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## Hearing Screening in Older Adults in Primary Care Clinics: How the Effects of Setting and Provider Encouragement Differ by Patient Sex and Race

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### Abstract

**OBJECTIVES:** Few studies have examined how patient sex or race influence hearing healthcare, which was our study purpose.

**DESIGN:** We performed a secondary analysis using data from a pragmatic clinical trial that examined the effect of provider encouragement (yes/no) or setting (at-home/clinic) for older adults to follow through with routine hearing screening in primary care and the hearing healthcare pathway. Three protocols were compared: at-home screening without provider encouragement, at-home screening with provider encouragement, and in-clinic screening with provider encouragement.

**RESULTS:** Poisson regression (n=627) showed few differences by patient sex but showed that Black patients in the at-home protocols were less likely to schedule or complete a formal diagnostic evaluation after a failed screening compared to Black patients in the clinic setting and White patients in all groups. Black patients, regardless of provider encouragement, were less likely to schedule or complete a diagnostic evaluation compared to White patients.

**CONCLUSIONS:** Results suggest that in-clinic screenings may increase the use of hearing healthcare for Black patients.

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## INTRODUCTION

Although hearing loss is among the most common chronic health conditions in U.S. older adults (reported by 27% of those aged 65–74 and 45% of those aged 75 and older) (CDC, 2017), utilization of diagnostic and therapeutic hearing healthcare is limited. The majority of older adults with hearing loss are undiagnosed and untreated – most older adults are not asked about their hearing during healthcare visits, are not regularly screened for hearing loss, and have never had their hearing tested (NASEM, 2016; Nieman et al., 2016; Wallhagen & Pettengill, 2008). Even when they do undergo appropriate screening and referral in primary care clinics, there is poor adherence to recommended treatment (NASEM, 2016; Nieman et al., 2016). This is particularly problematic because hearing loss is independently associated with several negative social, occupational, emotional, and physical health outcomes (Livingston et al., 2024; Shukla et al., 2020) (Riska et al., 2022; West et al., 2022).

Recent changes in healthcare policy and legislation in the U.S., including over-the-counter hearing aids (Food and Drug Administration, 2022), have resulted in a surge in interest and research in the realm of hearing healthcare. However, hearing screenings are currently not routinely performed and the U.S. Preventive Services Task Force (2021) concluded that there is insufficient evidence to assess the benefits and harms of universal hearing screening for asymptomatic adults over 50 years of age. One of the research gaps identified by the task force is evidence of the impact of hearing screening among diverse subpopulations. In addition, national reports have issued calls to increase the affordability and accessibility of hearing healthcare, with a specific focus on alternative and innovative means to deliver hearing healthcare to economically disadvantaged and racial/ethnic minority groups (NASEM, 2016; PCAST, 2015). In response to these noted gaps, the current study examines sex and race differences in the role of setting (home versus clinic) and primary care provider encouragement for engagement with the hearing healthcare pathway, namely, completing a hearing screening and, among those who fail, scheduling and completing a diagnostic evaluation.

### Hearing Healthcare Use by Sex and Race

Sex and race differences were examined because decades of research have documented how social factors contribute to sex and race differences in health outcomes in the U.S. (Chen et al., 2005; Williams et al., 2010). In terms of hearing healthcare, previous research has shown that females may adopt hearing aids slightly sooner than men (delaying 8.7 years versus 9.0 years, respectively) and are 78% more likely to adopt hearing aids than men (Simpson et al., 2019). Moreover, females tend to report a higher prevalence of daily, regular hearing aid use than men (Reavis et al., 2023; Staehelin et al., 2011). In terms of race, non-White<sup>1</sup> adults report lower use of hearing aids (10%–17%) compared to White adults (29%–35%) and a longer time to adopt hearing devices from diagnosis (15.2 years versus 8.6 years for White adults) (Bainbridge & Ramachandran, 2014; Nieman et al., 2016; Simpson et al.,

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<sup>1</sup>We use the term “non-White” here given the heterogeneity in which prior research has discussed race/ethnicity.

2019). This evidence highlights the importance of improving engagement with the hearing healthcare pathway, especially for male patients and Black patients.

### **Hearing Healthcare Use: Setting**

Patient sex and race may impact the hearing healthcare pathway based on the setting (clinic versus home) in which the screening occurs. Prior research has tended to characterize male patients as reluctant or unwilling to seek help from medical professionals when they experience a health problem (e.g., prostate cancer, coronary heart disease, mental health problems), with the subsequent delay in receiving timely advice resulting in lower chances of males receiving early detection, treatment, and disease prevention (Addis & Mahalik, 2003; O'Brien et al., 2005). In contrast, female patients are more likely to utilize health services and seek help from health professionals for mental and physical health concerns (Galdas et al., 2005). Based on this prior literature, we hypothesize that male patients may be more willing to engage with the hearing healthcare pathway when doing so from the privacy of their own home, whereas female patients may be comfortable in the clinic setting.

As for race, Black Americans tend to report greater distrust of physicians compared to White Americans (Armstrong et al., 2007). In a nationally representative survey on experiences of discrimination, non-Hispanic Black adults reported that they sometimes avoid seeking healthcare for themselves or their family members due to the anticipation of experiencing discrimination in the clinical encounter (Bleich et al., 2019). However, among Black Americans who present for primary care, it is unknown what factors influence their engagement in hearing screening and subsequent hearing intervention. Given distrust of the clinical setting, Black patients may be more likely to adhere to the hearing healthcare pathway in the home setting whereas White patients may be comfortable in the clinic setting.

### **Hearing Healthcare Use: Provider Encouragement**

Provider encouragement for hearing screening may also be differentially important depending on patient sex and race. While a “referral” is the act of directing a patient to a different place or person (e.g., to a medical specialist) for information, help, or action, “provider encouragement” refers to the act of motivating patients to actively participate in their own care by ensuring they have the knowledge, skills, and resources to manage their health, which can be achieved through effective communication, education, and support (Haskard Zolnierok & Dimatteo, 2009; Li et al., 2023; Robles & Kuo, 2022; Shimoga & Lu, 2019). Prior research has shown that encouragement from healthcare providers has a significant and positive impact on patient engagement with healthcare, including hearing and cancer screenings (Bennett et al., 2020; Carraise-Edinboro & Bradley, 2008; Peterson et al., 2016). For example, in a scoping review, Bennett et al. (2020) found that when primary care providers implemented hearing screening programs, the detection rate of hearing loss increased as did the number of patients who received hearing loss interventions. As such, primary care providers can be a crucial mechanism for guiding appropriate and timely choices to address hearing concerns.

