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Pathways that explain racial differences on edentulism among older adults: 2019 Brazil National Health Survey

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Abstract: This study aimed to evaluate the pathways that explain the association between race/skin color and edentulism in elderly Brazilians. This was a cross-sectional study using data from participants aged 60 years or older from the 2019 Brazilian National Health Survey, a nationally representative population-based sample. Data were obtained by a structured interview and participants were classified as edentulous if they reported having lost all natural teeth. Information on race, socioeconomic level, behavioral aspects, psychosocial aspects, and access to dental care was collected by interviewers using a questionnaire. The pathways between race/skin color and edentulism were analyzed using structural equation modeling. The final sample of the study included 22,357 participants. Most participants were white (51.5%; 95% confidence interval [CI]: 50.3–52.6), and 36.8% (95%CI: 35.7–37.9) were edentulous. Race/skin color was indirectly associated with edentulism via enabling factors. These findings suggest that socioeconomic inequalities are key in explaining racial inequalities in edentulism among Brazilian older adults.

Keywords: Aged; Mouth, Edentulous; Health Surveys; Oral Health; Race Factors.

Introduction

Reducing health inequalities and implementing health policies is a social responsibility because chronic diseases negatively impact the quality of life and well-being of older people, especially those who are poorer, disadvantaged, and socially marginalized.[1] According to the 2019 Global Burden of Diseases Study, there were approximately 294 million edentulous persons aged 50 years or older wordwide.[2]

Edentulism is associated with an important disease burden, and its consequences include both underweight and overweight[3] and esthetic and functional problems that negatively interfere in people's lives.[4] Moreover, some studies investigated race/skin color and its association with edentulism.[5-7] Race/skin color is defined in these studies as a social rather than a biological category, referring to social groups that generally share common characteristics.[8] How individuals classify their race/skin color may reflect the way they perceive themselves in front of others and in certain contexts.[9] The evidence suggests that the improvement of oral

health is not equally shared by all segments of society, with differences among racial groups.[5-7]

More than two decades ago, Andersen and Davidson (1997) proposed a theoretical model in which this association would be explained by primary determinants of oral health that include socioeconomic and psychosocial variables, access to dental care, and oral health behaviors.[10] However, the mechanisms underlying the association between race/skin color and edentulism have not been explored. This study aimed to evaluate the pathways that explain the association between race/skin color and edentulism in older Brazilians using Andersen and Davidson's model. The conceptual hypothesis is that non-white older Brazilians have a higher prevalence of edentulism than their counterparts and that this association is mediated by primary determinants, particularly enabling factors, and oral health behaviors.

Methodology

Study design and sample

This cross-sectional study analyzed data from the 2019 Brazilian National Health Survey (Pesquisa Nacional de Saúde – PNS), a nationally representative population-based study. The 2019 PNS is the second edition of this survey – the first one was carried out in 2013. The PNS used a cluster sampling plan with three stages: the census tracts in the Primary Sampling Units (UPA, in Portuguese) were the first stage, the household was the second stage, and within each permanent private household, a person aged 15 years or older (randomly selected) was the third stage of the selection of the PNS target population. More information on sampling, including the methods for sample size calculation, can be found in a specific publication on the subject.[11] The present study included data from participants aged 60 years or older.

Data collection

Data were collected by a structured interview carried out by trained interviewers at the participants' homes. A household questionnaire and an individual questionnaire were used.

The study outcome, edentulism, was defined as absence of natural teeth.[12] Participants were asked about the number of missing teeth and classified as edentulous (coded 1) if they reported they had lost all natural teeth and as dentate (coded 0) if they had lost fewer than 32 teeth (complete dentition).

Self-reported race was recorded through the question about race/skin color: 'What race are you?'. According to the Brazilian Institute of Geography and Statistics, the response options were: White, Brown, Black, Yellow, or Indigenous.[13] This variable was dichotomized into 'White' (0) or 'Non-White' (1) (Browns and Blacks). Yellow and Indigenous people were excluded from the sample, as has been done elsewhere.[14] The final study sample consisted of 22,357 participants.

