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An Ecological View of Internet Health Information Seeking Behavior Predictors: Findings from the CHAIN Study

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Abstract: *Objective*: The purpose of the study was to further elucidate proximal and distal demographic and social predictors of Internet Health Information Seeking Behavior (IHISB) among a cohort of HIV+ individuals through an ecological framework.

Methods: The Community Health Advisory & Information Network (CHAIN) project is an ongoing prospective study of a representative sample of persons living with HIV/AIDS in New York City and the Tri-County region. The study sample was drawn from a two-stage randomized technique with the clients of 43 medical and social service organizations with 693 HIV+ participants. Bivariate correlations were computed between IHISB and independent demographic variables in ecological blocks. Multivariate hierarchical logistic regression was used to test association between blocks of variables and IHISB.

Results: Among the surveyed respondents (n=645) 50.3% indicated that they used the Internet. Being above the poverty line, having less than a high school education, and having fewer neighbors were statistically significant predictors of IHISB related to HIV.

Conclusions: The benefits of accessing the Internet may influence health behavior and may be considered a target for interventions that aim to increase access to health related information online. Coupled with increased access, is the need for increased patient education interventions, and creative managed care approaches to ensure that information gleaned from online sources is interpretable and accurate in order to benefit the lives of those living with HIV/AIDS.

Keywords: Internet health information seeking behavior, PLWHA, HIV/AIDS, ecological model.

INTRODUCTION

Internet-based health interventions have been successful in managing several chronic diseases including diabetes and heart disease [1,2]. Due to the Internet's inexpensive and ubiquitous presence it has the potential to change HIV care. In addition to its direct medical applications, the Internet is a major source of consumer health information. According to a 2010 survey, 80% of Internet users in the United States engage in Internet health information seeking behavior (IHISB) [3], and 4% of all Internet searches are health-related [4].

The information technology revolution and the Internet have provided new opportunities for persons living with HIV/AIDS (PLWHA) to search for information about their diagnosis, seek out health care providers, and explore treatment and management options. Studies have shown that PLWHA and their caregivers not only demonstrate IHISB [5] but that those who do obtain information from the Internet know more about HIV disease treatments and report healthier behaviors [6]. With respect to IHISB as a specific predictor of medication adherence, several studies have shown mixed results. One study found that individuals who demonstrated IHISB were more likely to respond to HIV knowledge questions but were not more likely to report antiretroviral therapy (ART) adherence [7], while another study found increased ART adherence [8].

Despite its pervasiveness, Internet access for IHISB is not equally distributed among all groups. Evidence of a "digital divide" has been widely studied and discussed in the extant literature. In the case of PLWHA, those who are less educated, economically disadvantaged, and socially marginalized are the least likely to access the Internet [8,9]. One study published in 2001 found that 55% of English medical websites contained either incomplete or inaccurate information, and that accurate websites maintained by credible sources, were geared towards readers with higher education levels and moderate medical terminology fluency [10]. Provided that PLWHAs are more likely to have low incomes and modest educational attainment, they may be most vulnerable to misinformation.

New York City (NYC) represents a unique HIV population due to the pervasiveness of the disease. More than 107,000 New Yorkers know of their HIV diagnosis with thousands more going undiagnosed. The AIDS case rate in

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NY is three times the national average, and HIV is the third leading cause of death in the city for residents aged 35 to 64 [11].

Research exploring the potential for technology and social networking technology as an intervention among this hard to reach population needs further clarification. The purpose of the current study was to further elucidate proximal and distal demographic and social predictors of IHISB through an ecological framework. The ecological framework, first proposed by Bronfenbrenner [12], is a theory used to examine multiple levels of interrelatedness within an environment, and provides an interconnected view of study subjects and their social and built environments. The theory outlines proximal (intrapersonal and familial) level interactions to distal (policy and community) level interactions.

Research Question/Hypotheses

Based on the ecological model, what factors influence HIV related IHISB among HIV+ New Yorkers?

1. What intrapersonal level factors influence HIV related IHISB among HIV+ New Yorkers?
2. After controlling for intrapersonal level factors, what interpersonal level factors influence HIV related IHISB among HIV+ New Yorkers?
3. After controlling for intrapersonal and interpersonal factors, what organizational level factors influence HIV related IHISB among HIV+ New Yorkers?
4. After controlling for intrapersonal, interpersonal, and organizational level factors, what community and policy level factors influence HIV related IHISB HIV+ New Yorkers?

