


# Comparative study of different SES neighborhood clinics for health literacy and internet access

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## Abstract

**Background:** As healthcare services are increasingly dependent on patient utilization of technology to effectively deliver services, the digital divide has the potential to exacerbate health disparities if health literacy and internet access present formidable barriers to patient use of technology.

**Methods:** We examined the differences in health literacy and internet access between lower and upper SES neighborhood primary-care clinics in Northeast Florida. The REALM-SF for health literacy was used to assess health literacy and census survey questions were used to assess internet and technology access, during the Fall, 2020. The clinics were affiliated with a safety-net hospital in a major city in Southeastern U.S.

**Results:** Analysis of key demographic data confirmed that the responding patients from economically disadvantaged neighborhood clinics resided in economically disadvantaged zip codes (307 responding patients lived in lower SES neighborhoods) and did have lower education levels (3% of the patients from Upper SES clinics had 11 grade or lower education, compared to 21%–29% of patients from Lower SES clinics). Patient health literacy significantly differed between clinics located in economically disadvantaged neighborhoods and clinics located in more affluent neighborhoods, with Upper SES clinics being 2.4 times more likely to have 9th grade or higher reading level. Access to internet technology was also higher in the Upper SES clinics, with 59% of respondents from Upper SES clinics versus 32%–40% from Lower SES clinics owning a computer or an IPAD.

**Conclusion:** Results of this study have important implications for patient-engaged use of digital technology for health. Healthcare and public health clinics should be aware of the difference in health literacy and internet access when implementing technology-based services, so that advances in medicine, including precision medicine and telehealth, can be disseminated and implemented with broad populations, including disadvantaged groups.

## Keywords

Health literacy, digital divide, internet access, precision medicine, primary care practice, health disparity, health equity

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## Introduction

Healthcare and public health clinical services are increasingly dependent on patient utilization of technology to effectively deliver services.<sup>1–3</sup> This past year of COVID-19 has clearly demonstrated the value and need for technology such as telemedicine<sup>4–7</sup> and patient portals for electronic health records.<sup>8–12</sup> However, technology is becoming critical for healthcare beyond the challenges imposed by the pandemic. For example, the increasingly

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important role of screening and testing for genetic conditions as part of precision medicine relies heavily on the use of computer-based technology.<sup>13–19</sup> Clearly, technology is required to analyze genomes and understand the relationships of pathogenic mutations to clinical disease, but it is also required to identify those at risk for pathogenic mutations and help manage that risk. Seemingly simple aspects as identifying risk factors, such as multigenerational family health histories, cannot be done efficiently without technology that can be employed in primary care and public health settings for maximum distribution and implementation. Yet, variations in patient literacy<sup>20–27</sup> and access to computer and internet technology<sup>28–33</sup> can present challenges to implementing these precision medicine tools in these broader settings. Although precision medicine has the potential to decrease health disparities by relying on DNA instead of intuition to assess risk, differential access to and facility with technology could unintentionally widen the care gap. Therefore, technology issues are even more relevant with respect to disadvantaged patient populations.

Although the potential benefits of precision medicine (i.e. family history, inheritance, genetic testing) for improving individual and population health are well recognized, difference in populations that could impede access to these technologies are not well recognized. The impact of health literacy screening on outcomes is questionable, particularly for specific modification for accommodations to medical interventions.<sup>20</sup> Research raises questions about variations in computer access and internet access, with little understanding of the variations from clinic to clinic or the need for mitigation for these variations, particularly down to the neighborhood level.<sup>34</sup> As we look at how to implement precision medicine into everyday primary care, it will be imperative that we are making all efforts to not leave any population behind. Therefore, we are challenged to clarify variations in patient health literacy as well as their computer and internet access. Although important for improving the broad implementation of precision medicine, these results will also allow us to maximize the quality of care provided to our patients, such as using portals for COVID-19 treatment, vaccine distribution, and deploying digital health technologies for monitoring adverse events or disease management. Illuminating the variations and needs of our patients related to accessing precision medicine technologies will enable our healthcare and public health systems to tailor patient care, education, and digital assessment tools that can be integrated into electronic information systems.

