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A cross-sectional analysis of the HELIUS study

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Intent to vaccinate against SARS-CoV-2 and its determinants across six ethnic groups living in Amsterdam, the Netherlands: A cross-sectional analysis of the HELIUS study

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ABSTRACT

Background: Ethnic minority groups experience a disproportionately high burden of infections, hospitalizations and mortality due to COVID-19, and therefore should be especially encouraged to receive SARS-CoV-2 vaccination. This study aimed to investigate the intent to vaccinate against SARS-CoV-2, along with its determinants, in six ethnic groups residing in Amsterdam, the Netherlands.
Methods: We analyzed data of participants enrolled in the population-based multi-ethnic HELIUS cohort, aged 24 to 79 years, who were tested for SARS-CoV-2 antibodies and answered questions on vaccination intent from November 23, 2020 to March 31, 2021. During the study period, SARS-CoV-2 vaccination in the Netherlands became available to individuals working in healthcare or > 75 years old. Vaccination intent was measured by two statements on a 7-point Likert scale and categorized into low, medium, and high. Using ordinal logistic regression, we examined the association between ethnicity and lower vaccination intent. We also assessed determinants of lower vaccination intent per ethnic group.
Results: A total of 2,068 participants were included (median age 56 years, interquartile range 46–63). High intent to vaccinate was most common in the Dutch ethnic origin group (369/466, 79.2%), followed by the Ghanaian (111/213, 52.1%), South-Asian Surinamese (186/391, 47.6%), Turkish (153/325, 47.1%), African Surinamese (156/362, 43.1%), and Moroccan ethnic groups (92/311, 29.6%). Lower intent to vaccinate was more common in all groups other than the Dutch group ($P < 0.001$). Being female, believing that COVID-19 is exaggerated in the media, and being < 45 years of age were common determinants of lower SARS-CoV-2 vaccination intent across most ethnic groups. Other identified determinants were specific to certain ethnic groups.

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Conclusions: Lower intent to vaccinate against SARS-CoV-2 in the largest ethnic minority groups of Amsterdam is a major public health concern. The ethnic-specific and general determinants of lower vaccination intent observed in this study could help shape vaccination interventions and campaigns.
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1. Introduction

Coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has had a major impact on global public health and society since early 2020. Ethnic minority populations have been disproportionately affected by SARS-CoV-2, while experiencing higher infection, hospitalization, and mortality rates [1–7]. Vaccines against SARS-CoV-2 can effectively prevent severe disease progression [8]. However, the success of vaccination programs in protecting populations from the consequences of infection will depend on not only its effectiveness, but also its uptake, for which intent seems to be a key driver [9,10].

Studies from the United Kingdom (UK) and the United States (US) have identified negative attitudes towards SARS-CoV-2 vaccination and low intent to get vaccinated among ethnic minority groups [5,11–13]. Reasons for SARS-CoV-2 vaccine hesitancy among people from ethnic minority backgrounds include mistrust of vaccine benefits, worries about side effects, concerns about commercial profiteering, preference of natural immunity over vaccination, and general mistrust in government and public health institutions [14,15]. Differences in vaccination intent between ethnic groups might relate to differences in language barriers, culture, experiencing stigma and discrimination [16], information sources on COVID-19, and healthcare seeking behavior [17].

According to a series of cross-sectional surveys conducted in the Netherlands between November 2020 and March 2021, the intent to vaccinate against SARS-CoV-2 varied between 48% in November and 75% in March [18]. These surveys, however, underrepresented people who were male, less educated, under 25 years of age, and who had a migration background [19]. As a result, our understanding of whether SARS-CoV-2 vaccination intent differs between ethnic groups living in the Netherlands is incomplete. This is concerning given that differences in uptake of vaccination against infectious diseases included in the Dutch National Immunization Program have been previously reported between ethnic groups in the Netherlands [20]. For instance, the uptake of vaccination against Human Papillomavirus (HPV) was higher among girls with parents of Dutch compared to other than Dutch ethnic origin [21]. However, these results might not translate to vaccination against SARS-CoV-2, for which its use was implemented in the context of a pandemic (as opposed to routine HPV vaccination), its target population is broader (i.e., HPV vaccines are offered predominately at younger ages) and the clinical course of the infection its preventing is more acute (i.e., complications from HPV develop at later ages). To the best of our knowledge, there have been no studies conducted specifically aimed at studying ethnic differences in the intent or uptake of vaccination against H1N1 or other seasonal-influenza in the Netherlands. If any differences in vaccination intent against SARS-CoV-2 exist between ethnic groups, understanding the reasons for lower intent to vaccinate could be used to help develop targeted interventions aimed at improving vaccine uptake in ethnic minority groups.

Therefore, this study aimed to compare the intent to vaccinate against SARS-CoV-2 between six ethnic groups in Amsterdam, the Netherlands (Dutch, South-Asian Surinamese, African Surinamese, Ghanaian, Turkish, and Moroccan), and to explore determinants of lower vaccination intent within each ethnic group.

2. Methods

2.1. Study design and population

We used data from the Healthy Life in an Urban Setting (HELIUS) study, which is a population-based multi-ethnic prospective cohort study conducted in Amsterdam and focuses on the causes of potential ethnic disparities in cardiovascular disease, mental health, and infectious diseases. Detailed procedures have been previously described [22]. Briefly, HELIUS includes individuals of Dutch, Surinamese, Ghanaian, Turkish, and Moroccan origin, aged between 18 and 70 years at inclusion. A random sample, stratified by ethnic origin, was drawn from the municipality register of Amsterdam and subjects were invited to participate. A total of 24,789 participants were included between January 2011 and December 2015 [22]. Ethnic origin groups other than Dutch were defined as: (1) the individual, and at least one parent, were not born in the Netherlands (first generation), and (2) the individual was born in the Netherlands, but both parents were not (second generation) [22,23]. After data collection, participants of Surinamese origin were further classified into African, South-Asian, or 'other' based on self-report. Participants completed a questionnaire and underwent physical examination during which biological samples were obtained. The HELIUS study was approved by the Academic Medical Center Ethical Review Board, and written informed consent was obtained from all participants [22].

Participants of the parent HELIUS cohort who were still in follow-up and of Dutch, South-Asian Surinamese, African Surinamese, Ghanaian, Turkish or Moroccan origin were randomly selected within each ethnic group and were asked to participate in a two-visit longitudinal COVID-19 substudy. More detailed procedures on the sampling of participants for the COVID-19 substudy have been previously described [24]. In total, 2,497 participants were included between June 24 and October 9, 2020 for the first COVID-19 substudy visit. We invited all participants who completed the first COVID-19 substudy visit to participate in the second COVID-19 substudy visit between November 23, 2020 and June 4, 2021. This study included those who participated in the second COVID-19 substudy visit. We excluded all visits after March 31, 2021 since only fourteen individuals participated in the second COVID-19 substudy between April 1 and June 4, 2021. The Dutch vaccination campaign started on January 6, 2021 and SARS-CoV-2 vaccination became available to individuals working in healthcare or > 75 years old during our study period [25]. As such, most HELIUS participants were not yet eligible for vaccination during this study. We excluded the few participants who received SARS-CoV-2 vaccination. During both COVID-19 substudy visits, blood samples were obtained via venipuncture and were tested for SARS-CoV-2-specific antibodies, measured with the WANTAI SARS-CoV-2 Ab enzyme-linked immunosorbent assay (ELISA) (Wantai Biological Pharmacy Enterprise Co., Beijing, China) [26]). Participants completed questionnaires on SARS-CoV-2 exposure, testing, information source, prevention measures, and perceptions.