However, female patients are more likely to report receiving provider encouragement than males, as noted in a study on provider encouragement to increase utilization of patient portals (Shimoga & Lu, 2019). Moreover, males tend to view provider encouragement as patronizing, especially in mental health care (Kwon et al., 2023). Together, this research suggests that provider encouragement may be more effective in engaging female patients with the hearing healthcare pathway. In a different study of patient portal access, Black and Hispanic individuals were less likely to report receiving provider encouragement than White individuals (Richwine et al., 2022). Such a finding is problematic because provider encouragement has been shown to be important for improving adherence and treatment outcomes for Black cancer patients (Song et al., 2012). Therefore, provider encouragement may be an important tool for engaging Black patients with the hearing healthcare pathway.

### Current Study

The current study draws on data from a previously conducted multi-site, pragmatic clinical trial that examined the primary care encounter as a potential key setting to improve use of the hearing healthcare pathway. The primary goal of the pragmatic clinical trial was to compare the location of the hearing screening (in-home versus clinic) and primary care provider encouragement (yes or no) to understand what factors are important for encouraging older adults to complete a routine hearing screening and follow through with adherence to the hearing healthcare pathway following hearing screening. We extend this analysis by investigating whether there are differences in these behaviors by patient sex or race.

## MATERIALS AND METHODS

### Study Design

Data from this study come from a previously conducted parent pragmatic clinical trial study that has been described in detail elsewhere (Bettger et al., 2020; Dubno et al., 2022; Smith et al., 2023). In brief, pragmatic clinical trials are designed to overcome barriers to translation experienced by explanatory clinical trials, which are generally performed to assess intervention efficacy among highly selected patient samples under stringently controlled conditions (Schwartz & Lellouch, 1967). Results from a pragmatic clinical trial aim to guide clinical decision-making, promoting the integration of an intervention into practical clinical settings. Because the focus of pragmatic clinical trials is to recruit typical patients who would receive the intervention under study from a routine clinical provider during standard clinical practice, these types of trials often have limited inclusion/exclusion criteria, unblinded randomization, and unobtrusive data collection (Ford & Norrie, 2016).

A pragmatic clinical trial study design was selected for the parent study to assess if older adults (aged 65–75 years) would complete a routine hearing screening after a routine visit with a primary care provider. As such, the study recruited typical patients during their usual clinical encounters with primary care providers. Clinical sites were not randomized to the study protocols to ensure that each protocol was easy to adopt in the clinic setting and the least obtrusive to standard clinical workflow. Data collection procedures for the patient and the primary care provider were also kept to a minimum to further ensure that the study was

as unobtrusive as possible. More details about the study rationale and procedures can be found elsewhere (Bettger et al., 2020; Dubno et al., 2022; Smith et al., 2023).

The parent pragmatic clinical trial tested what level of provider encouragement is required to inform and encourage older adults to follow through with a self-administered telephone-based hearing screening (Watson et al., 2012) by comparing three settings:

- a. hearing screening at-home with instructions but no provider encouragement,
- b. hearing screening at-home with instructions and provider encouragement, and
- c. hearing screening in-clinic with instructions and provider encouragement.

All three protocols employ a self-administered telephone-based digits-in-noise test with reported good sensitivity and specificity (0.80 and 0.83, respectively) that uses pure-tone average >20 dB HL as the criterion measure (Watson et al., 2012; Williams-Sanchez et al., 2014). The provider encouragement strategy entailed the primary care provider reading a brief script informing patients that they would receive a free hearing screening and that a failed screening would result in a free formal diagnostic assessment. The script also explained the importance of early identification of hearing loss and the negative impacts of hearing loss.

Patients were recruited from six primary care clinics (three Family Medicine and three Internal Medicine) at the Duke University Health System. Each of the three screening groups included one Family Medicine clinic and one Internal Medicine clinic. Patients in each protocol were given an educational brochure that provided written materials regarding the impact of hearing loss on communication and instructions for completing the self-administered telephone-based hearing screening. Inclusion criteria were: 1) patients being seen for annual or non-acute follow-up primary care appointments, 2) patients were at least 65 years old (to ensure all patients were Medicare-eligible), and 3) patients were no more than 75 years old (to limit the number of patients that would be excluded due to prior history of hearing loss diagnosis or hearing aid use). Exclusion criteria included: 1) self-report of hearing loss and/or prior evaluation by an audiologist within the past five years and 2) current/prior history of using hearing aids.

### **Patient Sample**

A total of 660 patients participated in the parent pragmatic clinical trial (n=220 per protocol). Demographic information was collected via a self-administered checklist prior to the PC appointment. Age is a continuous variable ranging from 65–75 years; self-reported sex is a dichotomous variable (male=0, female=1); self-reported race/ethnicity included more than one race/ethnicity, American Indian or Alaska Native, Asian, Black/African American, Hispanic or Latino, Native Hawaiian or other Pacific Islander, White/Caucasian, and Unknown/prefer not to answer. Due to small sample sizes, the current analysis is limited to patients who self-reported as non-Hispanic Black/African American (hereafter referred to as Black) or as non-Hispanic White/Caucasian (hereafter referred to as White), resulting in a final sample size of 627 patients.

## Analytic Strategy

Overall distributions of study variables were calculated for the total sample. To examine the impact of setting, we combined the two at-home protocols and compared them to the clinic protocol. To examine the impact of provider encouragement, we compared the two home protocols to one another. There were three binary outcomes of interest in the study: whether patients 1) completed the telephone-based hearing screening within 60 days of a routine primary care visit and, among those who failed the screening, 2) scheduled, and 3) completed a diagnostic evaluation. To examine sex and race differences in the three study outcomes as a function of setting and provider encouragement, we estimated multivariable-adjusted incidence rate ratios and 95% confidence intervals using Poisson regression models with robust standard errors (Barros & Hirakata, 2003) using the *poisson* command in Stata 17.0 (StataCorp, 2021). We graph the results in the form of predicted probabilities using the margins command in Stata holding all other covariates at their means (Long & Mustillo, 2021).

