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The Impact of a Medication Refill Adherence Text Messaging Solution on Black and Latino Adults: Secondary Analysis of Randomized Controlled Trial

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The Impact of a Medication Refill Adherence Text Messaging Solution on Black and Latino Adults: Secondary Analysis of Randomized Controlled Trial

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Abstract

Background: Cardiovascular disease is a leading cause of death among adults, particularly for minority groups, such as African American or Black (hereafter referred to as Black) and Hispanic or Latino (hereafter referred to as Latino) adults. Mobile health solutions, specifically text messaging, are a promising method for delivering self-management interventions to adults who have cardiovascular disease. The Nudge study was a randomized controlled trial (RCT) text message intervention designed to improve medication refill adherence. This secondary analysis uses Nudge study to understand whether Black and Latino adults respond differently than White adults to one of the Nudge's theory-based study arm.

Objective: The study explored whether text message refill reminders could improve self-reported responses to refilling medication among Black and Latino adults with one or more cardiovascular diseases compared to White adults.

Methods: This study was a secondary analysis from the Nudge study to examine the effectiveness of one of the four intervention study arms (optimized study arm) designed with theory-based text messages. This study analyzed self-reported response times between Black, Latino, and White adults and self-reported responses between Spanish and English speakers. The dataset observed adult over 18 years old from Denver Health, a federally qualified health center, who were assigned to the optimized study arm between November 2019 and May 2020. Descriptive statistics were used to illustrate patient characteristics including: age, gender, race, ethnicity, and language preference for text message refill reminders. Linear regression models were used to estimate predictors, age and language preference, influencing refill adherence. Statistical analysis was performed in R studio.

Results: A total of 410 adults with CVD condition(s) from the optimized study arm at Denver Health received refill text message reminders. Of those 26.3% (108/410) responded by text message to self-report refilling their prescription. The estimated median response time(s) for 19% of White adults who responded was 2 hours, compared to the 15% of Black adults who responded within 30 hours, 62% of Latino adults who responded within 50 hours, and 4% of adults who identified as Other who responded within 60 hours. The estimated median response time for 62% of Spanish-speaking adults was the same for English-speaking adults, both at 50 hours. Linear regression was used however no association was found between response time and race (White; p =0.924). Another linear regression was used however no association was found between response time and language preference (Spanish; p=0.895).

Conclusions: This secondary analysis suggests Black and Latino adults with cardiovascular disease may take additional time to respond compared to White adults. The estimated self-reported response time between Spanish-speaking and English-speaking adults was the same. Although not significantly different, it suggests the importance of exploring other barriers that may impact response times among Black and Latino adults.

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Abstract

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Conclusions: This secondary analysis suggests Black and Latino adults with cardiovascular disease may take additional time to respond compared to White adults. The estimated self-reported response time between Spanish-speaking and English-speaking adults was the same. Although not significantly different, it suggests the importance of exploring other barriers that may impact response times among these populations.

Keywords

mobile health; text messaging; refill management; Black or African American; Hispanic or Latino; social determinants of health; cardiovascular disease; chronic disease

Introduction

Refill non-adherence, broadly defined as not refilling a medication by the expected refill date, could affect the growing medication non-adherence problem for adults with cardiovascular disease (CVD).[1,2] Medication non-adherence is a problem particularly for African American/Black adults (further referred to as Black adults) and Hispanic/Latino adults (further referred to as Latino adults) who face disparities that can result in a higher likelihood of CVD.

CVD is a leading cause of death among Black and Latino adults. [3,4,5,6] CVD risk factors, particularly hypertension and diabetes, are common among these communities. Prior studies have

demonstrated that Black and Latino adults with hypertension and/or diabetes are less likely to adhere to their medication. [7,8,9,10] Poor adherence can contribute to increased complications from CVD such as poor quality of life, functional impairment, and mortality. [7,8,9,10]

Despite the large body of work documenting the high likelihood of CVD among these populations along with the harmful outcomes, a systematic understanding on the relationship between race/ethnicity and non-adherence is generally unclear. The limited studies available broadly identify language barriers as one unique factor that can influence medication adherence among Black and Latino adults. [11,12] Both Black and Latino adults with limited English proficiency or who are non-English speakers have demonstrated lower rates of medication adherence. Presently, there is more evidence of language barriers affecting medication adherence among Latino adults than among Black adults. [4,11,12]