During the second COVID-19 substudy visit, additional questions on SARS-CoV-2 vaccination intent were administered.

2.2. Outcome

Vaccination intent was measured by two statements: (1) 'Are you planning to get vaccinated against SARS-CoV-2?' and (2) 'What is the chance that you would truly get vaccinated against SARS-CoV-2?'. Responses were provided using a 7-point Likert scale, beginning at 1 ('no, certainly not' and 'very small', respectively) to 4 ('maybe, maybe not' and 'not small, not large', respectively) and ending at 7 ('yes, certainly' and 'very large', respectively). Based on Ajzen's Theory of Planned Behavior, which states that both behavioral intentions and perceived behavioral control can predict behavior [10], we combined the two responses as a mean score, creating a more accurate measure of vaccination intent. Additionally, the internal consistency between the statements was high (Cronbach's α = 0.91, ranging between 0.89 and 0.91 for the South-Asian and African Surinamese groups, respectively). We then categorized the combined score into low (mean score 1.0–2.5), medium (3.0–5.0) and high (5.5–7.0), based on the distribution of the combined score (Supplementary Figure S1).

2.3. Potential determinants

We used the following data from the HELIUS baseline visit: socio-demographics (i.e., age [recalculated for the second COVID-19 substudy visit], sex, and educational level), access-to-healthcare indicators (i.e., difficulty with Dutch language, health literacy), ethnic identity and cultural orientation [no integration (including separation and marginalization) versus integration (also including assimilation)], perceived discrimination, psychological distress at work and at home, and social support. Comorbidities were based on self-report and/or on medication use: diabetes mellitus, asthma/Chronic Obstructive Pulmonary Disease (COPD), hypertension, and cardiovascular disease (CVD). Overweight was defined as a Body Mass Index (BMI) $\geq$ 25 kg/m^2, as measured during physical examination. Information on the instruments used is described in the Supplementary Methods 1.

We used the following data from the first COVID-19 substudy visit: job setting, source of COVID-19 information, COVID-19 hospitalization of household members (all self-report), and the presence of SARS-CoV-2 antibodies. We used the following data from the second COVID-19 substudy visit: eligibility for influenza vaccination, tested for SARS-CoV-2 infection since the first COVID-19 substudy visit, COVID-19 hospitalization of household members and/or close contacts since the first COVID-19 substudy visit, depressive symptoms, and COVID-19 perceptions (all self-report). Perceptions were divided into COVID-19-related stigma, emotional distress, and believing that COVID-19 is exaggerated in the media (Supplementary Methods 2).

2.4. Statistical analysis

The distributions (i.e., low, medium and high) of both the individual and combined vaccination intent variables were compared between ethnic groups using Pearson's χ^2 test. Vaccination intent was considered an ordinal outcome, and as such we modeled the probability of having a lower vaccination intent using ordinal logistic regression. We calculated the univariable odds ratio (OR) and its 95% confidence intervals (CI) comparing the average odds of a one-unit decrease in vaccination intent (i.e., comparing medium versus high and low versus medium intent) across ethnic groups. We adjusted for month of study visit, as vaccination intent might have changed at different stages of the pandemic, vaccine development and availability, and implemented policy measures [27].

We assessed the determinants of lower vaccination intent within each ethnic group, separately. We chose to stratify these analyses *a priori* on ethnicity because we hypothesized that ethnic differences in determinants of vaccination intent would exist between groups. We calculated the univariable OR and 95% CI comparing the average odds of a one-unit decrease in intent across levels of determinants using ordinal logistic regression. We then constructed a multivariable model by including all potential determinants with a *P*-value $\leq$ 0.20 in univariable analyses in a full model. After assessing covariate distributions and collinearity, we removed all determinants with a $P \geq 0.05$, except month of study visit, in backward stepwise fashion to obtain a final model. The proportional odds assumption was met for all models. To confirm whether certain factors were ethnic-specific, we entered ethnic group, all determinants that remained in at least one of the final multivariable models across ethnic groups, and the interaction between ethnic group and each of these determinants, one-by-one, in separate multivariable models. We tested the interaction term per ethnic group.

A *P*-value < 0.05 was considered statistically significant. All regression analyses were corrected for sampling, accounting for the population structure (i.e., age and sex) of ethnic groups in Amsterdam (i.e., post-stratification) [24]. All analyses were performed using STATA version 15.1 (College Station, TX, USA).

3. Results

3.1. Population description

Of the 2,497 HELIUS participants included in the first COVID-19 substudy visit, 2,075 (83.1%) participated in the second COVID-19 substudy visit between November 23, 2020 and March 31, 2021. Of them, those who were vaccinated against SARS-CoV-2 (n = 3), without data on vaccination intent (n = 3), or with incomplete data for sampling and post-stratification weights (n = 1) were excluded. In total, 2,068 individuals were analyzed (Figure 1). Response rates and participant characteristics of those invited and included in the first and second COVID-19 substudy visits have been described previously [6,24].

Participant characteristics are presented in Table 1. All characteristics differed significantly between ethnic groups, except for sex and having asthma or COPD (*P* = 0.067 and *P* = 0.53, respectively). Participant age ranged between 24 and 79 years at time of participation in the second COVID-19 substudy visit, and median age was 56 years [IQR 46–63]. The percentage of participants with higher-level education ranged from 10.0% in the Ghanaian group to 66.9% in the Dutch group. Participants of Ghanaian origin were the least likely (67.7%) to have adequate health literacy. Diabetes mellitus and CVD were most prevalent in the South-Asian Surinamese group (19.7% and 15.4%, respectively), and hypertension in the African Surinamese group (57.8%).

3.2. SARS-CoV-2-related variables across ethnic groups

Table 2 summarizes data on SARS-CoV-2 exposure, testing, information source, perceptions, and vaccination intent among included participants. The majority of participants (88.2%) received information about COVID-19 through radio, television, and newspapers. The Ghanaian group reported the lowest percentage of hospitalized household members and close contacts with COVID-19 (0.9%), and the lowest percentage tested for SARS-CoV-2 since the first COVID-19 substudy visit (28.2%). This group had the highest percentage of positive SARS-CoV-2 antibody results at the first COVID-19 substudy visit (25.8%).