METHODS

Theoretical Framework

The Ecological model has been derived to account for the proximal and distal impacts on individual behavior change. The theory states that different environmental strata influence behavior, which sets it apart from other health behavior models and theories that focus mostly on psychological level determinants of behavior. The four core principles of ecological models as outlined by Glanz *et al*. [13] include:

1. There are multiple influences on specific health behaviors, including factors at the intrapersonal, interpersonal, organizational, community and public policy levels.
2. Influences on behaviors interact across levels.
3. Ecological models should be behavior-specific, identifying the most relevant potential influences at each level.
4. Multi-level interventions should be most effective in changing behavior.

The primary purpose of using an ecologic model to analyze the data is to categorize variables in blocks and recognize that individual variables are not acting independently. The individual is considered to be part of a larger ecology, and the layers or strata can be grouped together to predict health behavior.

Research Design and Study Setting

The Community Health Advisory & Information Network (CHAIN) project is an ongoing prospective study of a representative sample of persons living with HIV/AIDS in New York City and the Tri-County region of Westchester, Rockland and Putnam Counties., just north of New York City. Researchers from Mailman School of Public Health at Columbia University support CHAIN as part of the evaluation activities of New York City's Health and Human Services Planning Council. Its purpose is to supply systematic data from the perspective of persons living with HIV about their needs for health and human services, their encounters with the full continuum of HIV services, and their physical, mental and social wellbeing [14]. The full research design of the CHAIN study has been previously published [15], but I will provide a brief summary to provide context for the current study's analytical approach. The study sample was drawn from a two-stage randomization technique with the clients of 43 medical and social service organizations, as well as socially disconnected street-based homeless individuals, who were aware of their positive serostatus at time of enrollment in 1994. Participants were eligible for inclusion if they were 20 years of age or older. Due to the attrition rate of original participants an entirely new cohort of 693 HIV+ individuals was recruited in 2002, following the same recruitment methodology as the original cohort. The 6th round of questions from this "new" CHAIN cohort comprise the data set analyzed for the current study; information was collected from 2009 to 2011. The original study received Institutional Review Board (IRB) approval from Columbia University, with the present study receiving IRB approval from Brigham Young University.

Measures

IHISB, the outcome variable, was measured in this study through the following question: "In the past six months, have you searched the Internet for any health or HIV information? Response options were: "Yes" or "No." Because the question implies Internet utilization, our outcome variable was restricted to those respondents who previously answered yes to the question: "Do you ever use the Internet or "world-wide web"?"

Information on age, gender, race, and educational attainment was collected earlier in previous waves. To evaluate the possibility that any observed association between IHISB and demographic (intrapersonal) variables was explained by other participant characteristics and to populate our various ecological model levels, we examined additional variables as potential confounders and predictors of IHISB. Variables were selected based on logical connectedness to IHISB, and placed into their respective ecological blocks (see Tables **1** and **2**).

Covariates

All demographic characteristics are self-report and associated with the surveys as a linked file. Education was coded as a dichotomous variable indicating completion of high school, or all pre-college level course work with certification. Intravenous drug utilization (IDU), CD-4

count, health status, number of friends and family are all included in the survey. Poverty was determined by calculating income and comparing it to federal guidelines. For example, in 2011 a person living alone would be considered below the poverty line if they made less than $10,890 [16]. Having access to appropriate medical care and being associated with a religious community were similarly self-reported.

Statistical Analysis

Variables were first analyzed for missing values, and were removed if more than 10% of individual item responses were missing, not applicable, or refused to answer. Next, variables were removed from consideration if they demonstrated weak variance (less than 80%/20% for dichotomous items). At this point it became apparent that none of our selected variables for the "policy" level (4th block) in our ecological model met our cutoff and therefore this block was removed from further consideration. Next, bivariate correlations were computed between IHISB and all of the remaining variables in the ecological blocks. Variables with the highest correlation coefficient and lowest p-values were selected for further consideration in the regression model. Lastly, we used a multivariate hierarchical logistic regression to test the association between the blocks of variables in our model and IHISB. Blocks were entered into the model from proximal to distal levels.

RESULTS

Study Sample

Of 645 eligible respondents, 325 (50.3%) answered "yes" to the question: "Do you ever use the Internet…?" of these 325 respondents, there were no missing values for IHISB.

IHISB Correlates

Intrapersonal, interpersonal, and community level study sample characteristics and frequency of IHISB are shown in Table **1**.