Evidence shows that interventions using mobile health or mHealth, specifically text messaging, has the potential to support Black and Latino adults who are looking to manage their CVD.[13,14] Furthermore, evidence shows that ownership of mobile devices and use of the internet on their mobile devices is on the rise for both populations, making mHealth interventions appropriate for these populations.[15,16] To date, several mHealth interventions that incorporate behavioral theories have been shown to improve adherence to CVD medication among Black and Latino adults. [17,18,19,20]

Even with strong evidence that mHealth interventions can improve CVD medication adherence for both Black and Latino adults, we know less about theory-based text message interventions addressing medication refill non-adherence. One study evaluated refill medication between Black and Latino adults compared to White adults.[21] The findings revealed that Black adults had higher refill rates than Latino adults yet both populations had lower refill rates compared to White adults. It is worth noting that the study took into account the unique factor of language barriers by translating the content into Spanish. Although the messages were translated, Spanish-speaking adults were less engaged than English-speaking adults. Another theory-based text message intervention addressing medication refill non-adherence, the Nudge study, examined the refill adherence of participants who received text message “nudges” to prompt adults to refill their medication. [2,22,23] However, overall results showed that refill text message intervention was not significant for the participants. We used data from the Nudge study to examine refill adherence of CVD medications and the influence of language barriers among Black and Latino adults in a single healthcare system compared to White adults.

Methods

Study Design

This is a secondary analysis using data collected from a mHealth randomized controlled trial (RCT) known as the Nudge study (NIH UH3 AT009845) which was conducted in Colorado from 2019 to 2024. The methods of the original RCT have been previously published.[2,23] The trial investigated medication refill adherence among adults across three healthcare systems (Veterans Affairs, UCHealth, and Denver Health) who were randomized into one of the four study arms: usual care arm (no intervention), generic arm (a basic, generic text reminder), optimized arm (nudge text reminder based on behavioral theories), and chatbot arm (first generation of optimized messages where adultss can interact with a fixed set of responses).

This analysis includes participants who were randomized into the optimized study arm because we are looking to further understand the influence theory-based messages has on different users. The study observed adults at Denver Health between November 2019 to May 2020. Denver Health is an integrated safety net healthcare system. with nearly 60% of its adults identifying as part of a racial or ethnic minority group.[24] This study was approved by the Colorado Multiple Institutional Review Board (#18-2779).

Study Participants

Participants enrolled in the Nudge study were 18 years old or older, had one or more cardiovascular

conditions, filled their designated cardiovascular prescription within 100 days prior to eligibility, and experienced a gap of ≥7 days in refilling their prescribed medication. Once randomized, adults remained in the same study arm and were sent text message notifications (i.e., 1, 3, 5, 7, and 10 days) every time they gapped of ≥7 days during the observed study period.

Intervention

Behavioral nudge text messages were sent 5 times over 10 days reminding adults to refill their medication (i.e., 1, 3, 5, 7, and 10 days). A behavioral nudge is a small change that predictably alters people's behavior and has been used in improving behaviors such as smoking cessation and weight loss.[2,25] The optimized study arm integrated multiple behavioral theories to promote positive attitudes and improve knowledge such as behavioral commitments (e.g. asking patients for demonstrated commitment to change through a pledge), self-efficacy, social norms (e.g. using examples of others who take action) and salience (making information or recommendations resonant through use of stories). [2,25] Participants who indicated that they already refilled their prescription replied with the text "Done". Participants who responded with messages other than "Done" continued to receive text message reminders until day 10. Adults who replied with the text "STOP" were opted out of the study.

Outcome Measures

The primary outcome for the original trial measured medication refill adherence to CVD medications by using pharmacy data. This outcome is based on the number of days a adult has a medication available, relative to the number of days during which a adult was prescribed the medication and should have depleted their supply.[2] The outcome(s) for this secondary analysis is a part of the primary outcome but focuses on adults' participation who self-reportedly refilled their medication. This self-reported data is later verified by pharmacy data included in the primary Nudge analysis. The first outcome of the secondary analysis measured exclusively time (in hours) from when an adult was first exposed to the intervention to the time they self-reportedly texted back "Done" to one of the text message notifications. Adults who only self-reportedly texted "Done" indicated they refilled their medication. Measuring response times can help determine the optimal number of text message notifications to send to a specific population and identify areas for improving the intervention in future studies.