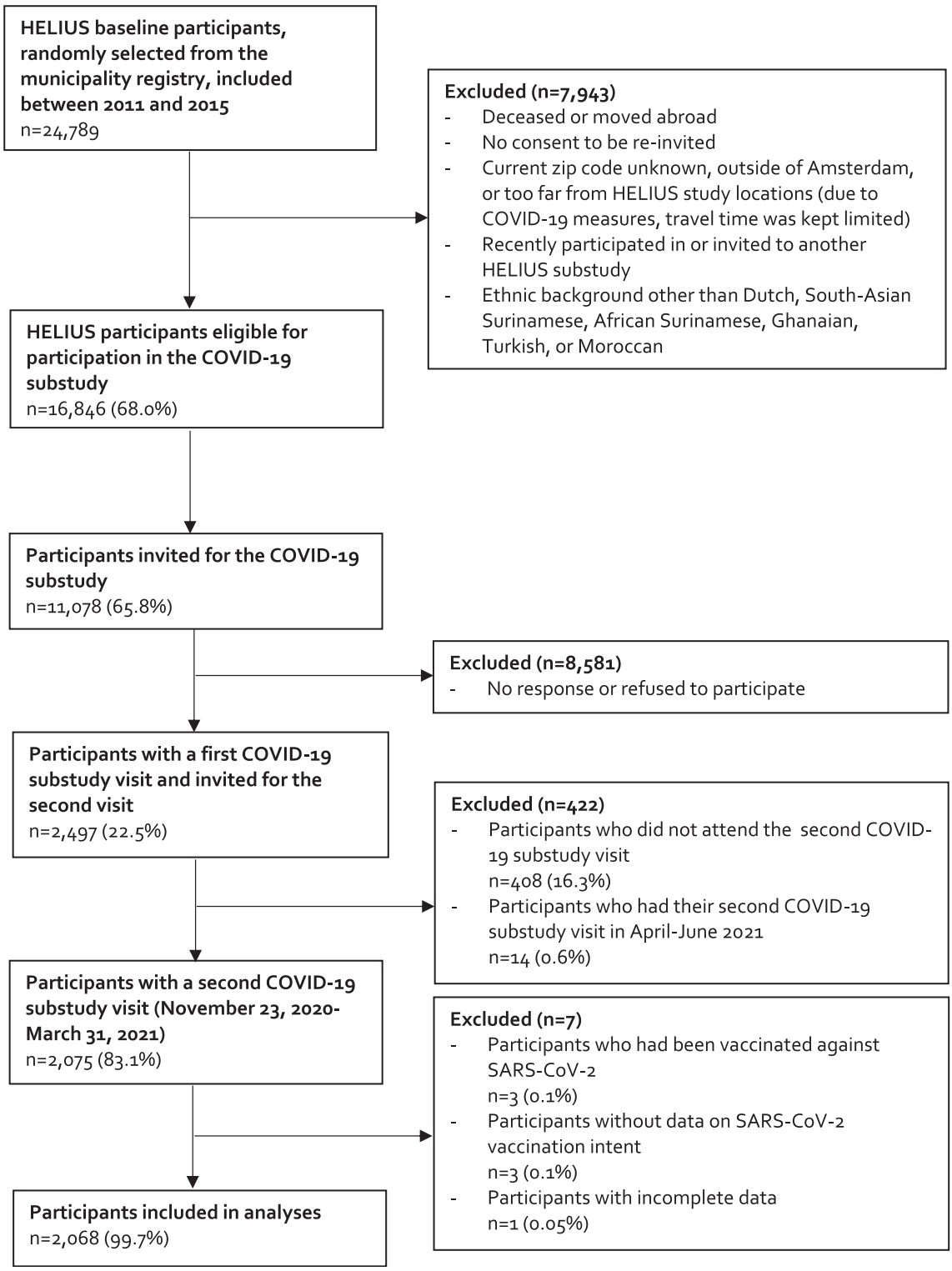

Fig. 1. Flowchart of the inclusion of HELIUS participants in the second visit of the longitudinal COVID-19 substudy, Amsterdam, the Netherlands, November 23, 2020 - March 31, 2021. Abbreviations: *HELIUS* Healthy Life in an Urban Setting; *COVID-19* Coronavirus disease 2019; *SARS-CoV-2* Severe Acute Respiratory Syndrome Coronavirus 2.

3.3. Association between ethnicity and vaccination intent

As shown in Table 2, vaccination intent varied significantly between ethnic groups, regardless of whether responses to both vaccination intent statements were analyzed together or separately (Supplementary Table S1). The Dutch group had the highest percentage of participants with a high vaccination intent (79.2%), followed by the Ghanaian group (52.1%) (Table 2, Figure 2). In contrast, the majority of Moroccan participants had either a low (29.9%) or medium (40.5%) vaccination intent.

In both unadjusted analyses and analyses adjusted for month of study visit, participants of other than Dutch origin were significantly more likely to report lower vaccination intent than participants of Dutch origin (Table 3). When compared to the Dutch

Table 1
Characteristics of the HELIUS participants included in the second visit of the longitudinal COVID-19 substudy, per ethnic group, Amsterdam, the Netherlands, November 23, 2020 - March 31, 2021 (n = 2,068).

