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Short communication

Examining COVID-19 testing and vaccination behaviors by heritage and linguistic preferences among Hispanic, Latino, or Spanish RADx-UP participants

Emily M. D'Agostino [a,b,c,*], Jorge Ramirez Garcia [d], Suzanne R. Bakken [e], Lisa Wruck [b], Ester Kim Nilles [b], Troy A. Stefano [f], Haley R. Martin [g], Annette Hungler [f], Rebecca E. Lee [h], Krista M. Perreira [i], Marianna K. Baum [g], David Brown [f]

[a] Department of Orthopaedic Surgery, Occupational Therapy Doctorate Division, Department of Population Health Sciences, Duke University School of Medicine, Durham, NC, USA
[b] Duke Clinical Research Institute, Duke University School of Medicine, Durham, NC, USA
[c] Duke Global Health Institute, Duke University School of Medicine, Durham, NC, USA
[d] Oregon Research Institute & Prevention Science Institute, University of Oregon, Eugene, OR, USA
[e] School of Nursing, Department of Biomedical Informatics, Data Science Institute, Columbia University, New York, NY, USA
[f] Herbert Wertheim College of Medicine, Florida International University, Miami, FL, USA
[g] Robert Stempel College of Public Health and Social Work, Florida International University, Miami, FL, USA
[h] Edson College of Nursing and Health Innovation, Arizona State University, Phoenix, AZ, USA
[i] Department of Social Medicine, University of North Carolina School of Medicine, Chapel Hill, NC, USA

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ABSTRACT

The Hispanic, Latino, or Spanish (hereafter, "Hispanic") populations in the U.S. bear a disproportionate burden of COVID-19-related outcomes, including disease incidence and mortality. Developing culturally appropriate national public health services for Hispanic persons remains a challenge. This study examined the association of heritage and language preference with COVID-19 testing (tested vs. not tested) and vaccination (vaccinated vs. not vaccinated) outcomes among Hispanic participants from 18 Rapid Acceleration of Diagnostics-Underserved Populations (RADx-UP) projects (n = 3308; mean age = 44.1 years [SD = 14.9], 60% women; 83% spoke other than English at home). Generalized estimating equation models adjusted for age, gender, education level, income, insurance coverage, geographic region, comorbidities, and prior infection. Relative to Mexican heritage, individuals identifying as Puerto Rican or Dominican were more likely to test for COVID-19, and South American heritage was associated with higher testing and vaccination rates. Speaking Spanish or another language at home was associated with increased testing compared with speaking English at home for individuals who preferred not to report their heritage, and increased vaccination for those with Mexican, Cuban, or Central American heritage. This study highlights heterogeneity in testing and vaccination behaviors among Hispanic populations based on heritage and language preference, underscoring the diversity within the U.S. Hispanic community. In contrast to other studies on linguistic acculturation and health care utilization, our study found that a language other than English spoken at home was associated with greater vaccine uptake. That is, enculturation – the retention of Spanish language and presumably of Hispanic cultural norms – was linked with being vaccinated.

1. Introduction

The disproportionate impact of COVID-19[1] on underserved populations brought attention to health disparities and the need for improved public health response. Data on race and ethnicity reveal that Hispanic, Latino, or Spanish (hereafter, "Hispanic") populations

* Corresponding author at: Duke University School of Medicine, 311 Trent Dr., 5244, Durham, NC 27710, USA.
E-mail address: emily.m.dagostino@duke.edu (E.M. D'Agostino).

[1] "COVID-19" is used herein to refer to SARS-Cov-2 (severe acute respiratory syndrome coronavirus 2), which led to a global pandemic manifested as coronavirus disease 2019 (COVID-19).

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experience a higher burden of COVID-19-related outcomes, particularly disease incidence and mortality. Approximately one-third of Hispanic individuals reported that COVID-19 vaccine distribution did not consider their needs, and 32% were not planning to receive the vaccine in January 2021 (McMorrow & Thomas, 2021; Xian et al, 2021). Developing culturally appropriate services for Hispanic individuals presents challenges due to the vast and diverse population of over 60 million (Lopez et al, 2022). Historical migration patterns have resulted in geographic variations in Hispanic populations across the U.S., including a concentration of individuals of Cuban heritage in Florida, individuals of Caribbean heritage in the Northeast, and individuals of Mexican heritage in Southwest border states. Recent trends indicate increasing representation of individuals with Central and South American heritages in various regions and communities across the U.S. (United States Census Bureau, 2022).