As mentioned earlier, language barriers are a unique factor that could influence refill adherence. Therefore, the second outcome measured the response times between Spanish and English speakers to understand if text messages translated into Spanish for Spanish-speaking adults would have an impact on their ability to self-reportedly text "Done".

User characteristics variables were measured at baseline: age (continuous); gender (dichotomized into female and male); race (categorical); ethnicity (dichotomized into Latino and non-Latino); response time (continuous); and language preference (dichotomized into Spanish and English). For race and ethnicity categories, we chose to observe White, Black, and Latino adults because they have the largest representation from the primary Nudge data set. Adults who did not fall within these categories were recoded as Other.

Statistical analysis

Baseline characteristics were summarized using descriptive statistics such as frequency (percentage) for categorical measures. A boxplot was constructed to visually represent the relationship between race, ethnicity, and the dependent variable, response time. The size of each box provides an estimate of the response times to the text message intervention. Linear regression models were conducted with the adult's response time as the dependent variable, and age, race, ethnicity, gender, and language preference as the independent variables. Results from the regression model are presented as 95% confidence intervals. Analyses were performed using R statistical software (version.3.6.2 R Foundation for Statistical Computing).[25]

Results

Response to Refill Intervention

Of those who received the text message notifications, 26.3% (108/410) texted “DONE” as reflected in Table 1 along with other relevant demographic data. The sample consisted of 19% of White adults, followed by 15% Black adults, and 4% categorized as Other, who responded to the text message notifications. Among ethnicity, 62% of Latino adults responded. Figure 1 displayed the boxplot of estimated response times to text notifications by race/ethnicity sorted by median. The response time of adults texting the keyword “DONE” was calculated on a 0-220 hours (1-10 days) scale. The estimated median time to respond “DONE” for adults who identified as White was within an estimated 2 hours as compared to Black and Latino adults who responded within an estimated 30 hours and 50 hours respectively. The boxplot seen in Figure 1 shows the upper quartile and median of Black and Latino adults have a higher degree of variation in response time compared to White adults. This means that both Black and Latino adults have a greater variability in their response time than White adults. Further investigation was needed to explore whether this variation was statistically significant. Therefore we conducted a linear regression to quantify the strength of the association between variables and whether the relationship is statistically significant (Castro & Ferreira, 2022).

Table 2 reports the linear regression model. Even though the variations of the estimated response times were visually different in Figure 1, there was no significant association with response time based on race and ethnicity.

Response Time by Language

Adults were automatically sent Spanish text messages based on the language preference indicated in their Denver Health profile, or they could request content to be translated into Spanish via text message. The boxplot seen in Figure 2 shows the estimated median response time for Spanish-speaking adults (50 hours) was the same as for English-speaking adults (50 hours). The upper quartile of English-speaking adults is larger than Spanish-speaking patients. This means that English speakers have greater variability in indicating that they refilled their medication. Similarly to the approach for response to refill intervention by race and ethnicity, the visual representation was followed up by a linear regression to determine statistical significance.

Table 3 reports the linear regression model. Based on language, there was no significant association with response time; however adults who spoke Spanish responded an average of 1.44 hours earlier than English speakers.

Table 1. Demographic characteristics of the participant sample.

Baseline[a] (N=410), n(%)[a]		Responded[b] (N=108), n(%)[a]
Gender		
Female	246 (60%)	66 (61%)
Male	164 (40%)	42(39%)
Age		
18-34	21(5%)	9 (8%)
35-44	53(13%)	9 (8%)
45-54	101(24%)	18(17%)
55-64	136 (33%)	40(37%)
≥65	99 (24%)	32 (30%)
Race		
White	68(17%)	20(19%)
African American /Black	69(17%)	16(15%)

Other	18(4%)	5(4%)
Ethnicity		
Hispanic/Latino	255(62%)	67(62%)
Non-Hispanic	152(38%)	40(38%)
Other	3	1
Spanish speaking		
Yes	161(39%)	43 (40%)
No	248(60%)	65(60%)
Other	1(1%)	--

a.Due to rounding, the sum of the percentages shown is not 100.
b.Subsample of participants who responded to the preferred Done message in the Nudge intervention.