Our research question was: What are key patient capacities to utilize emerging precision medicine technology (i.e., health literacy and computer and internet access) that may impact University affiliated primary care clinics' efforts to implement emerging advances in evidence-based precision medicine?

Two hypotheses guided the development of the research plan (data collection and analysis):

Hypothesis 1: Primary Care clinics in economically disadvantaged neighborhoods will have higher rates of low literacy than the primary care clinics in more affluent neighborhoods.

Hypothesis 2: Primary Care clinics in economically disadvantaged neighborhoods will have lower rates of computer and internet access than the primary care clinics in more affluent neighborhoods.

IRB Approval: The University IRB granted approval to conduct the study.

## Methods

We convened a team of research and clinic staff to assess health literacy as well as computer and internet access among a purposive sample of patients from economically diverse neighborhood primary care clinics that were affiliated with an academic health center serving a metropolitan area of Southeastern USA. Specifically, we tested and refined a minimally disruptive process for assessing patient health literacy and computer and internet access within selected primary care clinics, located in both more affluent and more economically disadvantaged neighborhoods. This was accomplished during the COVID-19 pandemic requiring some adaptations to the normal protocols to ensure COVID-19 safety rules were accommodated. However, it also provided some key lessons learned for conducting clinic-based research in a pandemic, while protecting patients, clinicians, and research staff from infectious disease spread.

## Sample populations

We used purposeful sampling<sup>35,36</sup> or purposive sampling<sup>37</sup> of clinics that constituted nonrandom (purposive) clusters of patients, enabling us to compare patients from the economically diverse neighborhoods served by the University based primary care practices. Purposeful sampling enables researchers to sample a population that is rich in the characteristics that are of concern and best addresses the study concern, in this case, economic differences in the patients served by the health system. Data collection and analysis procedures (see later sections) were also instituted to confirm that the patients were from both economically advantaged (Upper SES) and disadvantaged (Lower SES) neighborhoods. The disadvantaged neighborhood clinics were located in what had been identified by the local Health Department as Health Zone 1, a 6 zip-code part of the city/county that is 80% minority residents with high poverty rates and prevalent health disparities.<sup>38,39</sup>

Patient selection within the clinics started in the morning of clinic operations as early as data collection could be

arranged, following: IRB approval, training of the patient navigators (PNs), and coordination with clinic administrators. Following the beginning of data collection, patients were systematically seen in the clinic settings as they presented for medical appointments. High priority was given to provide minimal disruption to clinic practice as well as reduce the potential for the spread of COVID-19 infection, which required data collection procedures (patient interviews) to be highly tailored to each clinic's physical and workflow procedures. A power estimate calculated that 574 patients would be needed to determine the difference in health literacy using a sampling error of 3% based on the data presented in the validation study for the REALM-SF.<sup>40</sup>

Early in the execution of the study, it became clear that one of the economically disadvantaged neighborhood clinics was an outlier concerning the use of technology. Despite having socioeconomic challenges (49.5% of the patients with Medicaid as their insurer), this clinic leads the University Health system with 95% of their patients active on their patient portal. This clinic has been able to overcome barriers to patient use of technology by making patient portal and telemedicine training part of each visit for patients who are not currently using the patient portal (all patients are encouraged to use the patient portal to set up their online accounts prior to checking out).<sup>41</sup> To increase the use of the patient portal, this clinic's staff look for opportunities to use telemedicine to communicate with patients about their concerns and results to keep them engaged related to chronic diseases. They have expanded their access to early mornings and weekends to allow for their patients to be able to access their telehealth appointments at times beyond a typical workday. This clinic has also identified a key member of their staff for training and troubleshooting all technology issues. They also have a medical director who has been instrumental in having a vision and a high priority for improving their community through technology, and they have monthly meetings as a group to look at ways to improve. Consequently, this clinic, identified throughout this report as the Technology Mitigated Lower SES clinic, was treated as a third type of clinic and another disadvantaged neighborhood (Lower SES) clinic was added to the study to replace this clinic as a representative clinic of an economically disadvantaged neighborhood clinic.