Characteristic	Total (n = 2,068)	Dutch (n = 466)	South-Asian Surinamese (n = 391)	African Surinamese (n = 362)	Ghanaian (n = 213)	Turkish (n = 325)	Moroccan (n = 311)	
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	*P* value
Sex [a]								0.067
Male	914 (44.2)	215 (46.1)	150 (38.4)	151 (41.7)	105 (49.3)	152 (46.8)	141 (45.3)	
Female	1,154 (55.8)	251 (53.9)	241 (61.6)	211 (58.3)	108 (50.7)	173 (53.2)	170 (54.7)	
Age in years, median [IQR] [a]	56 [46–63]	59 [47–67]	57 [49–64]	60 [51–67]	56 [49–62]	50 [41–57]	50 [41–57]	<0.001
<45	488 (23.6)	101 (21.7)	80 (20.5)	43 (11.9)	34 (16.0)	112 (34.5)	118 (37.9)	
45–54	503 (24.3)	81 (17.4)	87 (22.3)	72 (19.9)	63 (29.6)	112 (34.5)	88 (28.3)	
55–59	350 (16.9)	68 (14.6)	72 (18.4)	64 (17.7)	48 (22.5)	51 (15.7)	47 (15.1)	
≥60	727 (35.2)	216 (46.4)	152 (38.9)	183 (50.6)	68 (31.9)	50 (15.4)	58 (18.7)	
Higher educational level/ university [a]								<0.001
No	1,319 (65.2)	154 (33.1)	301 (77.2)	248 (68.9)	180 (90.0)	220 (70.1)	216 (73.2)	
Yes	705 (34.8)	311 (66.9)	89 (22.8)	112 (31.1)	20 (10.0)	94 (29.9)	79 (26.8)	
Missing	*44*	*1*	*1*	*2*	*13*	*11*	*16*	
Job setting [b]								<0.001
No job/caretaker only	597 (28.9)	106 (22.8)	125 (32.1)	108 (29.8)	54 (25.4)	104 (32.0)	100 (32.3)	
Job without contact < 1.5 *m*	314 (15.2)	89 (19.1)	53 (13.6)	36 (9.9)	41 (19.3)	50 (15.4)	45 (14.5)	
Job with contact < 1.5 *m*	663 (32.1)	136 (29.2)	132 (33.9)	117 (32.3)	78 (36.6)	109 (33.5)	91 (29.4)	
Child care/education	194 (9.4)	61 (13.1)	26 (6.7)	39 (10.8)	5 (2.4)	22 (6.8)	41 (13.2)	
Bar/restaurant	58 (2.8)	11 (2.4)	10 (2.6)	10 (2.8)	17 (8.0)	5 (1.5)	5 (1.6)	
Healthcare [c]	240 (11.6)	63 (13.5)	44 (11.3)	52 (14.4)	18 (8.5)	35 (10.8)	28 (9.0)	
Missing	*2*	*0*	*1*	*0*	*0*	*0*	*1*	
Difficulty with Dutch language [a]								<0.001
No	1,447 (71.4)	466 (100.0)	299 (76.7)	321 (89.2)	33 (16.3)	157 (50.0)	171 (58.0)	
Yes	580 (28.6)	0 (0.0)	91 (23.3)	39 (10.8)	169 (83.7)	157 (50.0)	124 (42.0)	
Missing	*41*	*0*	*1*	*2*	*11*	*11*	*16*	
Health literacy [a]								<0.001
Adequate	1,836 (90.4)	464 (99.6)	379 (96.9)	355 (98.1)	136 (67.7)	255 (80.7)	247 (84.0)	
Low	194 (9.6)	2 (0.4)	12 (3.1)	7 (1.9)	65 (32.3)	61 (19.3)	47 (16.0)	
Missing	*38*	*0*	*0*	*0*	*12*	*9*	*17*	
Diabetes mellitus [a]								<0.001
No	1,829 (89.6)	444 (96.5)	309 (80.3)	321 (89.2)	186 (88.6)	297 (92.5)	272 (89.2)	
Yes	212 (10.4)	16 (3.5)	76 (19.7)	39 (10.8)	24 (11.4)	24 (7.5)	33 (10.8)	
Missing	*27*	*6*	*6*	*2*	*3*	*4*	*6*	
Hypertension [a]								<0.001
No	1,242 (60.9)	322 (69.9)	202 (52.5)	152 (42.2)	88 (42.3)	251 (78.0)	227 (74.4)	
Yes	799 (39.2)	139 (30.2)	183 (47.5)	208 (57.8)	120 (57.7)	71 (22.1)	78 (25.6)	
Missing	*27*	*5*	*6*	*2*	*5*	*3*	*6*	
BMI (kg/m^2), median [IQR] [a]	26.2 [23.5–29.2]	24.1 [22.0–27.1]	25.7 [23.2–28.6]	26.7 [24.1–29.4]	27.8 [25.2–29.9]	26.9 [24.2–30.4]	26.9 [24.0–29.8]	<0.001
<25 kg/m^2	822 (40.2)	272 (58.9)	170 (44.0)	125 (34.6)	48 (23.0)	107 (33.2)	100 (32.8)	
≥25 kg/m^2	1,223 (59.8)	190 (41.1)	216 (56.0)	236 (65.4)	161 (77.0)	215 (66.8)	205 (67.2)	
Missing	*23*	*4*	*5*	*1*	*4*	*3*	*6*	
CVD [a]								<0.001
No	1,845 (90.9)	452 (97.0)	338 (86.7)	322 (89.0)	185 (91.6)	279 (88.9)	269 (90.9)	
Yes	185 (9.1)	14 (3.0)	52 (13.3)	40 (11.1)	17 (8.4)	35 (11.2)	27 (9.1)	
Missing	*38*	*0*	*1*	*0*	*11*	*11*	*15*	
Asthma/COPD [a]								0.534
No	1,945 (95.0)	438 (94.8)	367 (95.1)	346 (95.8)	203 (96.7)	300 (93.2)	291 (95.1)	
Yes	102 (5.0)	24 (5.2)	19 (4.9)	15 (4.2)	7 (3.3)	22 (6.8)	15 (4.9)	
Missing	*21*	*4*	*5*	*1*	*3*	*3*	*5*	
Month of second study visit								<0.001
November 2020	251 (12.1)	88 (18.9)	69 (17.6)	40 (11.1)	0 (0.0)	10 (3.1)	44 (14.2)	
December 2020	820 (39.7)	220 (47.2)	174 (44.3)	186 (51.4)	35 (16.4)	101 (31.1)	104 (33.4)	
January 2021	613 (29.6)	110 (23.6)	99 (25.3)	98 (27.1)	103 (48.4)	112 (34.5)	91 (29.3)	
February 2021	259 (12.5)	29 (6.2)	35 (9.0)	28 (7.7)	41 (19.3)	76 (23.4)	50 (16.1)	
March 2021	125 (6.0)	19 (4.1)	14 (3.6)	10 (2.8)	34 (16.0)	26 (8.0)	22 (7.1)	

Abbreviations: *HELIUS* Healthy Life in an Urban Setting; *COVID-19* Coronavirus disease 2019; *IQR* interquartile range; *BMI* Body Mass Index; *CVD* Cardiovascular Disease; *COPD* Chronic obstructive pulmonary disease. [a] Measured at HELIUS baseline (2011–2015); [b] Measured at first COVID-19 substudy visit (June-October 2020). [c] Healthcare worker at a hospital, long-term care facility or elsewhere.

group, the Moroccan group was the most likely to report lower vaccination intent, both before (OR = 8.68, 95% CI = 6.10–12.35) and after (aOR = 9.56, 95% CI = 6.62–13.81) adjusting for month of study visit, followed by the African Surinamese group (OR = 7.01, 95% CI = 4.80–10.25, and aOR = 7.19, 95% CI = 4.92–10.50).

3.4. Determinants of lower SARS-CoV-2 vaccination intent per ethnic group

The determinants of lower SARS-CoV-2 vaccination intent in univariable analyses are presented for each ethnic group separately in Supplementary Tables S2-7. In all final multivariable

Table 2
SARS-CoV-2 exposure, testing, information source, perceptions, and vaccination intent among the HELIUS participants included in the second visit of the longitudinal COVID-19 substudy, per ethnic group, Amsterdam, the Netherlands, November 23, 2020 - March 31, 2021 (n = 2,068).