## RESULTS

### Descriptive analysis

Each protocol included roughly one-third of patients: at-home screening with no provider encouragement n=209, at-home screening with provider encouragement n=208, in-office screening with provider encouragement n=210 (Table 1). The overall sample had a mean (standard deviation) age of 69.30 (3.04) years. The sample was predominantly female (64.11%) and a sizeable portion (37.15%; n=233) identified as Black or African American. This is consistent with the demographic composition of the surrounding community, with Durham County being comprised of 52.1% females and 35.3% Black or African American persons in 2023 (U.S. Census Bureau, 2023). Supplemental Table 1 presents the proportion of patients in each step of the hearing healthcare pathway, by sex and by race.

### Sex differences

Table 2 (Panel A) and Figure 1 show the results of progression along the hearing healthcare pathway by sex; specifically, whether patients 1) completed the telephone-based hearing screening within 60 days of a routine primary care visit and, among those who failed the screening, 2) scheduled, and 3) completed a diagnostic evaluation. In terms of setting, all patients in the clinic setting, regardless of sex, completed the telephone-based hearing screening (outcome 1). In contrast, compared to male patients tested in the clinic, both male (IRR=0.25, 95% CI=0.19, 0.33) and female (IRR=0.25, 95% CI=0.20, 0.30) patients tested at home had a lower rate of completing the telephone-based hearing screening. There was no statistically significant difference in rate of completion between males and females tested in the clinic, suggesting that patients in the clinic setting are more likely to complete the hearing screening, regardless of sex.

The predicted probability of failing the hearing screening (outcome 2) in patients in the combined at-home protocols is 47.08% for males and 46.87% for females (Figure 1, Panel B), while the probability of failing in the clinic protocol is 38.13% for males and 32.33% for females. For outcomes 3 and 4, there were no statistically significant differences

between males and females for scheduling or completing the diagnostic evaluation. Overall, this pattern of results indicates that there are no sex differences between the combined at-home protocols and the clinic protocol, but that patients in the clinic protocols have higher probabilities of completing the hearing screening compared to those in the home protocols while patients in the home protocols have higher probabilities of failing the hearing screening than those in the clinic protocol, regardless of sex.

In terms of the effect of provider encouragement on completing the screening in the home settings (Table 3, Panel A), there were no statistically significant differences between males and females for completing the hearing screening (outcome 1) or results (pass/fail) of the screening (outcome 2). As for outcome 3, males in the at-home protocol *without* provider encouragement and who failed the screening had a higher probability of scheduling a formal diagnostic assessment (38.00%) compared to males in the at-home protocol *with* provider encouragement (21.76%) (Figure 1, Panel C). Results for completing a formal diagnostic assessment (outcome 4) are similar and therefore not shown.

### Race differences

Table 2 (Panel B) and Figure 2 show the results of the hearing healthcare pathway by race for the four study outcomes. All patients in the clinic setting completed the hearing screening test (outcome 1), regardless of race. In the combined at-home protocols, the predicted probability of completing the hearing screening was lower in both Black (19.29%) and White (27.78%) patients than in the clinic setting (Figure 2, Panel A). There was no statistically significant difference between patients by race in the combined at-home protocols, suggesting that patients in the clinic setting are more likely to complete the hearing screening compared to patients in the home setting, regardless of race.

The predicted probability of failing the hearing screening (outcome 2) is highest in the combined at-home protocols among Black patients (96.61%) (Figure 2, Panel B). Compared to Black patients tested at home, Black patients tested in the clinic (IRR=0.63, 95% CI=0.53, 0.75), White patients tested at home (IRR=0.87, 95% CI=0.76, 0.99), and White patients tested in the clinic (IRR=0.50, 95% CI=0.41, 0.61) had a lower rate of failing the hearing screening. There was no statistically significant difference in hearing screening result between Black and White patients in the clinic setting. This pattern of results suggests that patients in the combined at-home protocols have a higher probability of failing the hearing screening compared to those in the clinic setting, regardless of race.

Figure 2, Panel C shows that the predicted probability of scheduling a diagnostic assessment after failing the hearing screening (outcome 3) is close to 60% in White patients, regardless of whether they were in the clinic protocol (56.66%) or the combined at-home protocols (58.32%). Black patients in the clinic protocol have a slightly lower (but still statistically significant) predicted probability of scheduling a diagnostic assessment (49.44%). However, Black patients in the combined at-home protocols have an 18.78% predicted probability of scheduling a diagnostic assessment. The pattern of results for completing a diagnostic evaluation after failing the hearing screening (outcome 4) is similar to those for scheduling a diagnostic assessment (results not shown).

In terms of provider encouragement (Table 3, Panel B), there were no statistically significant differences by race for completing the hearing screening (outcome 1) or results of the screening (outcome 2). Figure 2, Panel D shows the predicted probability of scheduling a diagnostic assessment by race and level of provider encouragement (outcome 3), comparing the two at-home protocols. Here, there are no statistically significant differences within White patients or within Black patients in the probability of scheduling the assessment, regardless of provider encouragement. However, Black patients have a significantly lower probability of scheduling an assessment (<20%) compared to White patients (>50%), regardless of provider encouragement. The pattern of results for completing a diagnostic evaluation after failing the hearing screening (outcome 4) is similar to those for scheduling a diagnostic assessment (results not shown).

## DISCUSSION

The parent pragmatic clinical trial compared older adults' adherence rates to three different hearing screening protocols in the context of a routine visit in the PC clinic setting. Drawing on this data, the current study examined whether there were differences in adherence by patient sex and race.

### Hearing healthcare differences by sex

In terms of sex, results revealed few indications of sex differences along the hearing healthcare pathway following a hearing screening. While we found a statistically significant difference among hearing screening completions and failures, the difference was mostly based on the setting, rather than sex, as patients in the combined home-based protocols had a lower probability of completing the hearing screening and a higher probability of failing the hearing screening than patients in the clinic protocol.

This finding contradicts our hypothesis that female patients would be more willing to engage with the hearing healthcare pathway from the clinic while male patients would be more willing to do so from home. While much research has documented that female patients are more likely to utilize health services for mental and physical health concerns than male patients (Addis & Mahalik, 2003; Galdas et al., 2005; O'Brien et al., 2005), this is not the case in all circumstances. Specifically, when comparing health service utilization patterns in males and females with similar underlying morbidities (e.g., back pain, depression, cardiovascular disease), research has shown that men and women differ much less in their use of healthcare services than men and women in the general population (Hunt et al., 2011; Wang et al., 2013). Our findings lend support to this literature, suggesting that when considering a sample in which both sexes have the same underlying morbidity (hearing loss), there may be few sex differences in engaging with the hearing healthcare pathway.