### Data collection

Three data collection instruments were used to obtain data from each patient. These instruments were administered by community health workers/PNs who were trained to inform the patients of the study and obtain their verbal consent to participate in the study. The IRB\*\*\* approved a waiver of written consent because of anonymous recording of each patients' information including very limited demographic information. The data collection instrument

for health literacy was the REALM-SF.<sup>40</sup> This form consists of 9 items of which 2 are unscored single syllable words and 7 are multiple syllable words, which are scored to determine reading level. The REALM-SF form was rigorously validated<sup>40</sup> and was considered ideal for collecting health literacy data with minimal disruption to clinic workflow. The computer and internet access questions were replicated from the items on the US Census Bureau, American Community Survey.<sup>42</sup> Demographic questions were constructed from items used with other studies, but with an emphasis on avoiding patient privacy issues that would require greater human subject protections.

PNs were introduced to the patients by clinic staff at which time patients were provided the opportunity to decline participation in the study in addition to the opportunity to decline after the study was explained.

The data collection processes were field tested with the PNs who collected patient responses. Patient Navigators is a term used locally to apply to community health level workers who have been trained to handle patient personal information and function in clinical settings. The PNs asked the patients structured closed-ended questions about computer/internet access and demographic characteristics and the responses were entered into IPAD devices containing REDCap. Patients were handed the REALM-SF vocabulary list and asked to read each item, whereupon the PN entered the positive responses in the IPAD/REDCap if the patient was able to pronounce the term correctly, per the REALM-SF Procedures.

In addition to data collection being kept to a minimum to limit disruptions to clinic workflow, data collection was also challenged by the need to protect patients, clinic staff and research staff from unnecessary contact that might increase the spread of COVID-19 infection. Research staff worked with each clinic to develop the process for clinic staff to introduce the patients to the PNs and identify designated locations for conducting the interviews/data collection process. Initially, the proposed process had each clinic develop its own procedures for patient interviews related to the primary care visit either while waiting to see the provider or at the conclusion of the visit. Prior to launching the study, a decision was made to conduct data collection at the conclusion of the visit to facilitate provider assessment of the patients potential to spread COVID-19. When adequate screening processes for COVID-19 were in place upon admission, and when it was clear that refusal appeared to be high after completed provider visits, data collection was revised to permit data collection upon admission while waiting to see the provider. Each time a change was made, it was not implemented until presented to and approved by the IRB.

*Qualitative Data:* This study presented numerous challenges for collecting information from patients during the COVID-19 pandemic. In particular, the data collection processes were adapted for both the need to protect the safety of patients, clinicians, and researchers as well as maintaining

patient flow within primary care clinics, and avoiding burdens on already overtaxed staff. It was also important to avoid impeding revenue collection for safety-net hospital-affiliated clinics that were financially stressed.

## Analysis

Data were summarized using counts and percentages. Patients' characteristics, health literacy and computer and internet access, respectively, were compared across the three types of clinics (Lower SES neighborhood clinics, Upper SES neighborhood clinics and Technology Mitigated Lower SES clinics) using the Chi-square tests or the Fisher's exact tests. To estimate the magnitude of differences in health literacy across the three types of clinics, the level of health literacy was dichotomized to ninth grade or higher versus lower than ninth grade. Simple logistic regression was used to compare the odds of having a ninth grade or higher level of health literacy across the three types of clinics. The magnitude of the differences were estimated using the odds ratios (OR) along with their 95% confidence intervals (CI). All analyses were done in SAS® for Windows Version 9.4.

Qualitative data in the form of notes that key research staff took on the challenges and adaptations that were required to maintain safety and adapt to each clinic's unique physical and patient flow structures were synthesized and summarized for "lessons learned" or implications for future primary care clinical research with patient populations.

## Results

### Participation and refusals

Four clinics were initially selected to participate in the study. Two others were added to address challenges that emerged in two of the original clinics. One clinic (Clinic A), in a more affluent area outside of but adjoining the county where the

main safety-net hospital is located, had very high (59%) refusal rates making representativeness of the responding 41% highly questionable (see Table 1). Reasons for high rates of refusal for patients in this clinic were not discernible with the available data but were extremely inconsistent with the other clinics. After four days of data collection, this site was discontinued and another clinic (Clinic B) in a more economically advantaged part of the county with the disadvantaged neighborhood clinics was selected and approved by the IRB for inclusion in the study. The lower SES Technology Mitigated clinic (previously described in the Sample Populations section) formed the third category of neighborhood clinics.