Characteristic	Total (n = 2,068)	Dutch (n = 466)	South-Asian Surinamese (n = 391)	African Surinamese (n = 362)	Ghanaian (n = 213)	Turkish (n = 325)	Moroccan (n = 311)	
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	*P* value
Household member and/or close contact hospitalized for COVID-19 [a,b]								0.011
No	1,981 (96.1)	453 (97.2)	370 (95.4)	351 (97.0)	211 (99.1)	303 (93.5)	293 (94.8)	
Yes	81 (3.9)	13 (2.8)	18 (4.6)	11 (3.0)	2 (0.9)	21 (6.5)	16 (5.2)	
Missing	*6*	*0*	*3*	*0*	*0*	*1*	*2*	
Sources for COVID-19 information								
No source [a]								<0.001
No	1,888 (91.4)	442 (95.1)	362 (92.8)	335 (92.8)	197 (92.5)	281 (86.5)	271 (87.1)	
Yes	177 (8.6)	23 (5.0)	28 (7.2)	26 (7.2)	16 (7.5)	44 (13.5)	40 (12.9)	
Missing	*3*	*1*	*1*	*1*	*0*	*0*	*0*	
Governmental/medical [a]								0.017
No	1,239 (60.0)	252 (54.2)	223 (57.2)	224 (62.1)	130 (61.0)	210 (64.6)	200 (64.3)	
Yes	826 (40.0)	213 (45.8)	167 (42.8)	137 (38.0)	83 (39.0)	115 (35.4)	111 (35.7)	
Missing	*3*	*1*	*1*	*1*	*0*	*0*	*0*	
Radio/television/newspaper [a]								<0.001
No	243 (11.8)	28 (6.0)	35 (9.0)	35 (9.7)	25 (11.7)	60 (18.5)	60 (19.3)	
Yes	1,823 (88.2)	437 (94.0)	355 (91.0)	327 (90.3)	188 (88.3)	265 (81.5)	251 (80.7)	
Missing	*2*	*1*	*1*	*0*	*0*	*0*	*0*	
Personal communication/social media/internet/advertisement [a]								0.034
No	937 (45.4)	226 (48.6)	178 (45.6)	176 (48.8)	77 (36.2)	148 (45.5)	132 (42.4)	
Yes	1,128 (54.6)	239 (51.4)	212 (54.4)	185 (51.3)	136 (63.9)	177 (54.5)	179 (57.6)	
Missing	*3*	*1*	*1*	*1*	*0*	*0*	*0*	
Eligible for influenza vaccination [b]								<0.001
No	1,051 (50.8)	203 (43.6)	172 (44.0)	134 (37.0)	127 (59.6)	214 (65.9)	201 (64.6)	
Yes	1,017 (49.2)	263 (56.4)	219 (56.0)	228 (63.0)	86 (40.4)	111 (34.2)	110 (35.4)	
Tested for SARS-CoV-2 since visit 1 [b]								<0.001
No	1,284 (62.1)	266 (57.1)	263 (67.3)	245 (67.7)	153 (71.8)	175 (53.9)	182 (58.5)	
Yes	784 (37.9)	200 (42.9)	128 (32.7)	117 (32.3)	60 (28.2)	150 (46.2)	129 (41.5)	
Perceptions of COVID-19								
Disclosure concerns [b]								<0.001
Disagree	1,569 (76.2)	423 (91.0)	275 (70.3)	264 (73.1)	126 (59.7)	250 (77.6)	231 (75.0)	
Neutral/agree	489 (23.8)	42 (9.0)	116 (29.7)	97 (26.9)	85 (40.3)	72 (22.4)	77 (25.0)	
Missing	*10*	*1*	*0*	*1*	*2*	*3*	*3*	
Concerns with public attitude [b]								<0.001
Disagree	1,785 (87.0)	431 (92.9)	322 (83.2)	328 (90.9)	159 (75.0)	277 (86.0)	268 (87.9)	
Neutral/agree	266 (13.0)	33 (7.1)	65 (16.8)	33 (9.1)	53 (25.0)	45 (14.0)	37 (12.1)	
Missing	*17*	*2*	*4*	*1*	*1*	*3*	*6*	
Feeling of discomfort around an individual infected with SARS-CoV-2 [b]								<0.001
Disagree	753 (36.6)	132 (28.5)	147 (37.6)	135 (37.3)	81 (38.4)	113 (35.1)	145 (47.2)	
Agree	1,304 (63.4)	332 (71.6)	244 (62.4)	227 (62.7)	130 (61.6)	209 (64.9)	162 (52.8)	
Missing	*11*	*2*	*0*	*0*	*2*	*3*	*4*	
People infected with SARS-CoV-2 are treated as an outsider [b]								<0.001
Disagree	1,527 (74.2)	389 (83.7)	277 (70.8)	251 (69.3)	134 (63.5)	239 (74.5)	237 (76.7)	
Agree	532 (25.8)	76 (16.3)	114 (29.2)	111 (30.7)	77 (36.5)	82 (25.6)	72 (23.3)	
Missing	*9*	1	0	2	4	2	0	

Table 2 (*continued*)

Characteristic	Total (n = 2,068)	Dutch (n = 466)	South-Asian Surinamese (n = 391)	African Surinamese (n = 362)	Ghanaian (n = 213)	Turkish (n = 325)	Moroccan (n = 311)	
Feeling worse about having SARS-CoV-2 infection due to people's opinions [b]								<0.001
Disagree	1,680 (81.6)	435 (93.6)	302 (77.2)	314 (87.0)	128 (60.4)	238 (73.9)	263 (85.1)	
Agree	380 (18.5)	30 (6.5)	89 (22.8)	47 (13.0)	84 (39.6)	84 (26.1)	46 (14.9)	
Missing	*8*	*1*	0	*1*	*1*	*3*	*2*	
COVID-19 is exaggerated in media [b]								<0.001
Disagree/neutral	1,498 (72.9)	390 (83.9)	291 (74.4)	274 (75.9)	130 (61.6)	220 (68.5)	193 (62.9)	
Agree	558 (27.1)	75 (16.1)	100 (25.6)	87 (24.1)	81 (38.4)	101 (31.5)	114 (37.1)	
Missing	*12*	*1*	0	*1*	*2*	*4*	*4*	
Emotional distress [b,c]		3.0 (0.7)	3.3 (0.9)	3.2 (0.8)	3.0 (0.9)	3.1 (0.8)	2.9 (0.9)	<0.001
Mean (SD)	3.1 (0.8)							
Missing	*19*	*1*	*1*	*5*	*1*	*5*	*6*	
Antibody result [a]								<0.001
Negative	1,889 (91.7)	440 (95.0)	369 (94.6)	340 (94.7)	158 (74.2)	298 (92.0)	284 (91.6)	
Positive	170 (8.3)	23 (5.0)	21 (5.4)	19 (5.3)	55 (25.8)	26 (8.0)	26 (8.4)	
Missing	*9*	*3*	*1*	*3*	*0*	*1*	*1*	
SARS-CoV-2 vaccination intent [b,d]								<0.001
Low	412 (19.9)	35 (7.5)	83 (21.2)	97 (26.8)	40 (18.8)	64 (19.7)	93 (29.9)	
Medium	589 (28.5)	62 (13.3)	122 (31.2)	109 (30.1)	62 (29.1)	108 (33.2)	126 (40.5)	
High	1,067 (51.6)	369 (79.2)	186 (47.6)	156 (43.1)	111 (52.1)	153 (47.1)	92 (29.6)	

Abbreviations: *HELIUS* Healthy Life in an Urban Setting; *COVID-19* Coronavirus disease 2019; *SARS-CoV-2* Severe Acute Respiratory Syndrome Coronavirus 2; *SD* Standard Deviation. [a] Measured at first COVID-19 substudy visit (June-October 2020); [b] Measured at second COVID-19 substudy visit (November 2020-March 2021). [c] Responses ranged from 1 to 5, with higher scores indicating higher emotional distress (see Supplementary methods for a more detailed description of emotional distress). [d] Vaccination intent was defined by the statements 'Are you planning to get vaccinated against SARS-CoV-2' and 'What is the chance that you would truly get vaccinated against SARS-CoV-2?'. Responses ranged from 1 ('no, certainly not' and 'very small', respectively) to 7 ('yes, certainly' and 'very large', respectively) on a 7-point Likert scale, and were combined into a mean score. Vaccination intent was categorized into low (mean score 1.0–2.5), medium (3.0–5.0) and high (5.5–7.0).