Researchers have highlighted the influence of heritage and acculturation as determinants of health in the U.S. (Abraído-Lanza et al, 2016). English language proficiency, as an indicator of acculturation, has been associated with greater participation in health initiatives and systems. Additionally, researchers have recognized the need for further exploration of the complex effects of heritage and acculturation on factors that impact health service utilization and health behaviors, such as education, poverty, identity, norms, beliefs, values, and support networks (Abraído-Lanza et al, 2016; Sheinfeld Gorin & Heck, 2005). Acculturation may predict health behaviors and have varying effects on health outcomes in different heritage groups, considering factors like multigenerational households, geographic context, and age of migration to the US (Ramírez García, 2019).

This study aims to examine two significant indicators of Hispanic heterogeneity, namely place of origin (heritage) and language preference, in relation to COVID-19 testing and vaccination outcomes. This study is part of the National Institutes of Health Rapid Acceleration of Diagnostics-Underserved Populations (RADx-UP) initiative, which supports a consortium of 137 community-engaged research projects that aim to understand the drivers of COVID-19-related health disparities and improve access to and acceptance of COVID-19 diagnostic and preventive measures among underserved populations (Corbie et al, 2022). Empirical research on Hispanic heterogeneity has been limited due to sample sizes necessary for robust findings. This study is distinguished by its use of the RADx-UP national dataset, contributing to the growing literature on enhancing national public health readiness.

2. Material and methods

2.1. Study sample and population

The study included individuals who identified as Hispanic, Latino, or Spanish, were 18 years and older, resided in the U.S., and participated in a RADx-UP project between February 2021 and June 2022. RADx-UP projects collected a standardized set of predefined common data elements (CDEs) and uploaded them to the Coordination and Data Collection Center (CDCC) (Carrillo et al., 2022). Projects had to have at least 20% of available data for the primary, secondary outcomes, and exposure groups for inclusion (see Fig. S1). IRB approval was obtained at the institutional level and Duke University (CDCC).

2.2. Measures

The primary outcome was whether participants had ever been tested for COVID-19, based on their response to the question "Have you ever been tested for COVID-19?" The secondary outcome was whether participants had received at least one COVID-19 vaccine, based on their response to the question "Have you received a COVID-19 vaccine?" Questions referred to the participants' prior history of testing/vaccination, and our analysis included only responses collected at enrollment.

The main exposure variable for the primary hypothesis was heritage, categorized as Mexico, Cuba, Dominican Republic, Puerto Rico, other Central American, South American, or multiple countries of origin (participants who identified themselves as having more than one Hispanic country of origin or a country outside of the Americas). Covariates included age, gender identity (man, woman), highest level of education (no or lower grade education, high school graduate or completed GED, some college level/technical/vocational degree, college graduate or other advanced degree), insurance (none, private, public), income (less than $15 K, $15-$34999, $35-$74999, ≥$75 K), number of comorbidities (0, 1, ≥2), and residency geographic region (South, West, Midwest, Northeast; see Fig. S2). For the secondary hypothesis, the main exposure variable was language preference (speaking English only at home, or speaking Spanish or another language other than English at home), and the same covariates.

2.3. Statistical analysis

Descriptive statistics were used to summarize sample characteristics. Multiple imputation with chained equations was performed to impute missing covariate data (education, income, insurance coverage, comorbidities). The imputed data were summarized (see Table S1). The association between heritage and language preference and the primary outcome of COVID-19 testing (tested vs. not tested) and secondary outcome of COVID-19 vaccination (vaccinated vs. not vaccinated) was analyzed using generalized estimating equations with logit link function. Project was included as a clustering group variable in the models to account for geographic and project-based distributions, as RADx-UP projects are specific to certain populations/regions (RADx® Underserved Populations, 2022). Unadjusted models and models adjusted for age, gender, highest level of education, income, insurance coverage, comorbidities, geographic region, prior testing (vaccination model only), and number of comorbidities were run, considering the importance of health insurance coverage and comorbid conditions in COVID-19 outcomes (Campbell et al, 2022; Centers for Disease Control and Prevention, 2022). The models were repeated for language preference and with the interaction between heritage and language preference. Odds ratios (OR) with 95% confidence intervals (CIs) were reported. Hypothesis testing was two-sided, and Wald tests were used at an alpha level of 0.05.

