was via social media (1.96%). The mean score of health literacy was 2.16 (ranged 0 to 4). Patient activation had a mean score of 2.74 (ranged 1 to 4). The average score of self-reported emotional health condition was 3.72 (ranged 1 to 5). Compared with their counterparts, patients who have used MBPPC were younger, better educated, had higher household income, and higher level of health literacy.

The initial SEM model was saturated, without a Chi-square value, which required model modification. With close examination of each path, 1 path linking MBPPC to emotional health was insignificant (β = −.05, P = .31). According to prior research, non-significant paths could be pruned to seek more parsimonious explanation for a certain phenomenon.[25] Therefore, this insignificant path was deleted for better parsimony. The final SEM model had a satisfactory fit: $\chi^2(1) = 1.049$, P = .306; RMSEA = .010 (90% confidence interval, .000–.125); CFI = 1.000; and SRMR = .007.[26]

Results of the SEM are shown in Table 2. Several exogenous variables exerted direct effects on endogenous variables. Older age was associated with lower levels of MBPPC (β = −.13, P < .01) and health literacy (β = −.18, P < .001), but higher level of emotional health (β = .12, P < .05). Being female was negatively associated with health

TABLE 1 Descriptive statistics for study variables

	Total (n = 459) M (SD)	PPC User (n = 133) M (SD)	Non-user (n = 326) M (SD)	P Values
Age	66.12 (13.59)	62.96 (14.03)	67.41 (13.21)	.001
Gender	.38 (.48)	.39 (.48)	.37 (.48)	.421
Education	4.61 (1.65)	5.05 (1.61)	4.43 (1.63)	.000
Income	5.12 (2.06)	5.58 (2.04)	4.93 (2.04)	.002
Race	.74 (.44)	.77 (.42)	.73 (.44)	.668
Mobile PPC	.35 (.69)	NA	NA	NA
Health literacy	2.16 (1.13)	2.55 (1.13)	2.01 (1.09)	.000
Patient activation	2.74 (.66)	2.81 (.65)	2.71 (.67)	.165
Emotional health	3.72 (.67)	3.69 (.67)	3.74 (.66)	.417

TABLE 2 Predictors of endogenous variables in SEM

	Effect	Age	Gender	Education	Income	Race	Mobile PPC	Health Literacy
Mobile PPC	Direct	−.13**	−.01	.12*	−.01	.09		
	Indirect	NA	NA	NA	NA	NA		
Health literacy	Direct	−.18***	−.11**	.24***	.20***	.14**	.09*	
	Indirect	−.01	−.01	0.1	−.01	.01	NA	
Emotional health	Direct	.12*	−.06	.02	.16**	−.05	P	.12*
	Indirect	−.01*	−.02	.03*	.02*	.02	.01*	NA

*P < .05.

**P < .01.

***P < .001.

Coefficients are standardized.

NA, not applicable; P, pruned.

literacy (β = −.11, P < .01). Higher level of education had positive effects on MBPPC (β = .12, P < .05) and health literacy (β = .25, P < .001). Higher household income (β = .20, P < .001) and being white (β = .14, P < .01) both positively predicted health literacy.

As indicted in Table 2, MBPPC was positively related to health literacy (β = .09, P < .05). In other words, the more cancer survivors used MBPPC, the higher level of health literacy they had. Meanwhile, health literacy had positive effects on emotional health outcome (β = .12, P < .05), indicating that cancer survivors with higher level of health literacy reported better emotional health outcomes. It's worth

TABLE 3 Regression results for moderated mediation model

Predictor	β	SE	t	P
Block 1: Main predictors	Emotional health			
Health literacy (HL)	.13	.03	2.84	.005
Patient activation (PA)	.08	.05	1.69	.092
Block 2: Interaction terms				
Health literacy (HL)	.12	.03	2.67	.008
Patient activation (PA)	.09	.05	1.93	.054
HL × PA	.18	.03	3.87	.000
Conditional indirect effect	β	SE	z	P
	Emotional health			
M-1 SD	.10	.03	3.08	.002
M	.13	.04	3.05	.002
M + 1 SD	.15	.05	3.02	.003

noting that the direct effect of MBPPC on emotional health was not significant, demonstrating the complete mediation of health literacy. To further test this mediation effect, the Sobel test was used to generate a z-value. The z value for this indirect path was significant (z = 2.538, P < .05), supporting the mediating role of health literacy.