Participation by clinic is displayed in Table 1, including refusals to participate. The study did collect data from 809 patients, with the goal of 150 patients from each clinic based on a power estimate that was conducted prior to the execution of the study. The lower SES clinics had a total of 312 patients completing the study and the upper SES clinics had a total of 329 patients, with 154 patients participating from the lower SES Technology Mitigated clinic. After excluding Clinic A (14 patients), 4 patients did not have the capacity to participate (could not see, did not have glasses, two patients who could not read words), 791 records were analyzed.

### Demographic differences among clinics

Analysis of the demographic data shows that the patients for the Lower SES neighborhood clinics and the Lower SES Technology Mitigated clinic were predominantly from Health Zone 1 (80% African American urban core with high rates of health disparities),<sup>40,42</sup> whereas the two higher SES neighborhood clinics were predominantly from more affluent health zone or area out of the county ( $p = .001$ ). See Table 2 for counts and percentages for differences in Health Zone residence. Similarly, education levels were significantly different ( $p = .001$ ) between the upper SES clinics (3% with 11 grade or lower education levels) compared to the lower SES clinics (21% with 11 grade or lower) and the lower SES Technology Mitigated clinic (29% with 11 grade or lower SES).

Difference in health literacy was also observed as measured by the REALM-SF. See Table 3 for counts and percentages. Additionally, the OR analysis provides inferences for the magnitude of the difference. The participants from Higher SES neighborhood clinics were 2.4 times more likely to have ninth grade or higher reading level as compared to participants from Lower SES neighborhood clinics (OR = 2.40, 95%CI 1.61, 3.58). Similarly, the participants from Lower SES Technology Mitigated neighborhood clinic were 3.5 times more likely to have ninth grade or higher reading level as compared to participants from Lower SES neighborhood clinics (OR = 3.53, 95%CI 1.96, 6.36). However, there was no difference in the odds of having ninth grade or higher reading level between participants

**Table 1.** Participation and refusal by clinic.

Clinic	Number completed	Number declined	Number days of pt. navigator in clinic
A	14	20	4
C	154	30	9
L	157	25	18.5
W	153	37	21
S	155	0	8.5
B	176	38	9
Total	809	150	70

**Table 2.** Patient demographic characteristics among the three types of neighborhood clinics: higher SES neighborhood clinic, lower SES neighborhood clinic and technology mitigated lower SES neighborhood clinic. Data are counts (percentages).

Variable	Category	Higher SES	Lower SES	Technology mitigated Lower SES	Overall	p value
Health zone	1	16 (5)	200 (65)	91 (59)	307 (39)	<.001
	2	19 (6)	11 (4)	5 (3)	35 (4)	
	3	82 (25)	1 (0)	1 (1)	84 (11)	
	4	8 (2)	24 (8)	31 (20)	63 (8)	
	5	10 (3)	50 (16)	15 (10)	75 (9)	
	6	2 (1)	1 (0)	0 (0)	3 (0)	
	Outside of Duval County/Jacksonville City	188 (58)	23 (7)	12 (8)	223 (28)	
Education	11th grade or less or no school	10 (3)	63 (21)	43 (29)	116 (15)	<.001
	12th grade/ High school diploma/Equivalent (GED)	84 (26)	133 (44)	65 (44)	282 (37)	
	AA or bachelor or graduate degree	167 (52)	48 (16)	16 (11)	231 (30)	
	Vocational or some college	58 (18)	59 (19)	25 (17)	142 (18)	
Ethnicity	No	294 (92)	297 (96)	149 (96)	740 (95)	0.112
	Yes	24 (8)	13 (4)	6 (4)	43 (5)	
Gender	Female	187 (58)	234 (75)	105 (68)	526 (67)	<.001
	Male	138 (42)	76 (25)	50 (32)	264 (33)	
Race	African American	88 (27)	243 (79)	110 (72)	441 (56)	<.001
	Asian	36 (11)	5 (2)	1 (1)	42 (5)	
	Other	29 (9)	22 (7)	9 (6)	60 (8)	
	White	169 (52)	39 (13)	33 (22)	241 (31)	

All tests done using Chi-square test.

from Higher SES neighborhood clinics and participants from Technology Mitigated Lower SES neighborhood clinic (OR = 0.68, 95%CI 0.37, 1.26).