Univariate analysis demonstrated that study respondents had a mean age of 48.5 years. Most of the respondents were male (61%) and had at least a high school diploma at the time of the first interview. More than half of the respondents reported IHISB. Compared to those without IHISB, those reporting IHISB were more likely to be male, have less than a high school degree, and have ever been an IDU. T-Cell (CD4) count was inversely related to likelihood of IHISB in the study, meaning that those participants with lower T-Cell counts were more likely to take part in IHISB, but not in a statistically significant way. Those above the federal poverty line at the time of the interview, as well as those who reported a change in their health status over the preceding 6 months were more likely to demonstrate IHISB. Compared to those without IHISB, those who reported it were more likely to have smaller social circles. Reporting inadequate medical care and being a member of a religious community were predictive of IHISB (Table **1**), but not in a statistically significant way.

Associations between IHISB and ecological blocks of variables are shown in Table 2. After entering intrapersonal variables, only those who reported being below the Federal poverty line demonstrated a statistically significant relationship with IHISB; with a roughly 30% decreased odds of accessing the Internet for HIV related information (OR 0.56, 95% CI 0.35-0.90). This association persisted throughout the entry of the remaining blocks of variables and became slightly more pronounced with entry of interpersonal (OR=0.53 95% CI 0.33-0.87) and community level blocks

Table 1. Ecological Model Variable Blocks: Study characteristics by Internet Health Information Seeking Behavior

	Internet Health Seeking Behavior	
	Yes, n=171 (53%)	**No, n=154 (47%)**
Intrapersonal		
Gender –n (%)		
Female	63 (37%)	63 (41%)
Male	105 (63%)	91 (59%)
Education–n (%)		
Less than H.S.	40 (23%)	29 (18%)
H.S. Grad	130 (77%)	125 (82%)
Ever been IDU–n (%)		
Yes	42 (25%)	26 (17%)
No	129 (75%)	128 (83%)
T-Cell Count–n (%)		
<200	36 (22%)	26 (17%)
201-350	41 (25%)	37 (25%)
351-500	41 (25%)	35 (23%)
>500	48 (29%)	52 (35%)
Poverty Line–n (%)		
Above	79 (46%)	51 (33%)
Below	90 (54%)	103 (67%)
Health status compared to 6 mo. ago–n (%)		
Better	71 (42%)	44 (29%)
Same	72 (42%)	91 (60%)
Worse	27 (16%)	18 (11%)
Interpersonal		
# Of Neighbors –mean (St. Dev.)	8.90 (12.36)	11.58 (15.10)
# Of Kin–mean (St. Dev.)	8.18 (9.90)	9.31 (11.53)
Community		
Appropriate Medical Care		
Yes	117 (68%)	111 (73%)
No	54 (32%)	43 (27%)
Religious Community		
Yes	53 (31%)	44 (29%)
No	117 (69%)	109 (71%)

Table 2. Predictors of Internet Health Information Seeking Behavior: Contributions of Each Variable block to changes in R2 (n= 325)

Variable	B	S.E.	OR (95% CI)	B	S.E.	OR (95% CI)	B	S.E.	OR (95% CI)
Gender	.288	.221	1.33 (0.87-2.06)	.294	.223	1.34 (0.87-2.08)	.311	.226	1.37 (0.88-2.13)
Less than HS Education	.563	.317	1.76 (0.94-3.27)	.644	.323	1.90* (1.01-3.59)	.650	.324	1.92* (1.01-3.62)
Ever been IDU	.323	.298	1.38 (0.77-2.48)	.316	.302	1.37 (0.76-2.48)	.325	.303	1.39 (0.76-2.51)
T-Cell Count	-.109	.105	0.88 (0.73-1.10)	-.102	.106	0.90 (0.76-1.11)	-.107	.106	0.90 (0.73-1.11)
Below Poverty Line	-.588	.243	0.56* (0.35-0.90)	-.632	.249	0.53* (0.33-.87)	-.608	.251	0.54* (0.33-0.90)
Health status	-.192	.119	0.83 (0.65-1.04)	-.200	.121	0.82 (0.65-1.04)	-.189	.122	0.83 (0.65-1.05)
# of Neighbors				-.019	.009	0.98* (0.96-0.99)	-.020	.009	0.98* (0.96-0.99)
# of Kin				-.016	.012	0.98 (0.96-1.01)	-.019	.012	0.98 (0.96-1.01)
Appropriate Medical Care							-.179	.259	0.84 (0.50-1.39)
Religious Community							.223	.281	1.25 (0.72-2.17)
R2		0.065			0.092			0.096	

Note. A hierarchical regression strategy was used in the analysis in which blocks of variables were added to the regression sequentially. R2 refers to the overall regression equation after each block has been entered into the model.
*p<.05.