3. Results

3.1. Demographics

Among the 80 eligible projects that provided data from September 2020-June 2022, 18 projects (n = 3,308 individuals; see Fig. S1 and Table S2) met inclusion criteria. The analytic population included individuals across 18 states with the following heritage: Mexico (45%), Puerto Rico (17%), Cuba (14%), Dominican Republic (9%), South American countries (6%), other Central American countries (4%), and multiple Hispanic and non-Hispanic countries (1%); 4% preferred not to answer (Table S3). The mean age was 44.1 years (SD = 14.9), and 60% of the participants were women. Moreover, 83% of the participants spoke Spanish or another language other than English at home (see Table 1).

3.2. Heritage

Heritage was associated with COVID-19 testing ($p_a < 0.0001$). Participants with Puerto Rican, Dominican, and South American heritage had an adjusted odds ratio of 1.22 (95% CI_a = 1.03,1.44), 1.63 (95% CI_a = 1.22, 2.18) and 2.74 (95% CI_a = 1.66, 4.52), respectively, for testing compared to Mexican heritage (see Table S4a). Heritage also was associated with receiving at least one COVID-19 vaccine ($p_a < 0.0001$). Participants who reported South American heritage and individuals who preferred not to provide heritage had an adjusted odds ratio of 1.68

Table 1
Baseline characteristics by heritage among RADx-UP Hispanic, Latino, or Spanish participants.