When considering provider encouragement, there were no statistically significant differences by sex among hearing screening completions or failures. However, we found that males without provider encouragement were more likely to schedule and complete diagnostic assessments after failing a hearing screening compared to males with provider encouragement. This finding is consistent with previous research on men's engagement with mental health services that has found that some men may avoid seeking medical

help due to concerns about appearing vulnerable or weak, especially if they perceive provider encouragement as unnecessary or patronizing (Kwon et al., 2023). Without this encouragement, they may feel less judged and more inclined to take action.

It is possible that the male patients in the no provider encouragement protocol were encouraged to seek follow-up care by a care partner (e.g., significant other, family member). Care partners are often the primary communicator with the person with hearing loss, and often notice the hearing loss before the person with the hearing loss (Duijvestijn et al., 2003). As such, care partners have been shown to play an important role in the decision to seek hearing healthcare (Preminger & Meeks, 2010; van Leeuwen et al., 2021). Given the limited research examining sex differences and provider encouragement within hearing healthcare, future research should further examine the potential role of encouragement from care partners for sex differences in hearing healthcare utilization. Qualitative research studies may be particularly well-suited to supplement the findings of the current study.

### Hearing healthcare differences by race

Results revealed that the patterns of hearing screening completions and failures were similar, regardless of race, suggesting that setting is more impactful for utilization of the hearing healthcare pathway than race. Specifically, patients in the combined home-based protocols had a lower probability of completing the hearing screening and a higher probability of failing the hearing screening than patients in the clinic protocol. Among those who failed the hearing screening, Black patients in the combined at-home protocols had a lower probability scheduling or completing a diagnostic assessment than White patients, but Black patients in the clinic setting had a similar probability of completing these steps as White patients.

This finding suggests that in-clinic screening may be beneficial to increasing the use of hearing healthcare by Black patients. Acceptability is a core dimension of healthcare accessibility that entails understanding the social or cultural factors that determine whether a group of people accept the services and decide to seek care (Levesque et al., 2013). Prior research investigating attitudes and preferences toward healthcare services finds that Black males prefer to receive healthcare services in a traditional clinic setting, followed by a pharmacy setting, then in their own home (Chong et al., 2023). The current study provides some of the first insights regarding the impact of race on entry into the hearing healthcare pathway through a routine hearing screening by showing that the clinic setting may be a more acceptable route for accessing these services than the home setting. Overall, the lower utilization of hearing healthcare services by a minoritized racial group, even after a failed screening test, is a topic of great importance to the goal of hearing health at the population level, including its impact on overall quality of life and health.

Results from the current study also suggest that provider encouragement to complete a hearing screening may not mitigate racial differences in hearing healthcare use. Specifically, there were no statistically significant differences by race among hearing screening completions or failures. Black patients in both the provider encouragement and no-provider encouragement home protocols had a lower probability of scheduling or completing a diagnostic assessment compared to White patients. In terms of general healthcare, this finding is consistent with prior research showing that medical mistrust can reduce a patient's

commitment to the treatment plan prescribed by their health care provider (Abel & Efir, 2013; Cuffee et al., 2013). Black Americans can be reluctant to seek healthcare due to expectations of or prior experiences with discrimination in the healthcare setting (Bleich et al., 2019; Hamed et al., 2022). As a result, there is a higher prevalence of mistrust in healthcare in these groups that can have numerous negative consequences, including delayed access to care (Bleich et al., 2019). Racial concordance between providers and patients has been shown to mitigate this mistrust and increase engagement in healthcare services (Takeshita et al., 2020), suggesting that building trust with healthcare professionals may positively impact use of and adherence to the hearing healthcare pathway. Future research should examine the role of racial concordance between provider and patient for hearing healthcare utilization.

In terms of hearing healthcare, this finding contributes to the limited evidence of the role of mistrust in this field. Qualitative evidence has documented that some adults with hearing loss perceive that audiologists have financial incentives to sell hearing aids, which makes hearing healthcare professionals appear to be less trustworthy resources for individuals with hearing problems (Laplante-Lévesque et al., 2010). This is problematic, as a lack of trust in hearing healthcare providers can deter individuals from obtaining hearing aids (Kochkin, 2007). However, hearing healthcare providers can foster trust with their patients by avoiding a focus on hearing-aid sales; offering a professional clinic setting; displaying technical competence; promoting self-management; and offering comprehensive hearing rehabilitation services (Preminger et al., 2015). Further qualitative and quantitative research is needed to understand how these factors may influence the engagement of Black patients in the hearing healthcare pathway.

It is noteworthy that a systematic review examining U.S.-based clinical trials related to hearing loss between 1990–2020 found that very few studies reported racial data on their participants. Of the 125 clinical studies included in the review, only 16 (12.8%) reported data on race/ethnicity and, of those 16 studies, only five included more than 30% non-White representation among participants (Pittman et al., 2021). Whereas these studies included between 1–77 participants who identified as non-White, in our study, 37.15% (or 233 patients) of the sample identified as Black or African American.

### **Implications and future research**

The challenge of health equity is understanding the burdens and barriers that disproportionately impact patients from minority racial groups and impede their ability to engage in healthcare services, while addressing accessibility factors that are most likely to mitigate these effects and, if altered, increase use and access (Levesque et al., 2013). With the available data from the parent pragmatic clinical trial, we cannot directly address what is driving these results, but can speculate based on previous literature.

Research has shown that the hearing healthcare workforce is limited in size and restricted to urban locations (Planey, 2019). Transportation is a well-established barrier to healthcare access, with individuals living in rural areas experiencing challenges travelling to healthcare appointments and individuals living in urban areas often struggling with limited public transportation options (Schuh & Bush, 2022). While lack of transportation and distance

to hearing healthcare setting are likely to be barriers for all races, there may be multiple additional factors that may interact to produce the observed race-associated differences. For instance, residential racial segregation, a structural remnant of generations of discriminatory housing and banking policies (“redlining”) (Bailey et al., 2020; Massey, 2020) is likely to increase the logistical challenges and costs of being transported to hearing healthcare facilities for Black Americans, but not White Americans.