### Computer and internet access

Many of the internet and computer access questions did not yield statistically significant results (see Tables 4 and 5). However, of particular note in these results was the difference in Wireless Computer/IPAD ownership where 59% of upper SES neighborhood clinic patients indicated ownership, but only 40% of the lower SES neighborhood clinic patients and only 32% of the lower SES Technology Mitigated clinic patients indicated ownership (See Table 5). There were also

some significant differences (See Table 4) in prepaid cellular data plans.

### Conclusions

The results of this study provided some clear conclusions, including:

1. The demographic data confirmed that patients in higher SES neighborhood clinics were statistically different in education, ethnicity, health zone residence, and several other characteristics than lower SES neighborhood clinics.
2. Wireless computer/laptop access was statistically different for the lower vs upper SES neighborhood clinics.

**Table 3.** Health literacy among the three types of neighborhood clinics: higher SES neighborhood clinic, lower SES neighborhood clinic and technology mitigated lower SES neighborhood clinic. Data are counts (percentages).

Variable	Category	Higher SES	Lower SES	Technology mitigated lower SES	Overall	<i>p</i> Value
Reading level	Third grade or less (0)	2 (1)	3 (1)	1 (1)	6 (1)	<.001
	Fourth to sixth grade (1-3)	1 (0)	11 (4)	1 (1)	13 (2)	
	Seventh to eighth grade (4-6)	42 (13)	72 (23)	13 (8)	127 (16)	
	Ninth grade or higher (7)	281 (86)	224 (72)	139 (90)	644 (81)	

All tests done using Fisher's exact test.

Scores were categorized as third grade or less (0), fourth to sixth grade (1-3), seventh to eighth grade (4-6), and ninth grade or higher (7).

- Health literacy level was statistically different between the higher and lower SES neighborhood clinics.
- These clinics were University-based primary care clinics whose patients appear to have higher education levels than other studies of safety-net hospital patients that use the hospital<sup>43</sup> and ED,<sup>44</sup> perhaps because they lack insurance that enables them to access primary care.
- Clinicians should be aware that even higher SES patients may have limitations related to health literacy level and computer access.
- The COVID-19 pandemic presented a number of challenges on top of the previously existing economic and political pressures for safety-net hospital-based, University affiliated primary clinics.

### Limitations

The use of purposeful sampling provided procedures to answer the research question but limited generalizability to other populations. The study was effectively designed to measure variations in primary care neighborhood clinics for health literacy and internet access, but the uninsured urban population that does not have access to primary care clinics was not included in this sample. Also, although smartphones are ubiquitous, even in low SES environments, internet access is critical for deploying technology for healthcare into the home environment. The census survey questions provided standardized questions for assessing internet and computer access but appeared to be insensitive to the extra data charges that accompany some cell phone plans and may pose major barriers to use of technology to enhance medical services. Development of more sensitive questions may be critical to provide insights to the barriers that patients may experience in trying to access medical services through internet exchanges. The demands of the pandemic and a highly contentious political environment required adjustment to be made in data collection similar the adaptations to community participation associated with Action Research,<sup>45</sup> or more applied science approaches to Implementation Research.<sup>46</sup>

Another limitation was the problem with high refusal rates in one of the initially selected primary care clinics. The high refusal rate undermined any inferences related to this population since the patient characteristics of the refusing or participating patients could not be determined, and continued inclusion of this clinic would have undermined the results. Consequently, another economically advantaged neighborhood clinic was selected, where participation did support drawing inferences from the results. The economically advantaged clinic with high refusal rates did provide important lessons learned despite introducing limitations for this study. In particular, this clinic illustrated that patients of a more economically advantaged neighborhood can also have the reluctance to participate in health science studies, a problem frequently attributed to minority disadvantaged populations.

### Adaptations and lessons learned

The following "lessons learned" or implications for future primary care clinical research with patient populations are summarized from the managing researchers.