Figure 1. Estimated response time by race and ethnicity

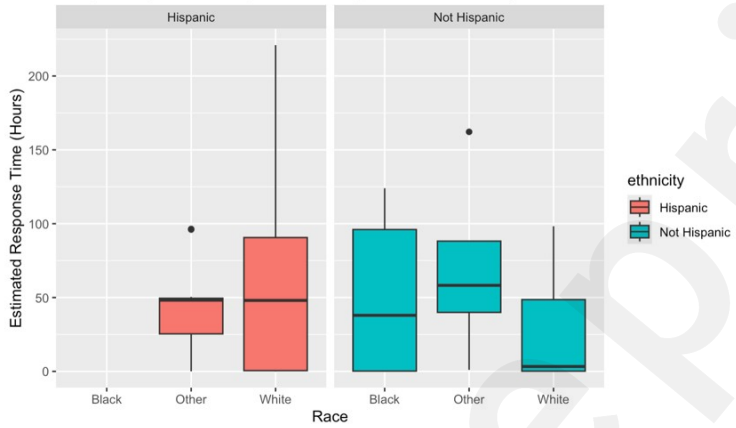


Table 2. Linear regression model on the outcome by race.

Variable	Coefficient (SE)	*t* value	*P* value
Intercept	44.11	3.408	<0.00
Race (reference: Black)	-	-	-
White	1.356	0.095	0.924
Other	7.150	0.384	0.702

Figure 2. Estimated response time by adult's preferred language

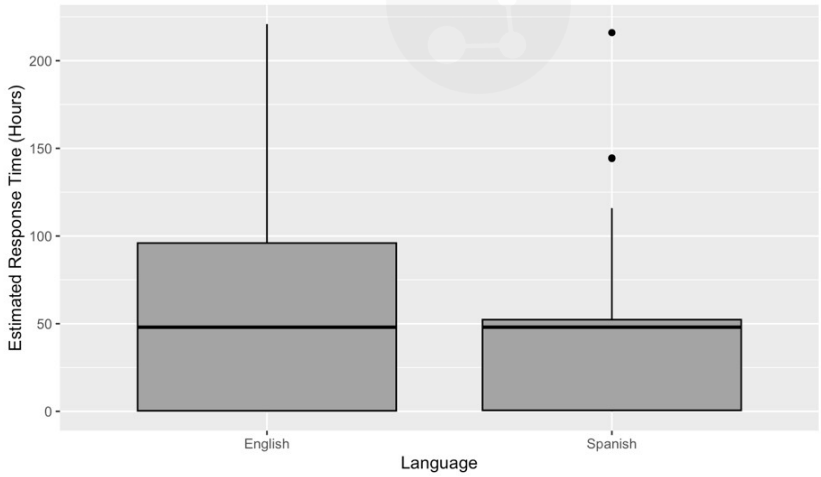


Table 3. Linear regression model results for the effects of language by race.

Variable	Coefficient (SE)	*t* value	*P* value
Intercept	44.11	3.408	<0.000
Race (reference: Black)	-	-	-
White	2.029	0.134	0.8939
Other	7.821	0.404	0.6872
Language (reference: English)	-	-	-
Spanish	-1.439	-0.132	0.8949

Opt-Out Rates by Race/Ethnicity

A total of 27 out of 410 adults with CVD condition(s) opted out of the 6-month intervention by typing the keyword “STOP”. Table 4 represents a summary of adults who opted out by race and ethnicity. This summary was conducted to identify adults who actively no longer wanted to participate in the intervention. Adults who identified as Black opted out at the highest rate (7/69,10.1%), second to White than Latino adults respectively (5/68,7.4%, 14/255,5.5%). This metric divides the number of adults who opted out of the study by the number of patients at the beginning of the intervention. Due to the small sample of patients opting out of the study, we did not perform a statistical analysis.