Figure 3 is a map showing the location of the six clinics that recruited patients for the parent pragmatic clinical trial. Five of the clinics are clustered within thirteen miles of one other, with the farthest clinic located 30 miles away. It is possible that patients who do not live close to the cluster of clinics in the Durham area may have a long distance to travel to the clinics and lack of availability of transportation may have impacted some patients’ abilities to schedule and complete their evaluations. In analyses not shown, we found that patients at sites 2, 3, and 5 (the most distant clinic) did not differ according to race. In contrast, sites 1 and 4 saw significantly more White than Black patients, while site 6 saw significantly more Black than White patients. Future research is needed to disentangle whether these differences reflect ecological obstacles based on the location of the sources of healthcare and the related repercussions of travel time and distances (Levesque et al., 2013).

Superimposed on these underlying structural inequities that influence healthcare access are the choices that patients make based on the prioritization of their daily needs, perceived health risks, actual and perceived accessibility or acceptability of available services, trust in the health system, and concerns about discrimination or stigma (Levesque et al., 2013). Our results provide new insight into a significant effect of race on a critical decision point in the hearing healthcare pathway that needs further investigation. As noted above, our findings suggest that fostering trust between patients and healthcare professionals may positively impact engagement with the hearing healthcare pathway among Black patients. However, previous research has shown that the hearing healthcare workforce has experienced only modest progress in the representation of individuals from racial/ethnic minority groups (Fenton et al., 2023). The underrepresentation of Black professionals in the hearing healthcare workforce may, therefore, contribute to differences in patient engagement in hearing-related care. Future research should explore the role of limited access and diversity of the hearing healthcare workforce as targets for improving the uptake of hearing healthcare across all segments of the population.

## Limitations

The current study is a secondary analysis of data collected during a pragmatic clinical trial, and the limitations have been documented elsewhere (Smith et al., 2023). Briefly, patients were encouraged to use a landline phone for the telephone-based hearing screening but for those with wireless phones, ear buds were recommended for screening. It is possible that some patients in the at-home screening protocols may have lacked access to landline phones or ear buds. Moreover, although the telephone-based hearing screening was a speech-in-noise task, the study could not account for ambient noise levels in patients’ homes. Second, the study was unable to follow patients outside of the clinical trial, and patients may have followed through with treatment recommendations outside of the trial

facilities. Third, patients were followed for 60 days post exposure to a single hearing screening opportunity, while serial screening may reveal more nuanced information about hearing screening and follow-up hearing healthcare in the PC setting. Fourth, we lack access to social determinants variables that may be related to community trust in the healthcare system, which may impact healthcare use, in general, among Black patients. Future research should examine how variables related to trust may impact the hearing healthcare pathway, including cultural sensitivity (lack of cultural competence among healthcare providers may lead to misunderstandings and lower trust); representation (a lack of sex/race representation among healthcare professionals may contribute to mistrust); health communication (limited access to clear, culturally relevant health information may lead to misinformation and mistrust); and language barriers (difficulty in communication due to language differences can impact the patient-provider relationship), among others. Fifth, we lacked sufficient data to analyze other U.S. racial/ethnic groups. There is some evidence suggestive that Asian Americans with hearing loss are less likely than White, Black, and Hispanic adults to receive a hearing test and also less likely to use hearing aids compared to White adults (Choi et al., 2018). As such, future research should examine other racial/ethnic group differences along the hearing healthcare pathway. Sixth, to reduce the obtrusiveness of data collection procedures, pragmatic clinical trials are unable to measure all possible variables that may explain or influence study results. For example, the parent study did not measure socioeconomic position (e.g., income, education, or employment). Instructional materials for the study were written at the eighth-grade level, which may exceed the educational level of patients in the sample, which could have contributed to the lower uptake of hearing screening in the at-home groups. Finally, the current study was not powered to examine the experiences of intersecting identities (e.g., sex and race/ethnicity) (Crenshaw, 1991). Future research is needed to understand how the convergence of multiple identities may impact hearing healthcare utilization patterns by exploring, for example, the experiences of Black male patients versus White male patients. As such, findings from the current study should be interpreted with these limitations in mind.