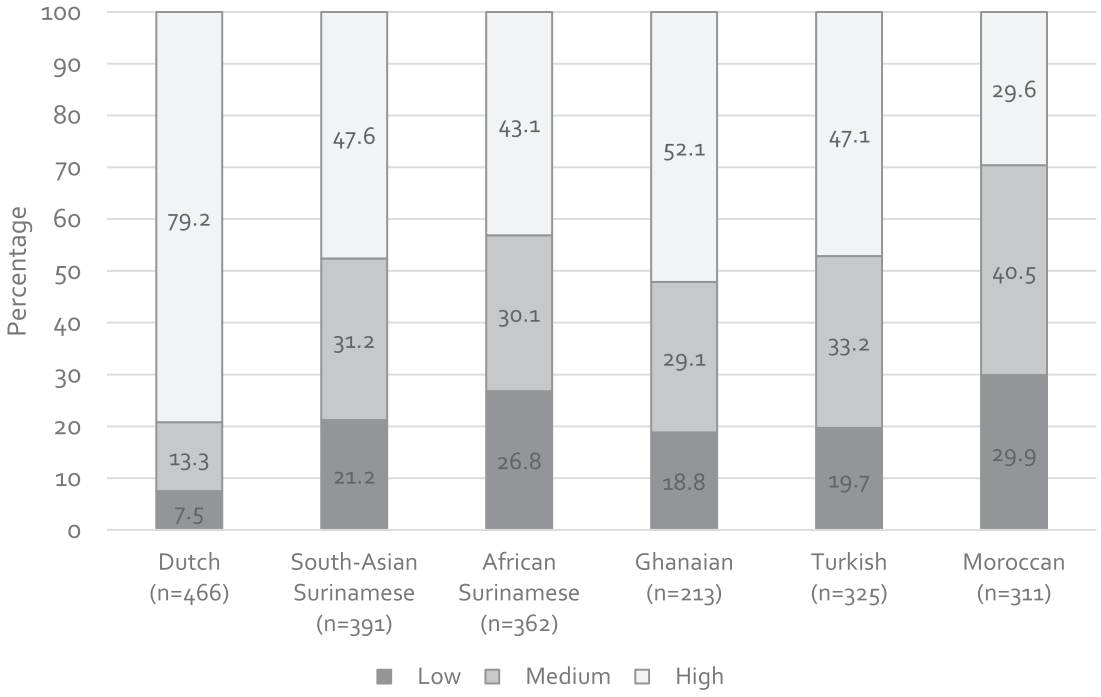

Fig. 2. SARS-CoV-2 vaccination intent* among the HELIUS participants included in the second visit of the longitudinal COVID-19 substudy, per ethnic group, Amsterdam, the Netherlands, November 23, 2020 - March 31, 2021. *Vaccination intent was defined by the statements 'Are you planning to get vaccinated against SARS-CoV-2?' and 'What is the chance that you would truly get vaccinated against SARS-CoV-2?'. Responses ranged from 1 ('no, certainly not' and 'very small', respectively) to 7 ('yes, certainly' and 'very large', respectively) on a 7-point Likert scale, and were combined into a mean score. Vaccination intent was categorized into low (mean score 1.0–2.5), medium (3.0–5.0) and high (5.5–7.0). The distribution of responses to both statements and the combined score on a 7-point Likert scale and categorized, respectively, are shown in Supplementary Figure S1 and Table S1.

Table 3
Association between ethnicity and a lower intent to vaccinate against SARS-CoV-2* among the HELIUS participants included in the second visit of the longitudinal COVID-19 substudy, Amsterdam, the Netherlands, November 23, 2020 - March 31, 2021 (n = 2,068).

	Univariable model†		Adjusted for month of study visit†‡	
Ethnicity	OR (95% CI)	*P* value	aOR (95% CI)	*P* value
Dutch	Ref	<0.001	Ref	<0.001
South-Asian Surinamese	4.55 (3.10–6.65)		4.76 (3.24–6.98)	
African Surinamese	7.01 (4.80–10.25)		7.19 (4.92–10.50)	
Ghanaian	3.81 (2.50–5.79)		5.01 (3.17–7.89)	
Turkish	3.85 (2.67–5.54)		4.66 (3.13–6.94)	
Moroccan	8.68 (6.10–12.35)		9.56 (6.62–13.81)	

Abbreviations: *SARS-CoV-2* Severe Acute Respiratory Syndrome Coronavirus 2; *COVID-19* Coronavirus disease 2019; *OR* odds ratio; *aOR* adjusted odds ratio; *CI* confidence interval; *Ref* Reference category. † The association between ethnicity and lower vaccination intent was examined using ordinal logistic regression (reference = high SARS-CoV-2 vaccination intent). Model accounts for study design and post-stratification. ‡ November 2020 - March 2021. * Vaccination intent was defined by the statements 'Are you planning to get vaccinated against SARS-CoV-2' and 'What is the chance that you would truly get vaccinated against SARS-CoV-2?'. Responses ranged from 1 ('no, certainly not' and 'very small', respectively) to 7 ('yes, certainly' and 'very large', respectively) on a 7-point Likert scale, and were combined into a mean score. Vaccination intent was categorized into low (mean score 1.0–2.5), medium (3.0–5.0) and high (5.5–7.0).

models (Figure 3, Supplementary Table S8), females were significantly more likely to report lower intent compared to males, except in the African Surinamese and Ghanaian groups. Participants believing that COVID-19 is exaggerated in the media were also more likely to report lower vaccination intent in all ethnic groups, except in the South-Asian Surinamese group.

Other determinants of reporting lower vaccination intent were being under 45 years of age (South-Asian Surinamese, African Surinamese, Moroccan), having a job in a bar or restaurant (Dutch), reporting adequate health literacy (South-Asian Surinamese), being less ethnically integrated in the host society (Moroccan), being less culturally integrated in the host society (South-Asian Surinamese, African Surinamese), reporting CVD (South-Asian Surinamese), not having asthma or COPD (South-Asian Surinamese), experiencing sufficient social support (Dutch), being ineligible for influenza vaccination (Ghanaian, Turkish), reporting hospitalized household members or close contacts with COVID-19 (Moroccan), having had a positive SARS-CoV-2 antibody test result at the first COVID-19 substudy visit (African Surinamese), perceiving that people feel uncomfortable with individuals with a SARS-CoV-2 infection (Turkish), feeling that people with a SARS-CoV-2 infection are treated as an outsider (South-Asian Surinamese), feeling less emotionally distressed due to COVID-19 (Dutch), and not seeking information related to COVID-19 using governmental and medical sources (South-Asian Surinamese, Turkish) or radio, television and newspaper (South-Asian Surinamese). Participants who had their second COVID-19 substudy visit during earlier months were also more likely to report lower vaccination intent in all ethnic groups.