Table 4. Opt-out rates by race/ethnicity.

Baseline characteristics	Opt-out rate, (n),%
Race	
Black	7, (10.1%)
White	5, (7.4%)
Other	1, (5.5%)
Ethnicity	
Hispanic/Latino	14, (5.5%)

Discussion

Principal Results

The 6-month analysis of the intervention specifically the theory-based text messaging study arm examined self-reported medication refill adherence response times between White, Black, and Latino adults. Even though self-reported refill adherence did not meet the conventional levels of statistical significance (i.e., $p < 0.05$), the visual representation indicates that adults who identified as Latino (median 50 hours) and Black (median 30 hours) took longer to respond to the text message notifications indicating that they had refilled their medications compared to White adults (median 2 hours). The lack of statistical significance could be due to a small sample size which may reduce statistical power.[26] It also may suggest that other predictors could have a stronger association between variables. Although not significant, the visual findings align with previous literature.[21] Although these differences in response times by race and ethnicity were not statistically significant, this study shows that researchers or developers who are tailoring future mobile health interventions for Black and Latino adults should take into account that they may take additional time to respond to the text message notifications compared to White adults. Furthermore, knowing that Black and Latino adults may require more time, researchers might consider increasing the number of text messages within a 40-hour window, followed by a tapering off of notifications. These findings also contribute to the narrative of Black and Latino adults' willingness to engage in theory-based mobile

health interventions, as supported by the low opt-out rate percentages. Latino adults had the lowest opt-out percentage (5.5%) and overall the adults in the sample avoided to opt-out from the study. Measuring response time can help determine the optimal number of text message notifications to send to a specific population. Lastly, the findings also suggest that Black and Latino adults may have alternative determinants that may have contributed to their delayed action in responding "DONE," indicating they had refilled medications.

Understanding barriers that influence refiling medication

In the primary Nudge study, English text messages were translated into Spanish for Latino adults who preferred receiving text messages in their language. This feature was developed to remove the language barrier that Latino adults can face when participating in a text message intervention. [4,1,12] We examined self-reported medication refill adherence between Spanish-speaking Latino adults and English-speaking adults. Although not statistically significant, the boxplot displayed that the estimated median response times were the same for Spanish-speaking Latino adults (50 hours) compared to English-speaking adults (50 hours). This revealed that while adjusting for the determinant, language barrier, Spanish speakers respond within the same estimated time as English-speaking speakers. Although this finding differs from Brar et al (2019), it contributes to the need for a systematic review to describe the unique determinants that could influence refill adherence among these population groups. Presently, the limited publications available on self-reported perceived discrimination show that adherence is lower among communities of color.[27,28] Discrimination in healthcare settings and community stressors are some examples that can lead to non-adherence of refilling their medications.[29,30] Constructs such as self-esteem and self-efficacy have been documented to overcome perceived discrimination among Latino adults.[30] Further research should tailor their messaging design to integrate self-esteem and self-efficacy constructs and examine if populations respond differently to empathic messaging.

Limitations

This study shared valuable insights on how overlooked populations can benefit from text message interventions. However, the findings of this study had some limitations. The small sample size of adults assigned to the optimized study arm who responded to the text message notifications was primarily located in the Denver metro area. Therefore, we acknowledge that the findings may not be generalizable to adults with CVD in other geographic locations. Additionally, the Denver Health setting operates as a safety net healthcare system that provides affordable health services to special populations such as low-income, uninsured adults.[26] Therefore it may be challenging to replicate similar results from a different, non-safety net healthcare setting. For example, Brar et. al (2019) publication similarly examined refill non-adherence yet recruited adults from a coordinated care healthcare system which primarily covers adults with employer-sponsored insurance, individual healthcare insurance coverages, and limited coverage for Medicaid beneficiaries. Thirdly, although adults could text other response options, we limited examining the response options to only "Done" and "STOP" because these options indicated whether an adult intended to refill or drop out of the study. Future studies could compare the response options of Black and Latino adults who responded "Done" to Black and Latino adults who texted with different keywords.