Table 3 presents the results of the moderation effect. The interaction term between health literacy and patient activation was positive and significant (β = .18, P < .001), suggesting that patient activation enhanced the positive effect of health literacy on emotional health. That is, a cancer survivor with a higher level of health literacy, when activated in the course of care, would have better emotional health outcomes. Table 3 also demonstrates the moderated mediation effect: patient activation strengthened the indirect effect of MBPPC on emotional health. Therefore, MBPPC can exert stronger indirect effects on emotional health, through health literacy when cancer survivors become more activated in health care. Also, regardless of the level of patient activation, health literacy remained a significant mediator in the pathway linking MBPPC to emotional health.

4 | CONCLUSIONS

The current study has broken new ground in investigating the social mechanism that underlies the impact of MBPPC on emotional well-being of cancer survivors. Our data revealed that more use of MBPPC was associated with higher level of health literacy, which led to better emotional health; patient activation moderated the relationship

between health literacy and emotional health. The finding of no direct relationship between MBPPC and emotional health among cancer survivors was similar to earlier studies.[27,28] The positive relationships between MBPPC and health literacy, health literacy and emotional health, patient activation, and emotional health also corroborated the literature.[29,30] To the best of our knowledge, this study was the first to examine the mediation effect of health literacy and moderation effect of patient activation in the pathway linking MBPPC and emotional health. These findings have important implications.

First, MBPPC alone does not directly lead to improved emotional health; rather, health literacy is the key to realize the health benefits of MBPPC. Given the important mediating role of health literacy between MBPPC and health outcomes, when promoting MBPPC in the era of eHealth movement, it's essential to educate patients and enable them to obtain, interpret, and understand health information online, so they can actually use MBPPC to increase their health benefits. For example, a number of interventions have trained older adults to use mobile-based health information seeking and communication, and these programs included health literacy education as an important component of the intervention, which led to positive improvement in health outcomes.[31]

Second, considering that patient activation significantly strengthens the relationship between health literacy and emotional health, future patient education program needs to empower patients so they can be actively involved in their medical decision making, so as to enhance the effects of MBPPC and health literacy on emotional health outcomes of cancer survivors. For example, an intervention to enhance patient activation led to patients' better engagement in health communication and other positive health outcomes.[32] We need to design and evaluate more mobile-based programs to engage patients and facilitate their communication with providers.[8]

Third, data suggested that cancer survivors of older age and lower-level of education were less likely to have MBPPC, indicating a significant digital divide. They also had lower level of health literacy, patient activation, and emotional well-being, suggesting significant health disparities. Literature has documented the reciprocal relationship of digital divide and health disparities.[33] Health literacy is critical for patients to navigate the health care system, especially in the eHealth era. Also, technological literacy has a significant effect on whether an eHealth application would be used when made accessible.[34] Thus, as we embrace the eHealth movement, targeted intervention is needed for underserved populations, especially older and less-educated cancer survivors. On the one hand, we need innovative programs to promote MBPPC for patients with low level eHealth literacy, so they can also benefit from the technology development and have open and efficient communication with their health care providers. On the other hand, when designing eHealth programs, we must be cognizant of the challenges faced by vulnerable social groups of low-level health literacy, so they won't be left out in the eHealth movement.

4.1 | Clinical implications

Our findings have the following clinical implications. First, approximately 30% of participants in this study have used MBPPC. We expect the percentage will continue to rise given the high penetration rate of mobile technologies and growing popularity of telemedicine. Clinicians need to adopt and utilize mobile resources for more efficient patient-provider communication. However, simply throwing this interactive mobile technology at health concerns may not be sufficient to improve health and well-being. Therefore, clinicians should think about what intermediate outcomes might be accomplished with MBPPC (in this case, health literacy), which in turn can have more direct influences on health outcomes. Second, recognizing the importance of health literacy in realizing the benefits of MBPPC for cancer survivors, patient education with focus on improving health literacy is critically needed, especially for patients of low socio-economic status. Third, patient activation amplifies the beneficial effect of MBPPC on health outcomes. Thus, clinicians should encourage patients to be more actively involved in their medical decision making. We call for stronger partnership between medical, community, and academic entities to empower cancer survivors with better health literacy and activation, so they can utilize MBPPC for optimal health outcomes. Finally, even when more patients opt for MBPPC, we should make extra efforts to mitigate impediments underserved populations are facing and provide targeted and culturally sensitive programs to reduce health disparities.