We found that the strength of association between social support, eligibility for influenza vaccination, feeling that COVID-19 is exaggerated in the media, feeling emotionally distressed due to COVID-19, and using governmental and medical sources to seek information related to COVID-19 and SARS-CoV-2 vaccination intent significantly differed between specific ethnic groups (Supplementary Table S9). For the other determinants, there was no evidence that the strength of association differed between ethnic groups.

4. Discussion

In this cross-sectional analysis of a representative multi-ethnic cohort, we have shown that adult individuals belonging to one of the five major ethnic minority groups in Amsterdam, the Netherlands, had a much lower intent to vaccinate against SARS-CoV-2 than individuals of Dutch origin. More specifically, the percentage of individuals of other than Dutch origin reporting low and medium intent to vaccinate, respectively, went from 18.8% and 29.1% in the Ghanaian group to 29.9% and 40.5% in the Moroccan group, which contrasts to 7.5% and 13.3% in the Dutch group. Although vaccination intent was measured throughout the second wave of the SARS-CoV-2 pandemic in the Netherlands (i.e., November 23, 2020 to March 31, 2021), these between-ethnic differences remained when accounting for the month of study participation. We observed variation in the determinants of SARS-CoV-2 vaccination intent for different ethnic groups, but being female and believing that COVID-19 was exaggerated in the media were common determinants across most ethnic groups.

In line with our findings, previous studies have shown increased hesitancy towards, and lower acceptance of, SARS-CoV-2 vaccines in ethnic minority groups [5,12,28,29]. For example, a US survey showed that Black and Hispanic respondents less commonly intended to receive vaccination than White participants [28]. Furthermore, a UK study among healthcare workers conducted during the same period as our study found that those from several ethnic minority groups (e.g., Black Caribbean, Black African) were more hesitant to receive vaccination compared to white British healthcare workers [12]. It is striking to observe similar ethnic differences in vaccination intent in a country, such as the Netherlands, with rather different ethnic backgrounds and cultural histories of ethnic groups than either the UK or US.

We identified two consistent determinants of lower vaccination intent across most ethnic groups. First, females of Dutch, South-Asian Surinamese, Turkish, and Moroccan origin had lower SARS-CoV-2 vaccination intent compared to males. This association might have also been apparent for those of African Surinamese and Ghanaian origin, as it did not significantly differ between ethnic groups when testing for interaction. Higher vaccination intent among males might perhaps indicate that they are aware of being at higher risk of severe COVID-19 than females [30,31]. Moreover, previous studies on intent, attitude, hesitancy, and resistance towards SARS-CoV-2 vaccination have demonstrated similar sex differences [27,29]. Some evidence has pointed towards women more frequently believing that SARS-CoV-2 vaccines are insufficiently safe and effective [29] or may cause infertility [32]. Similar concerns were noticed during prevention activities of the Public Health Service of Amsterdam among women in Amsterdam (T Leenstra 2022, personal communication, 18 April), but whether these beliefs apply to our multi-ethnic study population needs further investigation.

Second, individuals of Dutch, African Surinamese, Ghanaian, Turkish, and Moroccan origin who believed that COVID-19 was exaggerated in the media had lower vaccination intent than those without this belief. Perceptions of exaggerations in the media might represent a general distrust in the government or medical

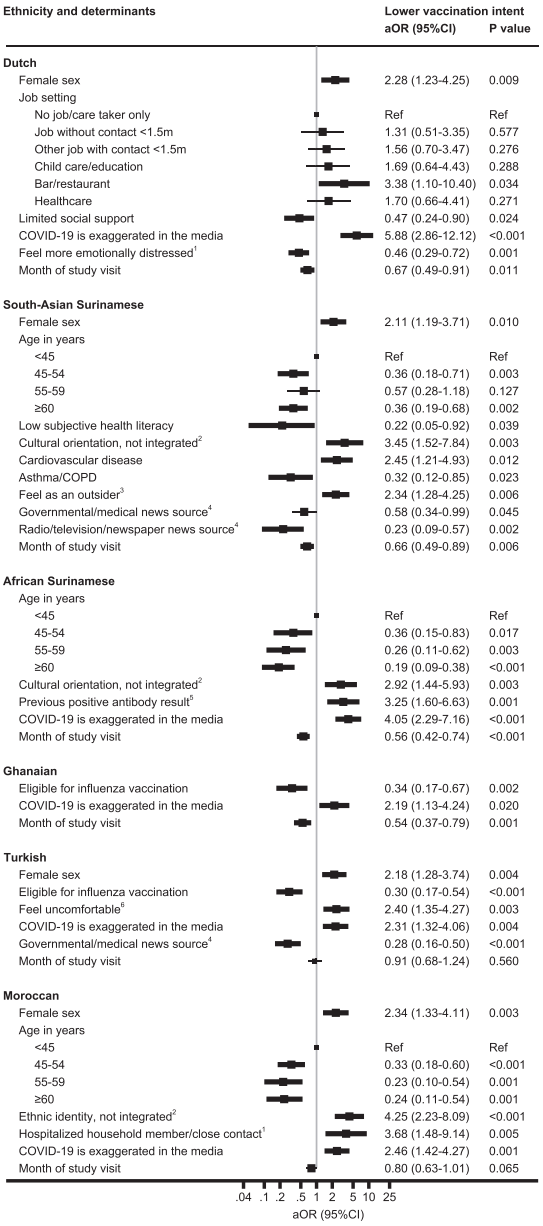

Fig. 3. Determinants of lower SARS-CoV-2 vaccination intent per ethnic group (multivariable ordinal logistic regression analysis), Amsterdam, the Netherlands, November 23, 2020 - March 31, 2021. Abbreviations: *SARS-CoV-2* Severe Acute Respiratory Syndrome Coronavirus 2; *COVID-19* Coronavirus disease 2019; *COPD* Chronic Obstructive Pulmonary Disease; *aOR* adjusted odds ratio; *CI* confidence interval; *Ref* Reference category. Univariable odds ratios are provided per ethnic group in Supplementary Tables S2-7. The final multivariable models were obtained by removing determinants with a $P \geq 0.05$ in a backward stepwise fashion in ordinal logistic regression analyses (reference = high SARS-CoV-2 vaccination intent). The models account for study design and post-stratification. [1] Due to COVID-19. [2] Separation, marginalization. [3] 'People with a coronavirus infection are treated as an outsider'. [4] For COVID-19 information. [5] SARS-CoV-2 antibodies were measured at the first COVID-19 substudy visit. [6] 'Most people feel uncomfortable around someone with a coronavirus infection'.

field. It may also be related to individuals turning to other sources (e.g., social media, media from country of origin) to obtain information on COVID-19. These individuals may believe that other sources are superior to governmental and other medical institutions when gathering information on COVID-19 [33]. Using social media especially as news source seems to be a driver of vaccine hesitancy [34]. As approximately half of our study population received information on COVID-19 through personal communication or social media, it is important to examine the content of this information. On the other hand, using institutional websites as an information source for COVID-19 is an important correlate of vaccine willingness [35]. Indeed, we found that participants of South-Asian Surinamese or Turkish origin who used governmental or medical sources had higher SARS-CoV-2 vaccination intent than those who did not.