## CONCLUSION

Hearing healthcare is increasingly recognized as a public health issue, with national reports issuing calls to increase the affordability and accessibility of hearing healthcare, especially for racial minority groups (NASEM, 2016; PCAST, 2015) and the lack of evidence of the impact of hearing screening among diverse subpopulations (US Preventive Services Task Force, 2021). Results from the current study suggest that such approaches should take into consideration in-clinic screening as a means for increasing uptake of the hearing healthcare pathway among racial minorities. Future research is needed to disentangle the motivating factors, underlying barriers, and compliance predictors for hearing healthcare adherence within the primary care setting.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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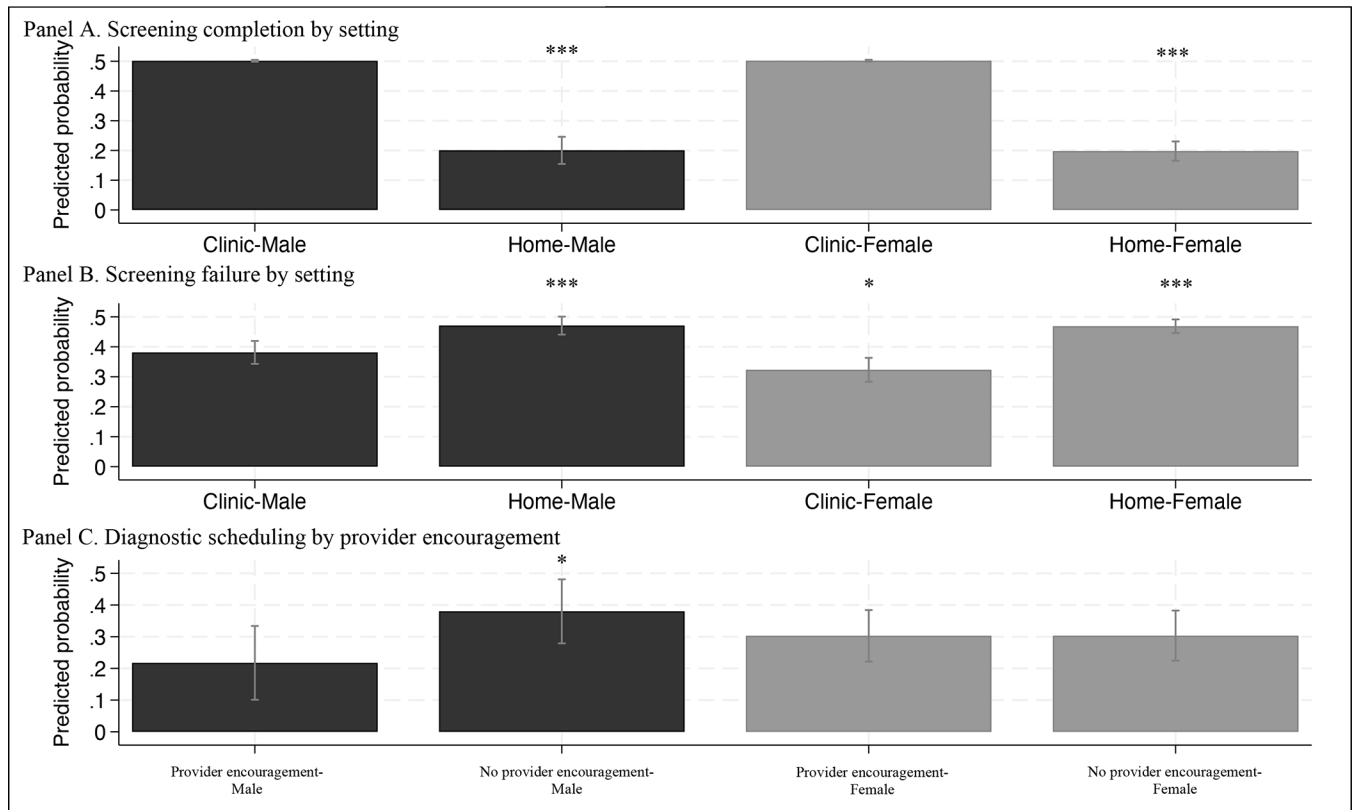
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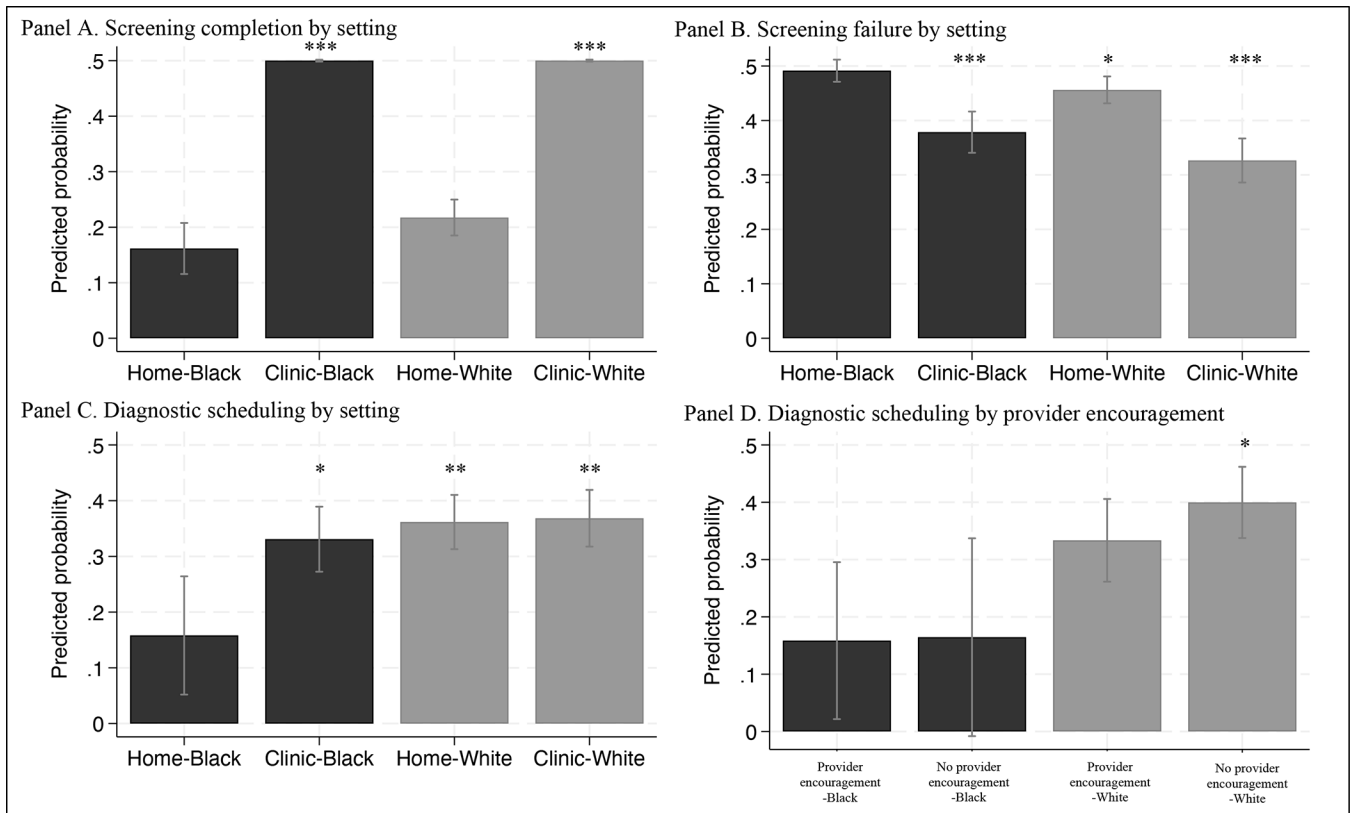
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**Figure 1.**

Predicted probabilities of study outcomes by sex.