Characteristic	Mexico (N = 1,497)	Puerto Rico (N = 547)	Cuba (N = 451)	Dominican Republic (N = 280)	Other Central American countries (N = 144)	South American countries (N = 214)	Multiple Hispanic and Non-Hispanic Countries* (N = 46)	Prefer not to answer (N = 129)	Total (N = 3,308)	P-value*
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	
Age, mean (SD)	39.4 (13.7)	47.1 (12.4)	54.1 (14.6)	47.0 (15.9)	43.9 (15.4)	46.8 (15.4)	40.1 (12.9)	42.3 (14.7)	44.1 (14.9)	<0.0001
Gender identity										<0.0001
Woman	1,034 (69)	197 (36)	221 (4%)	187 (67)	81 (56)	132 (62)	32 (70)	87 (67)	1,971 (60)	
Man	463 (31)	350 (64)	230 (51)	93 (33)	63 (44)	82 (38)	14 (30)	42 (33)	1,337 (40)	
Language spoken at home										<0.0001
English only	317 (21)	90 (16)	33 (7)	35 (13)	17 (12)	24 (11)	23 (50)	33 (26)	572 (17)	
Not English only	1,180 (79)	457 (84)	418 (93)	245 (88)	127 (88)	190 (89)	23 (50)	96 (74)	2,736 (83)	
Highest education										<0.0001
No or some education (no school, lower grade education)	416 (28)	218 (40)	157 (35)	94 (34)	52 (36)	32 (15)	**	41 (32)	1,016 (31)	
High school graduate or GED completed	331 (22)	145 (27)	103 (23)	51 (18)	36 (25)	34 (16)	**	26 (20)	731 (22)	
Some college level / technical / vocational degree	399 (27)	118 (22)	100 (22)	64 (23)	34 (24)	56 (26)	18 (39)	29 (22)	818 (25)	
College graduate or other advanced degree	308 (21)	56 (10)	90 (20)	67 (24)	21 (15)	92 (43)	16 (35)	24 (19)	674 (20)	
Missing	43 (3)	10 (2)	1 (0)	4 (1)	1 (1)	0 (0)	1 (2)	9 (7)	69 (2)	
Health insurance coverage										<0.0001
Private (purchased directly or through employment)	462 (31)	61 (11)	95 (21)	58 (21)	30 (21)	95 (44)	13 (28)	36 (28)	850 (26)	
Public (Medicare, Medicaid, Tricare)	615 (41)	435 (80)	267 (59)	186 (66)	62 (43)	73 (34)	24 (52)	55 (43)	1,717 (52)	
I do not have health insurance	329 (22)	35 (6)	81 (18)	23 (8)	43 (30)	38 (18)	**	13 (10)	569 (17)	
Missing	91 (6)	16 (3)	8 (2)	13 (5)	9 (6)	8 (4)	**	25 (19)	172 (5)	
Number of comorbidities										<0.0001
None	909 (61)	202 (37)	198 (44)	143 (51)	75 (52)	123 (57)	23 (50)	69 (53)	1,742 (53)	
One	349 (23)	151 (28)	121 (27)	75 (27)	29 (20)	50 (23)	13 (28)	22 (17)	810 (24)	
Two or more	229 (15)	193 (35)	131 (29)	62 (22)	38 (26)	39 (18)	**	35 (27)	737 (22)	
Missing	10 (1)	1 (0)	1 (0%)	0 (0)	2 (1)	2 (1)	**	3 (2)	19 (1)	
Income level										<0.0001
Less than $15 K	176 (12)	282 (52)	252 (56)	94 (34)	46 (32)	77 (36)	12 (26)	29 (22)	968 (29)	
$15-$34,999	348 (23)	116 (21)	111 (25)	92 (33)	41 (28)	66 (31)	**	30 (23)	812 (25)	
$35-$74,999	299 (20)	62 (11)	44 (10)	46 (16)	19 (13)	34 (16)	**	15 (12)	526 (16)	
$75 K and above	165 (11)	18 (3)	21 (5)	21 (8)	**	13 (6)	14 (30)	11 (9)	268 (8)	
Missing	509 (34)	69 (13)	23 (5)	27 (10)	***	24 (11)	5 (11)	44 (34)	734 (22)	
US Region										<0.0001
Northeast	43 (3)	305 (56)	16 (4)	233 (83)	**	***	**	20 (16)	639 (19)	
Midwest	810 (54)	123 (22)	**	**	38 (26)	29 (14)	**	49 (38)	1,065 (32)	
South	303 (20)	****	429 (95)	42 (15)	96 (67)	167 (78)	25 (54)	16 (12)	1,196 (36)	
West	341 (23)	**	**	**	**	**	12 (26)	44 (34)	408 (12)	
Ever tested positive for COVID										<0.0001
No	722 (48)	361 (66)	298 (66)	169 (60)	66 (46)	132 (62)	29 (63)	68 (53)	1,845 (56)	
Yes	348 (23)	79 (14)	87 (19)	77 (28)	44 (31)	64 (30)	11 (24)	32 (25)	742 (22)	
Prefer not to answer	427 (29)	107 (20)	66 (15)	34 (12)	34 (24)	18 (8)	6 (13)	29 (22)	721 (22)	

Baseline characteristics were compared between heritage groups using Kruskal-Wallis test for means and chi-square tests for percentages. *Includes more than one country or a non-Hispanic country reported by a participant. **Values between 1–10 are suppressed to reduce risk of identity disclosure. ***Values between 11–35 that are suppressed to ensure small values cannot be uncovered through back calculation. ****Values above 100 that are suppressed to ensure small values cannot be uncovered through calculation.

(95% CI $_a$ = 1.06, 2.64) and 0.57 (95% CI_a = 0.33, 0.98), respectively, for vaccination compared to Mexican heritage (Table S4b).

3.3. Language preference

Participants who spoke only English at home (n = 572) were more likely to be younger, better educated, and have Mexican heritage, private insurance, and higher income (each p <.0001) (Table S5a). Language preference was not associated with COVID-19 testing in unadjusted or adjusted models (Table S5b). However, those who spoke Spanish or another language at home (vs. English) were more likely to have received a COVID-19 vaccine (n = 2192 [80%] vs. n = 418 [73%]; OR_a = 1.73, 95% CI_a = 1.26, 2.39; Table S5c).