Furthermore, adults who did not respond to the text messages but also did not opt out were not measured in this study. Building on that, we did not measure pharmacy data, as the primary Nudge will reveal those results for the entire Nudge sample. While the primary objective is to understand adults' responses to a study arm featuring theory-based messages, this data highlights the need for further investigation into the demographics and potential reasons why adults are disinterested in responding to a text message intervention. Lastly, the study was only able to analyze one example of social determinants of health: language. The primary Nudge study collected basic demographic information; therefore we were unable to examine other potential determinants that could impact these populations.

Conclusions

This study highlights the differences in how Black and Latino adults respond to theory-based text

messages designed to address medication refills, in comparison to White adults. Lastly, it provides insights indicating that further exploration of tailored interventions and an understanding of users' needs are vital for achieving results that could improve health outcomes.

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Conflict of Interest
The authors declare no conflict of interest.

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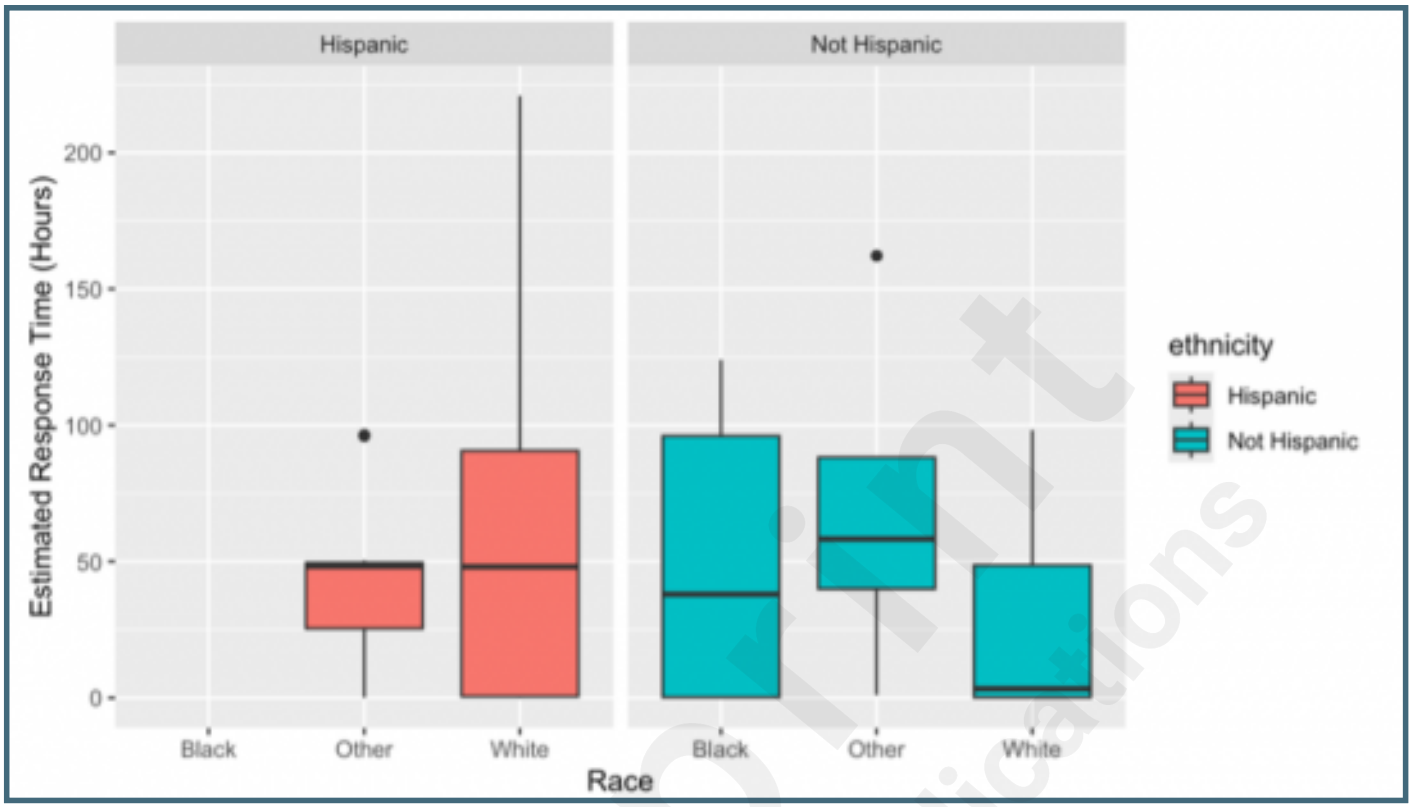
Supplementary Files