- During field testing, it was determined that the census Community Survey questions on patient access to computer and internet access needed to be defined further to be accurately counted. The internet providers that were available in the community were researched and added to the different options in REDCap, so that the patients would have a clearer understanding of the question. The patient navigators were then trained further on how to determine the accurate response with these lists as reference.
- Constant communication is needed to refine the research process to be minimally disruptive to the existing clinical set-up without sacrificing the integrity of the research. This was crucial for this study, which was done in several primary care clinics with different processes in place, and during the COVID-19 pandemic,

**Table 4.** Internet access among the three types of neighborhood clinics: higher SES neighborhood clinic, lower SES neighborhood clinic and technology mitigated lower SES neighborhood clinic. Data are counts (percentages).

Variable	Category	Higher SES	Lower SES	Technology mitigated lower SES	Overall	p Value
At your residence, do you or any member of your household have access to the internet?						
Internet_access	No access to the internet at this residence (house, apartment, or mobile home)	15 (5)	10 (3)	3 (2)	28 (4)	.177
	Yes, WITHOUT paying a cell phone company or internet service provider	7 (2)	8 (3)	0 (0)	15 (2)	
	Yes, by paying a cell phone company or internet service provider	303 (93)	289 (94)	151 (98)	743 (95)	
Internet using cellular data plan for smartphone or other mobile device	Yes (using Sprint, T-Mobile, Verizon, AT&T, pre-paid plans:)	190 (58)	174 (56)	65 (42)	429 (54)	.002
	No	136 (42)	136 (44)	90 (58)	362 (46)	
Internet using broadband (high speed) internet service such as cable, fiber optic or dsl service in your household	Yes (using AT&T, Xfinity/Comcast, Verizon Fios, EarthLink, Cox, Mediacom, MegaPath, Townes)	157 (48)	151 (49)	82 (53)	390 (49)	.601
	No	169 (52)	159 (51)	73 (47)	401 (51)	
Internet using a satellite internet service installed in your household	Yes (yes using Viasat/Exede, EarthLink, HughesNet)	5 (2)	17 (5)	5 (3)	27 (3)	.023
	No	321 (98)	293 (95)	150 (97)	764 (97)	
Internet using DIAL UP INTERNET SERVICE installed in your household	Yes (using AOL, NetZero)	0 (0)	4 (1)	2 (1)	6 (1)	.067*
	No	326 (100)	306 (99)	153 (99)	785 (99)	

All tests done using Chi-square test, unless otherwise specified by \*Fisher's exact test.

- for which new protocols were instituted at the clinics for the safety of all. This was not limited to verbal conversations, but also included emails, and data exchange for the stakeholders to maximize agility in decision making. Involving the various stakeholders in the conversations about the processes as they are implemented is also vital to adapting to the realities of each clinic environment for the successful completion of the study.
- In this study, with the constant communication among the research and clinic staff, it was determined that participant enrollment increased by not limiting the research

interaction only to after the visit is done, but by allowing the research staff to conduct the surveys at any time after the patient is checked-in until after being seen by the provider. With continuous communication, the clinic staff was reassured that contrary to initial fears, this had minimal disruption of clinic operations.

- Conducting research in clinical setting entails buy-in not just from the medical director of the clinic but also from the clinic staff. The medical director's directives and attitude towards the research sets the tone in the acceptance of conducting the research in the clinic, however, the

**Table 5.** Computer access among the three types of neighborhood clinics: higher SES neighborhood clinic, lower SES neighborhood clinic and technology mitigated lower SES neighborhood clinic. Data are counts (percentages).

Variable	Response	Higher SES	Lower SES	Technology mitigated lower SES	Overall	<i>p</i> Value
Any member of your household own	Yes	270 (83)	216 (70)	85 (55)	571 (72)	<.001
or use any desktop or laptop	No	56 (17)	94 (30)	70 (45)	220 (28)	
Any member of your household own	Yes	289 (89)	282 (91)	120 (77)	691 (87)	<.001
or use a smartphone	No	37 (11)	28 (9)	35 (23)	100 (13)	
Any member of your household own	Yes	191 (59)	124 (40)	50 (32)	365 (46)	<.001
Tablet or other portable wireless computer (e.g., ipad, surface)	No	135 (41)	186 (60)	105 (68)	426 (54)	
Any member of your household does	Yes	11 (3)	9 (3)	9 (6)	29 (4)	0.273
Not own or use any type of computer	No	315 (97)	301 (97)	146 (94)	762 (96)	

All tests done using Chi-square test, unless otherwise specified by \*Fisher's exact test.

relationship-building skills of the research staff who interact with the clinic staff are also very important in encouraging active participation from all the clinic staff.