3.4. Interaction of heritage and language preference

The association between language preference and COVID-19 testing differed by heritage (p_a < 0.0001). Participants who preferred not to provide heritage and spoke Spanish or another language at home (vs. English) were more likely to have been tested for COVID-19 (OR_a = 2.29, 95% CI_a = 1.19, 4.41). For other heritages, the adjusted association of language preference and COVID-19 testing did not reach significance (Table 2).

There was also a significant association between heritage, language preference, and receiving at least one COVID-19 vaccine (p_a < 0.0001). Participants who spoke Spanish or another language at home (vs. English) were more likely to receive a COVID-19 vaccine if they reported Mexican (OR_a = 2.04, 95% CI_a = 1.49, 2.80), Cuban (OR_a = 3.28, 95% CI_a = 2.04, 5.27), or other Central American heritage (OR_a = 3.29, 95% CI_a = 1.24, 8.75). However, the adjusted association of language preference and COVID-19 vaccination did not reach significance for other heritage groups in this sample (Table 2).

4. Discussion

This study, which included over 3,000 Hispanic, Latino, or Spanish RADx-UP participants, reveals variation in COVID-19 testing and vaccination behaviors based on heritage and language preference. Participants with Dominican and Puerto Rican heritage were more likely to undergo testing for COVID-19 compared to those with Mexican heritage, while participants with South American heritage were more likely to both test and receive vaccination. Speaking Spanish or a language other than English at home was associated with greater COVID-19 testing for individuals who preferred not to identify their heritage, and higher vaccination rates for individuals who identified their heritage as Mexican, Cuban, or other Central American heritage.

The challenge in reducing barriers to health care access and utilization for Hispanic individuals is amplified by the population's large size, diversity, geographic dispersion, and heterogeneity in cultural, linguistic, and immigration experiences (Abraído-Lanza et al, 2016). Similar to previous research, this study highlights significant differences in health services utilization (Guerrero et al, 2013; Haviland et al, 2011; Logan & Turner, 2013; Pearson et al, 2008; Sheinfeld Gorin & Heck, 2005), including testing and vaccination, among different ethnic subgroups (Perreira et al., 2021). In contrast to other studies on linguistic acculturation and health care service utilization (Haviland et al, 2011; Pearson et al, 2008), our study found a language other than English spoken at home was associated with greater vaccine uptake. That is, *enculturation* – the retention of Spanish language and presumably of Hispanic cultural norms – was linked with being vaccinated. This may be attributed to factors such as immunization laws and universal access to primary care in many Latin American countries, the politically charged environment surrounding COVID-19 vaccination in the U.S., effective community engagement strategies employed in RADx-UP, or other regional or project-related factors. Further research investigating the relationship between linguistic preferences, acculturation indicators, and health behaviors can contribute to our understanding of the socioeconomic and health care needs of underserved populations (Albrecht 2022).

4.1. Strengths and limitations

RADx-UP is founded on principles of community-engaged research with data collection conducted through extensive engagement with community partners during the COVID-19 pandemic, when public trust of science and public health was in flux and health misinformation rampant (Tagliabue et al, 2020). This study provides a unique opportunity to analyze standardized data from 18 projects across the U.S., encompassing Hispanic participants from over 26 countries of origin.

However, there are several limitations to consider. Certain confounding factors could not be accounted for due to their absence in the RADx-UP dataset or missing data. These factors include timing of testing (although we examined whether project timing may be correlated with testing and vaccination for particular heritage groups, see Table S6), or

Table 2
Association of heritage and language preference with taking a COVID-19 test and receiving at least one COVID-19 vaccine among RADx-UP Hispanic, Latino, or Spanish participants.