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Figures

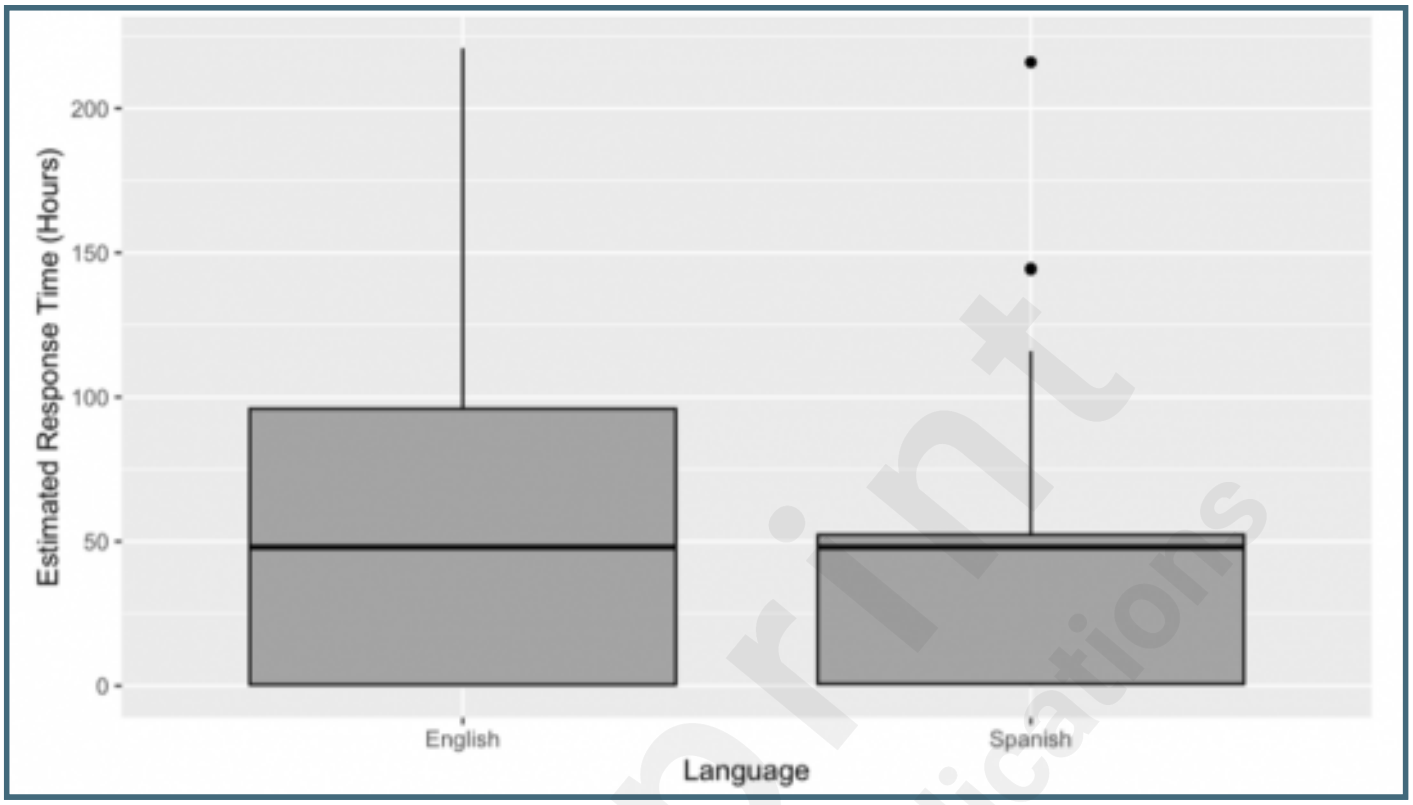
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Estimated response time by race and ethnicity.



Preprint JMIR Publications

Estimated response time by adult’s preferred language.



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