5. Training is vital for the research staff as well as the clinic staff for the smooth implementation of the study. Clearly defining the roles of the research and staff members prevents errors and alleviates staff frustration. Conducting initial clinic visits and dry runs for each clinic helped both research and clinic staff to generate and navigate the changes needed to existing workflows to incorporate the research protocol into the current clinic processes.

## Implications

### *Implications for broad implementation of precision medicine*

Results of this study are immensely valuable and provide insight into the technological abilities and limitations for both high and low SES primary care clinics. Importantly, there were many similarities across the clinics. For example, in both high and low SES clinics, the vast majority had a ninth grade or higher reading level (81% overall) and 97% read at a seventh grade or higher level. In addition, very few (4% overall) did not have access to internet at their residence. We have known from census data for some

time that smartphones are ubiquitous, even in low SES environments. However, internet access is critical for deploying technology for public health and healthcare into the home environment. With this as a baseline, it's clear that technology access should not be an impenetrable barrier to implementing precision medicine in public health or healthcare clinics; however, the differences between clinics highlight the nuances with which implementation will need to proceed. For example, differences related to ownership of computers versus mobile devices, charges for data access, and mobile versus broadband data streams suggest a need for mobile friendly applications, offline access, and small data footprints. In addition, they enable healthcare providers to tailor support to each individual, to ensure all patients benefit from the emerging tools of precision medicine. These findings are promising and support the premise that precision medicine can be implemented in a broad range of neighborhood healthcare and public health clinics but needs to be done carefully to avoid widening the disparity gap.

### *Implications for population health informatics*

The lower SES neighborhood Technology Mitigated Clinic had previously achieved higher access to the patient portal for EHRs,<sup>41</sup> demonstrating that healthcare and public health clinics can mitigate the disparities caused by the digital



divide. Other clinic adjustments, informed by these findings, which can be made to reduce the impact of the digital divide are:

- Patients screened for low literacy or lack of internet access may need to be provided in-home visits by community health workers (CHW) with IPADS;
- Develop tailored education for patients with low literacy to improve confidence in using technology for their health;
- Adopt policy changes for health data to accommodate cell phone use (e.g., no charge for health data);
- Adapt screening tools for use on cell phones/mobile technology that are easy to access and use;
- Consider mitigation for literacy and access for all clinics since some level of low literacy and access were present in all clinics;
- Develop more sensitive questions to provide insights to the barriers that patients may experience in trying to access medical services through internet exchanges.

Application of technology for precision medicine screening offers considerable promise for broad distribution and implementation of precision medicine but should also consider issues that disadvantaged populations can have in accessing that technology.

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**Contributorship:** WL, CS (DO), and LO conceived of the study or elements of the study. WL, CS (DO), MB, and CS (MS) developed the preliminary data collection and analysis plan. CS (DO), WL, and MB worked with DA, JC, RG, and ES to develop site specific data collection plans. WL, CS (MS), CS (DO), and MB conducted preliminary data analysis. All authors contributed to final analysis and conclusions. Preliminary draft of the manuscript was developed by WL, CS (DO), CS (MS), and MB, with LO, DA, JC, RG, and ES providing additional text and edits. All authors reviewed and approved a final version of the manuscript. Other substantial contributions were provided by faculty and staff of the Office of Research Affairs, University of Florida College of Medicine-Jacksonville and clinic staff whose support was essential to complete the study.

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**Ethics approval:** This study was reviewed and approved (IRB202000508) by the University of Florida, Human Subjects Research Institutional Review Board (IRB). The University of Florida Human Subjects Research IRB waived a signed written

Informed consent based on Implied consent and minimum risk. All methods were performed in accordance with the relevant guidelines and regulations. The raw data for this study are archived in protected files for health equity research within the Center for Data Solutions, Office of Research Affairs at the University of Florida, College of Medicine-Jacksonville, and are available from the corresponding author on reasonable request.

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