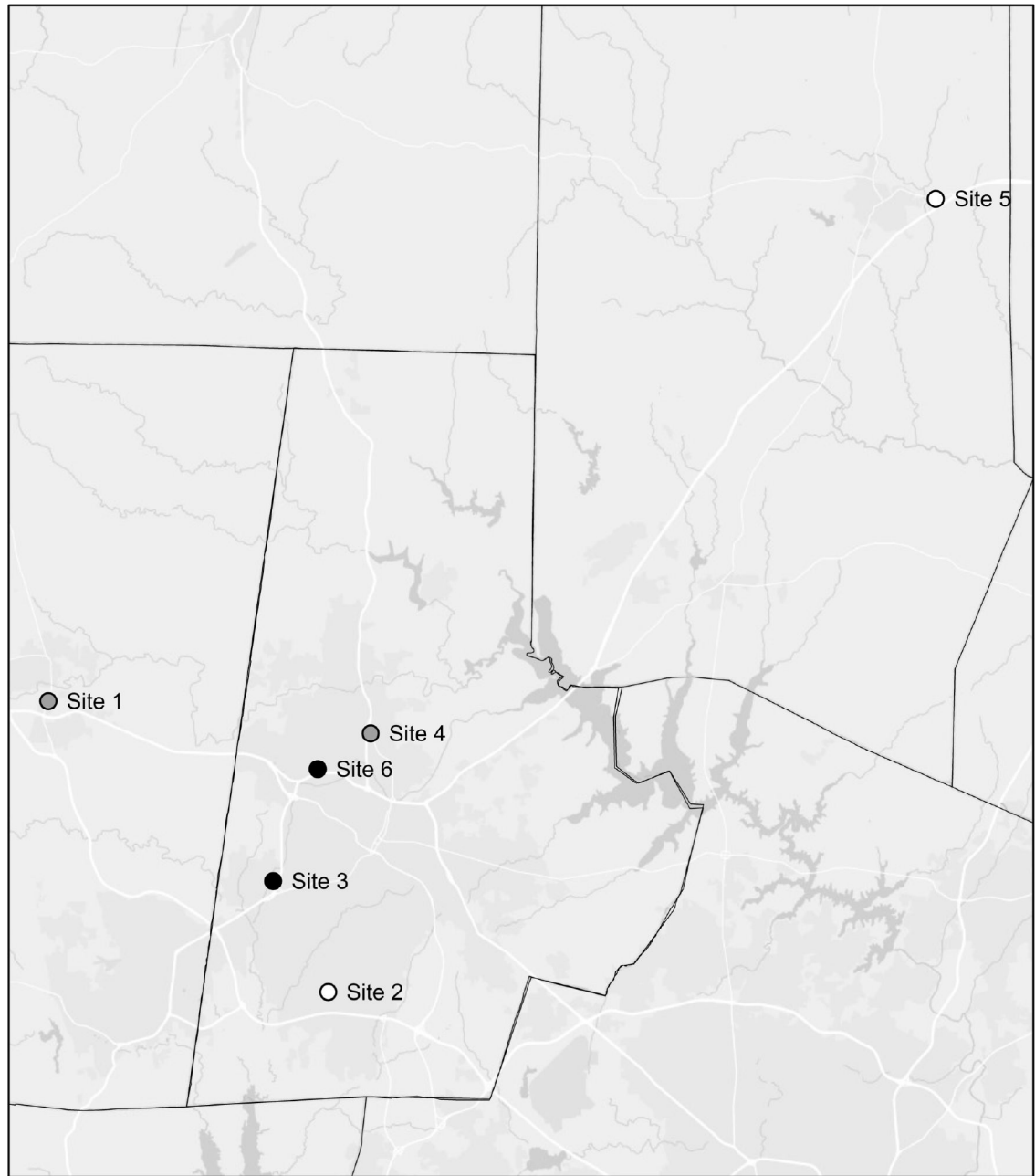
Note: Predicted probabilities were derived from incident rate ratios in Tables 2–3 holding all covariates at their means. Home=combined at-home protocols, Clinic=clinic protocol. \* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$



**Figure 2.**

Predicted probabilities of study outcomes by race.

Note: Predicted probabilities were derived from incident rate ratios in Tables 2–3 holding all covariates at their means. Home=combined at-home protocols, Clinic=clinic protocol. \* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$ .



**Figure 3.**

Map of the Six Clinic Sites in Durham, North Carolina.

- Clinic-Provider Encouragement
- Home-Provider Encouragement
- Home-No Provider Encouragement

Note: Site 1 is located in Orange County; Sites 2, 3, 4 and 6 in Durham County; and Site 5 in Granville County.

Table 1.

Patient characteristics overall and within each protocol.

	Total sample	Home – No Provider Encouragement	Home – Provider Encouragement	Clinic
	n=627	n=209	n=208	n=210
	n (%)	n (%)	n (%)	n (%)
Age, mean (SD)	69.30 (3.04)	69.38 (3.06)	69.43 (3.03)	69.08 (3.03)
Black / African American	233 (37.16%)	60 (28.71%)	80 (38.46%)	93 (44.29%)
Female	402 (64.11%)	150 (71.77%)	128 (61.54)	124 (59.05%)

Notes: SD=standard deviation.

**Table 2.**

Multivariable-adjusted incident rate ratios for study outcomes depending on hearing screening setting, by sex (Panel A) and race (Panel B).

	Panel A: by sex				Panel B: by race			
	IRR	95% CI	p		IRR	95% CI	p	
<b>Telephone-based hearing screening completed within 60 days of PCP visit</b>								
Clinic-Male [ref]								
Home-Male	0.25	(0.19, 0.33)	0.000	Home-Black [ref]	5.19	(3.70, 7.28)	0.000	
Clinic-Female	1.00	(0.99, 1.02)	0.900	Home-White	1.44	(0.98, 2.13)	0.066	
Home-Female	0.25	(0.20, 0.30)	0.000	Clinic-White	5.19	(3.70, 7.28)	0.000	
Black race	0.90	(0.81, 1.00)	0.051	Female	0.99	(0.89, 1.11)	0.923	
Age	1.00	(0.99, 1.02)	0.682	Age	1.00	(0.99, 1.02)	0.721	
Constant	0.81	(0.23, 2.80)	0.736	Constant	0.15	(0.04, 0.55)	0.004	
<b>Screening failure result</b>								
Clinic-Male [ref]				Home-Black [ref]				
Home-Male	1.44	(1.18, 1.77)	0.000	Clinic-Black	0.63	(0.53, 0.75)	0.000	
Clinic-Female	0.78	(0.61, 0.99)	0.038	Home-White	0.87	(0.76, 0.99)	0.030	
Home-Female	1.43	(1.19, 1.73)	0.000	Clinic-White	0.50	(0.41, 0.61)	0.000	
Black race	1.21	(1.04, 1.41)	0.016	Female	0.63	(0.74, 1.00)	0.055	
Age	1.02	(1.00, 1.05)	0.087	Age	1.02	(1.00, 1.05)	0.103	
Constant	0.12	(0.02, 0.74)	0.022	Constant	0.24	(0.04, 1.45)	0.121	
<b>Formal diagnostic assessment scheduled</b>								
Clinic-Male [ref]				Home-Black [ref]				
Home-Male	0.89	(0.55, 1.43)	0.627	Clinic-Black	2.63	(1.14, 6.09)	0.024	
Clinic-Female	1.29	(0.91, 1.85)	0.157	Home-White	3.02	(1.33, 6.85)	0.008	
Home-Female	0.94	(0.64, 1.39)	0.769	Clinic-White	3.11	(1.36, 7.09)	0.007	
Black race	0.65	(0.48, 0.89)	0.006	Female	1.21	(0.91, 1.60)	0.187	
Age	1.00	(0.95, 1.04)	0.832	Age	1.00	(0.96, 1.04)	0.897	
Constant	0.78	(0.04, 17.38)	0.876	Constant	0.20	(0.01, 4.59)	0.318	