(OR=0.54 95% CI 0.33-0.90). Education was not statistically significant after entry of intrapersonal variables, but with the addition of the remaining blocks of variables the lack of HS education became a significant predictor of IHISB. Those without a HS education had nearly twofold greater odds of reporting IHISB than those with a HS diploma; (OR=1.90 95% CI 1.01-3.59) after interpersonal block entry and a stronger odds ratio (OR=1.92 95% CI 1.01-3.62) after community level variables were considered. The same pattern held true for those who reported fewer neighbors, demonstrating a small but statistically significant predictor of IHISB among the respondents (OR=0.98 95% CI 0.96-0.99).

DISCUSSION

In this sample of HIV positive New Yorkers, nearly half reported IHISB. Those who accessed the Internet for HIV related information were more likely than nonusers to be less educated, above the poverty line, and have fewer neighbors. Some of these findings have been replicated in other research [7,8,17-20], but differences between our findings and those of prior studies that explored similar questions merit further discussion.

In the current study sample, respondents who indicated that they had not graduated from high school at the time of the first interview were more likely to utilize the Internet for health related information; a finding which has not been shown in previous literature [7,8,18,20]. This result only became statistically significant after entry of more distal variable blocks. This finding points to the importance of future chronic disease research related to technology utilization to incorporate an ecological approach.

The "digital divide," a term used to indicate the disparity in Internet access between groups, was evidenced by our result that those who lived above the poverty line were more likely to demonstrate IHISB. This result has been corroborated by other research on PLWHA7,8, and has been also found in research related to other chronic diseases [17,19]. Interestingly, a recent survey indicated that Internet access through mobile phones may drastically "bridge" the digital divide3, an area that should be explored in future research with PLWHA. This finding also lends weight to the argument that more aggressive steps should be taken to expand Internet access to low income and other marginalized inner-city populations, whose social determinants preclude them from full "digital citizenship" [21].

Respondents with fewer neighbors were more likely to demonstrate IHISB in the current study. This finding was in contrast to a priori hypotheses based on previous research indicating that larger social circles are correlated with both increased Internet access and IHISB. In a study on social isolates-those with reduced social circles-researchers found that social circle size was directly correlated with online health information seeking behavior [22]. Many other studies with respondent pools composed entirely of those with HIV/AIDS demonstrated similar findings, with larger social circle size being associated with higher Internet access and IHISB [7,23]. Considering the social marginalization experienced by PLWHA, this disparate finding may demonstrate participants being more willing to develop online social networks due to the semi-anonymous nature of Internet relationships.

In a study performed in 2002, Kalichman *et al.* [8] established that individuals who used the Internet to access health information demonstrated more knowledge of HIV/AIDS, than fellow Internet users who did not search for health information online. Additionally, they found that Internet users for health information were more likely to be treatment adherent and demonstrate more self-efficacy related to treatment adherence. While the current study demonstrated no statistically significant difference between IHISB and non-IHISB as to CD4 count, it is possible that this null finding is due to the inclusion of a single measure of treatment adherence (i.e. current CD4 level), and future

research would do well to include additional items to measure HIV/AIDS management.

Findings from the current study should be interpreted in light of its methodological limitations. Although we found significant evidence for the association between disparities of IHISB and blocks of demographic and social characteristics, our data relied on self-reported surveys and may not reflect actual rates of Internet use. Also, it is possible that IHISB, the main outcome variable may be perceived as a positive behavior, and respondents may be more inclined to misreport it than other variables. Additionally, the cross-sectional nature of the analysis limits causal connections based on a temporal sequence of events. Bias due to these and other limitations were mitigated by the use of highly trained interviewers.

CONCLUSION

The benefits of accessing the Internet may influence health behavior and may be considered a target for interventions that aim to increase access to health related information online. Interventions that target health and digital disparities, as to increasing Internet access and training on how to search and apply Internet research may be a valued tool in order to enhance the lives of PLWHA. Coupled with increased access, is the need for increased patient education interventions, and creative managed care approaches to ensure that information gleaned from online sources is interpretable and accurate in order to benefit the lives of those living with HIV/AIDS.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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