4.2 | Study limitations

Our study has the following limitations. First, the cross-sectional nature of the survey precludes interpreting association as causal relationship. Longitudinal studies are needed to confirm the predictive relationship illustrated in the pathway model. Second, the measure of MBPPC is limited with only 4 communication tools. The big variety of mobile-based communication channels were not captured, especially the increasingly popular areas of health information technology. Also, MBPPC is measured by a summed index of the 4 communication channels. It has limitations such as arbitrary assigning same weight to each channel. We call for more studies on better measurement of MBPPC for cancer survivors. Third, the scales for health literacy, patient activation, and emotional well-being were not cancer specific. It is desirable for future research to use scales that are standardized objective measures and validated in psycho-oncology. Fourth, we only include emotional well-being as the outcome variable in the model. We call for future research that examines other health outcomes as benefits of MBPPC, such as quality of life.

To conclude, effective patient-provider communication remains the corner stone for cancer survivors' health outcomes. The increasingly popular MBPPC provides additional communication channels but does not guarantee better health outcomes unless patients are enabled with health literacy. As access to Internet and mobile tools becomes ubiquitous, and more people enjoy the convenience of mobile-based communication, we should not assume that MBPPC is a quick remedy for patient-centered care; instead, we should design more innovative programs to promote health literacy so as to realize the benefits of MBPPC on health outcomes and to empower patients so that these benefits can be maximized. We should also pay special attention to the underserved populations with low level of health literacy; innovative and culturally appropriate programs are needed

to alleviate their barriers to eHealth adoption and to reduce health disparities.

CONFLICT OF INTEREST

None declared.

ORCID

Shaohai Jiang http://orcid.org/0000-0002-8265-9778

REFERENCES

1. Ye J, Rust G, Fry-Johnson Y, Strothers H. E-mail in patient–provider communication: a systematic review. *Patient Educ Couns*. 2010; 80(2):266-273.

2. Jiang S, Street RL. Factors influencing communication with doctors via the Internet: a cross-sectional analysis of 2014 HINTS survey. *Health Commun*. 2017;32(2):180-188.

3. National Cancer Institute. Health information national trends survey (HINTS). 2015; https://hints.cancer.gov/default.aspx. Accessed May 6, 2017.

4. Chou W-yS, Liu B, Post S, Hesse B. Health-related Internet use among cancer survivors: data from the Health Information National Trends Survey, 2003–2008. *J Cancer Surviv*. 2011;5(3):263-270.

5. Miller KD, Siegel RL, Lin CC, et al. Cancer treatment and survivorship statistics, 2016. *CA Cancer J Clin*. 2016;66(4):271-289.

6. Derksen F, Bensing J, Lagro-Janssen A. Effectiveness of empathy in general practice: a systematic review. *Br J Gen Pract*. 2013;63(606): e76-e84.

7. Jiang S. Pathway linking patient-centered communication to emotional well-being: taking into account patient satisfaction and emotion management. *J Health Commun*. 2017;22(3):234-242.

8. Basch E, Dueck AC, Rogak LJ, et al. Feasibility assessment of patient reporting of symptomatic adverse events in multicenter cancer clinical trials. *JAMA Oncol*. 2017;3(8):1043-1050.

9. Goldzweig CL, Orshansky G, Paige NM, et al. Electronic patient portals: evidence on health outcomes, satisfaction, efficiency, and attitudes: a systematic review. *Ann Intern Med*. 2013;159(10):677-687.

10. Jiang S. The role of social media use in improving cancer survivors' emotional well-being: a moderated mediation study. *J Cancer Surviv*. 2017;11(3):386-392.

11. Jiang S, Street RL. Pathway linking Internet health information seeking to better health: a moderated mediation study. *Health Commun*. 2017;32(8):1024-1031.