Heritage	Tested at least once for COVID-19			Received at least one COVID-19 vaccine		
	Unadjusted odds ratio* (95% CI)	Adjusted odds ratio* (95% CI)	Interaction p-value**	Unadjusted odds ratio* (95% CI)	Adjusted odds ratio (95% CI)	Interaction p-value**
Mexico	1.05 (0.82, 1.34)	1.17 (0.88, 1.54)	<0.0001	**1.76 (1.34, 2.31)**	**2.04 (1.49, 2.8)**	<0.0001
Puerto Rico	0.85 (0.39, 1.86)	0.96 (0.50, 1.84)		1.64 (0.96, 2.82)	1.17 (0.81, 1.71)	
Cuba	0.48 (0.22, 1.03)	0.54 (0.20, 1.48)		**3.52 (2.85, 4.35)**	**3.28 (2.04, 5.27)**	
Dominican Republic	**1.84 (1.09, 3.13)**	1.56 (0.91, 2.67)		0.92 (0.49, 1.71)	0.79 (0.39, 1.58)	
Other Central American countries	0.60 (0.12, 2.97)	0.66 (0.10, 4.41)		**3.13 (1.31, 7.48)**	**3.29 (1.24, 8.75)**	
South American countries	**0.30 (0.12, 0.78)**	0.40 (0.14, 1.12)		0.30 (0.05, 1.78)	0.26 (0.04, 1.79)	
Multiple Hispanic and non-Hispanic countries	0.55 (0.14, 2.12)	0.64 (0.13, 3.23)		0.86 (0.36, 2.06)	1.35 (0.54, 3.35)	
Prefer not to answer	1.86 (0.9, 3.85)	**2.29 (1.19, 4.41)**		1.50 (0.63, 3.58)	1.69 (0.55, 5.21)	

*Odds ratios are estimates of odds for getting tested or vaccinated given another language is spoken at home compared to English only is spoken at home (reference group). ** P-value is for fully adjusted model estimates with heritage, language spoken at home, their interaction, age, gender, education, income, insurance coverage, geographic region, prior testing (vaccination model only), and comorbidities. Boldface indicates p <.05.

prior COVID-19 infection, contextual factors influencing testing and vaccination behaviors, essential worker status, and living arrangements such as congregate or multigenerational housing. The variables used in the analysis serve as limited proxies for more precise measures unavailable in the RADx-UP CDEs. For instance, the dataset does not distinguish between single-dose, multi-dose, and up-to-date vaccination status. Moreover, categorizing heritage based on place of origin and language spoken at home oversimplifies the complexity of heritage and acculturation, although these categorizations are commonly used in the literature (Abraído-Lanza et al., 2016). Important measures of heritage and acculturation such as nativity, generation, duration in the US, residence in cultural enclaves, and immigration status are not included in the dataset. Additionally, while the analysis accounts for project-based variability, certain heritage countries may be overrepresented in specific U.S. regions, limiting the ability to disentangle heritage from study design, sampling methods, and contextual factors. Furthermore, data from other projects may have been excluded from the analysis due to missing CDEs that could be specifically relevant to certain Hispanic subgroups. Finally, although the study's sample includes individuals who identify as Hispanic, Latino, or Spanish from diverse U.S. regions, it was not designed to be representative of the U.S. Hispanic, Latino, or Spanish populations.

5. Conclusions

This study highlights heterogeneity in testing and vaccination behaviors among Hispanic populations based on heritage and language preference, underscoring the diversity within the U.S. Hispanic community. Further research examining COVID-19 testing and vaccination within different racial and ethnic subgroups is essential to guide researchers, policymakers, and practitioners in reducing health disparities in accessing COVID-19 containment measures and addressing similar public health challenges.

CRediT authorship contribution statement

Emily M. D'Agostino: Supervision, Conceptualization, Methodology, Writing – original draft. **Jorge Ramirez Garcia:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **Suzanne R. Bakken:** Conceptualization, Methodology, Writing – review & editing. **Lisa Wruck:** Supervision, Data curation, Methodology, Formal analysis, Writing – review & editing, Visualization. **Ester Kim Nilles:** Data curation, Methodology, Formal analysis, Writing – review & editing, Visualization. **Troy A. Stefano:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **Haley R. Martin:** Conceptualization, Writing – review & editing. **Annette Hungler:** Conceptualization, Writing – review & editing. **Rebecca E. Lee:** Conceptualization, Writing – review & editing. **Krista M. Perreira:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **Marianna K. Baum:** Conceptualization, Writing – review & editing. **David Brown:** Supervision, Conceptualization, Methodology, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Requests to access the datasets should be directed to the RADx-UP Data Core, RADx-UP-CDCC@dm.duke.edu.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2023.102359.

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