Tackling misperceptions about COVID-19, combating misinformation from media sources, debunking fake news, and restoring institutional trust would seem imperative to increase vaccination intent among multiple ethnic groups. Dissemination of evidence-based and up-to-date information might be enhanced when governmental and medical sources increase their presence on social media. Qualitative research could aid in gaining a thorough understanding of why people believe that COVID-19 is exaggerated in the media and how provision of information by governmental and medical sources could be improved. The reasons for these beliefs could be addressed through more transparent and straightforward communication from governmental and medical sources, including potential risks of vaccination, which might increase trust in such sources [12]. Clear provision of evidence-based information in native languages of different communities, through social media and by establishing and maintaining trusted networks, might also encourage individuals to become vaccinated.

Lower SARS-CoV-2 vaccination intent among ethnic minority groups is likely related to a variety of structural factors, such as institutional distrust, language barriers, lower health literacy, fear of stigma, cultural variation, unemployment, and lower educational levels [36,37]. We indeed found that reporting being less integrated in the host society was associated with having lower vaccination intent in the South-Asian Surinamese, African Surinamese, and Moroccan groups. However, we also found that adequate health literacy in the South-Asian Surinamese group was associated with having lower vaccination intent.

Of those who become infected with SARS-CoV-2, older individuals and those with comorbidities are at increased risk of progression to severe COVID-19, hospitalizations and death [4]. Since vaccination in these groups is clearly beneficial, they have been prioritized for SARS-CoV-2 vaccination in the Netherlands and elsewhere. Indeed, we found that participants of 45 years of age or older (in the South-Asian Surinamese, African Surinamese and Moroccan groups, and based on the lack of significant interaction, the other ethnic groups), those having asthma or COPD (in the South-Asian Surinamese group), and those eligible for influenza vaccination (in the Ghanaian and Turkish groups) (which commonly include older individuals and those with comorbidities [38]), had higher intent to vaccinate against SARS-CoV-2. Higher vaccination intent in these groups potentially indicates the realization that they belong to a risk group, but also adequate health literacy and medical trust.

Concerningly, participants of South-Asian Surinamese origin with CVD had lower vaccination intent than those without CVD. Lower intent might stem from concerns about vaccine safety and side effects, as such concerns have been observed during prevention activities of the Public Health Service of Amsterdam (T Leenstra 2022, personal communication, 18 April) and reported among African American primary care patients at an Internal Medicine Clinic in the US [39]. These individuals could benefit from more information and awareness on the safety and risk factors of SARS-CoV-2 vaccination, also in relation to medication use, which could be provided by their primary physician.

Interestingly, participants of Dutch origin who experienced sufficient social support, as well as those who felt less emotionally distressed due to COVID-19, had lower vaccination intent. Sufficient social support can result in increased preventive behavior

by increasing access to risk and prevention information and promoting feelings of self-efficacy [40]. However, increased self-efficacy might reduce one's own perceived risk, which in turn might impede engaging in preventive activities [40]. It is also unclear whether the people providing social support are circulating accurate information about COVID-19 and vaccines. Some groups could be a conduit for spreading misinformation, rumors and conspiracy theories, which could lead to lower vaccination intent [41]. Lower emotional distress could also indicate lower perceived risk of severe COVID-19 and may therefore reduce vaccination intent. These findings together imply that improving risk perceptions about SARS-CoV-2 and increasing the feeling of collective responsibility might be necessary to increase vaccination intent in these individuals.

The finding that large ethnic differences exist in SARS-CoV-2 vaccination intent is of great importance, as ethnic minority populations are at higher risk of SARS-CoV-2 infection and severe disease progression related to COVID-19 [1–3]. An important limitation of this study is however its cross-sectional design, making it impossible to investigate individual changes in vaccination intent over time. Another limitation is the potential for selection bias between participants in the COVID-19 substudy compared to the parent HELIUS cohort. Although the proportion responding to the COVID-19 substudy varied between ethnicities, the distribution of characteristics was comparable between included and non-included individuals, hence this bias was likely limited [24]. Additionally, changes may have occurred in psychosocial, access-to-healthcare indicators, ethnic identity, cultural orientation, and comorbidity variables measured during the baseline visit of the HELIUS study compared to the present COVID-19 substudy. Lastly, some potential determinants of vaccination intent were not addressed, such as trust in the government [18,42], concerns about vaccine safety [29], and vaccine type [43].

Even though intent is a key driver of uptake [10], it remains important to investigate if SARS-CoV-2 vaccination intent actually leads to its uptake. Our study took place between December 2020 and March 2021, and we found that vaccination intent was lower in earlier study months, which is in line with observations from surveys among predominately highly educated people without a migration background over the same period [18]. During our study period, SARS-CoV-2 vaccination only became available to healthcare workers and individuals older than 75 years. Intent might have changed over time following shifts in perceived threat of SARS-CoV-2, concerns about vaccine safety and efficacy, available and offered vaccine types, national prevention measures, and media attention [27,44]. Data on the actual uptake of SARS-CoV-2 vaccination in different ethnic groups is thus far unavailable in Amsterdam, but future studies should investigate the extent to which SARS-CoV-2 vaccination intent leads to uptake.

In conclusion, the intent to vaccinate against SARS-CoV-2 is significantly lower in ethnic minority groups than in people of Dutch origin in Amsterdam, the Netherlands. The considerable gap in vaccination intent could result in low vaccination uptake and exacerbate the already existing inequalities in COVID-19 burden in these groups [5,6]. Therefore, it is urgently warranted to increase vaccination intent and monitor vaccination uptake among people with ethnic backgrounds other than Dutch. It can be assumed that those reporting medium vaccination intent are more receptive to health promotion and one-third of those with ethnic backgrounds other than Dutch reported medium vaccination intent; encouraging vaccination for these individuals could be particularly helpful. Importantly, as identified determinants were specific to certain ethnic groups, generalization of interventions might be inappropriate, giving preference to implementing targeted interventions. This may be achieved through clear provision of evidence-based informational materials, inclusive communication in the native language of ethnic groups, co-creation of interventions with specific groups, and building trust relationships and investing in long-term engagement of different ethnic groups in health promotion, perhaps involving healthcare workers and other trusted networks within ethnic groups.

Authors contributions

MP, KS, JS and CA conceived, designed, or oversaw the study. HG, AK and JS were involved in the acquisition of data. SC conducted the statistical analysis and drafted the manuscript in collaboration with GR and LC under the supervision of AB and MP. All authors read and approved the final manuscript and attest they meet the ICMJE criteria for authorship.

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Data availability

Data requests can be submitted to the steering committee of the HELIUS study

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.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.vaccine.2023.02.030.

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