Panel A: by sex						Panel B: by race						
	IRR	95% CI	P		P	IRR	95% CI	P		IRR	95% CI	P
<b>Formal diagnostic assessment completed</b>												
Clinic-Male [ref]												
Home-Male	0.89	(0.55, 1.43)	0.625	Home-Black [ref]								
Clinic-Female	1.19	(0.82, 1.72)	0.361	Clinic-Black		2.52	(1.09, 5.85)	0.031				
Home-Female	0.95	(0.65, 1.39)	0.788	Home-White		3.01	(1.33, 6.83)	0.008				
Black race	0.66	(0.48, 0.90)	0.010	Clinic-White		2.89	(1.26, 6.63)	0.012				
Age	1.00	(0.96, 1.05)	0.941	Female		1.15	(0.86, 1.53)	0.343				
Constant	0.49	(0.02, 12.14)	0.666	Age		1.00	(0.96, 1.05)	0.888				
				Constant		0.14	(0.01, 3.47)	0.230				

Note: IRR=incident rate ratio; CI=confidence interval; PCP=primary care provider; Home=home hearing screening protocols combined; Clinic=clinic hearing screening protocol.

**Table 3.**

Multivariable-adjusted incident rate ratios for study outcomes depending on provider encouragement, by sex (Panel A) and race (Panel B).

<b>Panel A: by sex</b>	<b>IRR</b>	<b>95% CI</b>	<b>p</b>
<b>Telephone-based hearing screening completed within 60 days of PCP visit</b>			
Home- Provider Encouragement-Male [ref]			
Home-No Provider Encouragement-Male	0.78	(0.43, 1.41)	0.418
Home-Provider Encouragement-Female	0.97	(0.62, 1.53)	0.909
Home-No Provider Encouragement-Female	0.82	(0.52, 1.30)	0.401
Black race	0.68	(0.46, 1.01)	0.054
Age	1.01	(0.96, 1.06)	0.736
Constant	0.16	(0.00, 6.87)	0.343
<b>Screening Failure Result</b>			
Home-Provider Encouragement-Male [ref]			
Home-No Provider Encouragement-Male	0.95	(0.73, 1.23)	0.684
Home-Provider Encouragement-Female	1.00	(0.84, 1.18)	0.992
Home-No Provider Encouragement-Female	0.92	(0.76, 1.12)	0.398
Black race	1.13	(1.01, 1.27)	0.040
Age	1.00	(0.98, 1.03)	0.814
Constant	0.70	(0.11, 4.45)	0.709
<b>Formal diagnostic assessment scheduled</b>			
Home-Provider Encouragement-Male [ref]			
Home-No Provider Encouragement-Male	2.20	(1.04, 4.69)	0.040
Home-Provider Encouragement-Female	1.56	(0.74, 3.31)	0.245
Home-No Provider Encouragement-Female	1.57	(0.74, 3.29)	0.237
Black race	0.34	(0.15, 0.78)	0.010
Age	0.99	(0.93, 1.06)	0.818
Constant	0.65	(0.01, 75.85)	0.859
<b>Formal diagnostic assessment completed</b>			
Home-Provider Encouragement-Male [ref]			
Home-No Provider Encouragement-Male	2.20	(1.04, 4.69)	0.040
Home-Provider Encouragement-Female	1.56	(0.74, 3.31)	0.245
Home-No Provider Encouragement-Female	1.57	(0.74, 3.29)	0.237
Black race	0.34	(0.15, 0.78)	0.010
Age	0.99	(0.93, 1.06)	0.818
Constant	0.65	(0.01, 75.85)	0.859
<b>Panel B: by race</b>	<b>IRR</b>	<b>95% CI</b>	<b>p</b>

**Telephone-based hearing screening completed within 60 days of PCP visit**

Home-Provider Encouragement-Black [ref]			
Home-No Provider Encouragement-Black	0.78	(0.39, 1.59)	0.497
Home-Provider Encouragement-White	1.43	(0.87, 2.35)	0.160
Home-No Provider Encouragement-White	1.20	(0.72, 1.99)	0.485
Female	1.00	(0.71, 1.43)	0.982
Age	1.01	(0.96, 1.06)	0.729
Constant	0.11	(0.00, 4.46)	0.243

**Screening Failure Result**

Home-Provider Encouragement-Black [ref]			
Home-No Provider Encouragement-Black	1.07	(0.94, 1.21)	0.294
Home-Provider Encouragement-White	0.95	(0.81, 1.12)	0.559
Home-No Provider Encouragement-White	0.84	(0.69, 1.03)	0.093
Female	0.99	(0.85, 1.15)	0.871
Age	1.00	(0.98, 1.03)	0.761
Constant	0.72	(0.12, 4.27)	0.716

**Formal diagnostic assessment scheduled**

Home-Provider Encouragement-Black			
Home-No Provider Encouragement-Black	1.05	(0.21, 5.29)	0.957
Home-Provider Encouragement-White	2.66	(0.91, 7.79)	0.075
Home-No Provider Encouragement-White	3.53	(1.23, 10.19)	0.019
Female	1.04	(0.67, 1.62)	0.848
Age	0.99	(0.92, 1.06)	0.713
Constant	0.43	(0.00, 46.07)	0.725

**Formal diagnostic assessment completed**

Home-Provider Encouragement-Black [ref]			
Home-No Provider Encouragement-Black	1.05	(0.21, 5.29)	0.957
Home-Provider Encouragement-White	2.66	(0.91, 7.79)	0.075
Home-No Provider Encouragement-White	3.53	(1.23, 10.19)	0.019
Female	1.04	(0.67, 1.62)	0.848
Age	0.99	(0.92, 1.06)	0.713
Constant	0.43	(0.00, 46.07)	0.725

Note: IRR=incident rate ratio; CI=confidence interval; PCP=primary care provider.