12. Street RL. Mediated consumer–provider communication in cancer care: the empowering potential of new technologies. *Patient Educ Couns*. 2003;50(1):99-104.

13. Ratzan SC, Parker RM, Selden C, Zorn M, Ratzan S, Parker R. National Library of Medicine Current Bibliographies in Medicine: Health Literacy. NLM Pub. No. CBM 2000-1. US Department of Health and Human Services, National Institute of Health Bethesda, MD; 2000.

14. Koch-Weser S, Bradshaw YS, Gualtieri L, Gallagher SS. The Internet as a health information source: findings from the 2007 Health Information National Trends Survey and implications for health communication. *J Health Commun*. 2010;15(sup3):279-293.

15. Rice RE, Katz JE. Internet use in physician practice and patient interaction. *The Internet and Health care: Theory, Res Pract*. 2006;149-176.

16. Hibbard JH, Stockard J, Mahoney ER, Tusler M. Development of the Patient Activation Measure (PAM): conceptualizing and measuring activation in patients and consumers. *Health Serv Res*. 2004;39(4p1):1005-1026.

17. Epstein R, Street R Jr. Pathways from communication to health outcomes: mediators and moderators. *Patient-centered Communication in Cancer Care*. 2007;39-66.

18. Hibbard JH, Mahoney ER, Stock R, Tusler M. Do increases in patient activation result in improved self-management behaviors? *Health Serv Res*. 2007;42(4):1443-1463.

19. Nelson D, Kreps G, Hesse B, et al. The health information national trends survey (HINTS): development, design, and dissemination. *J Health Commun*. 2004;9(5):443-460.

20. Champlin S, Mackert M. Creating a screening measure of health literacy for the Health Information National Trends Survey. *Am J Health Promot*. 2016;30(4):291-293.

21. Jiang S, Beaudoin CE. Health literacy and the internet: an exploratory study on the 2013 HINTS survey. *Comput Hum Behav*. 2016;58:240-248.

22. Zarcadoolas C, Pleasant A, Greer DS. Understanding health literacy: an expanded model. *Health Promot Int*. 2005;20(2):195-203.

23. Radloff LS. The CES-D scale: a self-report depression scale for research in the general population. *Appl Psychol Measur*. 1977;1(3):385-401.

24. Preacher KJ, Hayes AF. SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behav Res Methods Instrum Comput*. 2004;36(4):717-731.

25. McCoach DB. SEM Isn't just the Schoolwide Enrichment Model anymore: Structural Equation Modeling (SEM) in gifted education. *J Educ Gift*. 2003;27(1):36-61.

26. Hu L-T, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternative. *Struct Equ Model*. 1999;6(1):1-55.

27. Weiner JP. Doctor-patient communication in the e-health era. *Israel J Health Policy Res*. 2012;1(1):33

28. de Jong CC, Ros WJ, Schrijvers G. The effects on health behavior and health outcomes of Internet-based asynchronous communication between health providers and patients with a chronic condition: a systematic review. *J Med Internet Res*. 2014;16(1):e19):e19

29. Xie B. Improving older adults'e-health literacy through computer training using NIH online resources. *Libr Inf Sci Res*. 2012;34(1):63-71.

30. Kuijpers W, Groen WG, Aaronson NK, Harten W. A systematic review of web-based interventions for patient empowerment and physical activity in chronic diseases: relevance for cancer survivors. *J Med Internet Res*. 2013;15(2):e37):e37

31. Watkins I, Xie B. eHealth literacy interventions for older adults: a systematic review of the literature. *J Med Internet Res*. 2014;16(11): e225):e225

32. Ibe C, Bowie J, Roter D, et al. Intensity of exposure to a patient activation intervention and patient engagement in medical visit communication. *Patient Educ Couns*. 2017;100(7):1258-1267.

33. Hong YA, Cho J. Has the digital health divide widened? Trends of health-related internet use among older adults from 2003 to 2011. *J Gerontol B Psychol Sci Soc Sci*. 2016;72(5):856-863.

34. Ahern D, Phalen JM, Eaton CB. The role of eHealth in patient engagement and quality improvement. *eHealth Solutions for Healthcare Disparities*. 2008;75-92.