The independent variables included in this study were selected in accordance with a theoretical model (Figure 1) based on the Andersen and Davidson[10] Behavioral Model of Oral Health Services Use (1997) adapted by Hugo et al.[15]

Enabling factors were family income, schooling, occupation, and car ownership. Per capita family income was categorized into 'up to ¼ minimum wage (MW)' (0), 'more than ¼ up to ½ MW' (1), 'more than ½ up to 1 MW' (2), 'more than 1 up to 2 MW' (3), 'more than 2 up to 3 MW' (4), 'more than 3 up to 5 MW' (5), and 'more than 5 MW' (6). The Brazilian MW was equivalent to $198,00 USD in 2019. Schooling was categorized into 'no schooling' (0), 'incomplete elementary school' (1), 'complete elementary school' (2), 'incomplete high school' (3), 'complete high school' (4), 'incomplete university education' (5) or 'complete university education' (6). Occupation in the reference week and car ownership were recorded as yes (1) or no (0). Car ownership was assessed by reporting property (1) or not (0) of a car in the household.

Self-perceived need for dental care was evaluated through oral health perception, which was dichotomized as 'poor' (0) (regular, poor or very poor) and 'good' (1) (very good or good), based on a study that investigated self-rated oral health.[16]

Oral health behaviors were included in the model, as they can influence the association between race/skin color and edentulism. The variables were tooth brushing and tobacco smoking. The assessment of tooth brushing was based on answers to the question

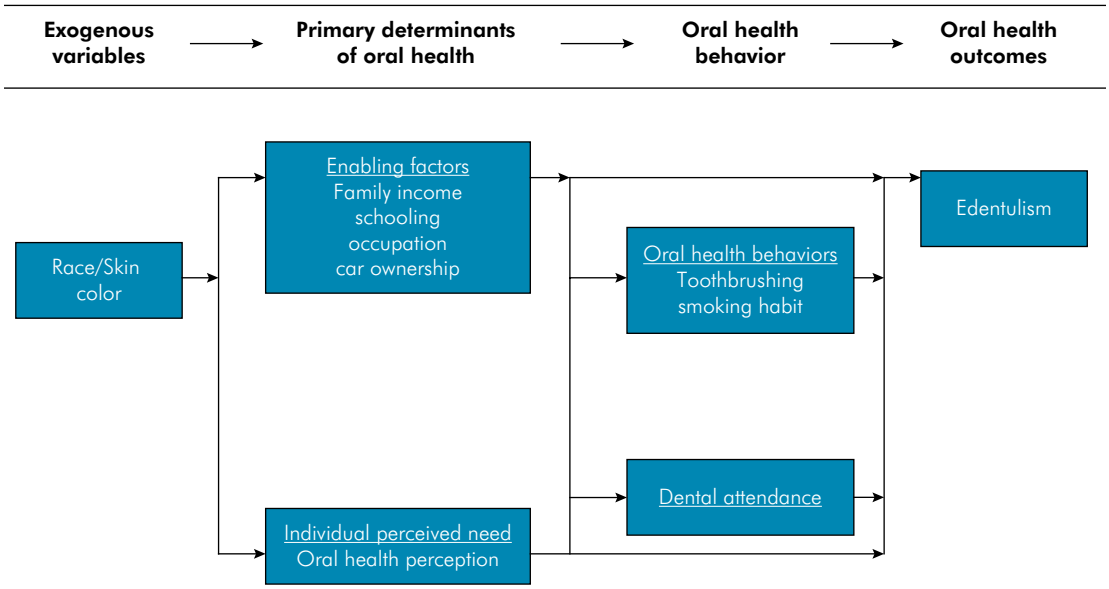

Figure 1. Hypothetical model from the association between race/skin color and edentulism.

'How often do you use a toothbrush for oral hygiene?' The variable was categorized into 'Not every day' (0), 'Once a day' (1), 'Twice a day' (2) and 'Three or more times a day' (3). Smoking was categorized into 'No' (0) and 'Yes' (1). Participants who exhibited any frequency of consumption ('yes, daily'; and 'yes, less than daily') were assigned to the 'yes' category.

Dental visit was assessed by the question: 'When was the last time you saw a dentist?' (up to 1 year; more than 1 year to 2 years; more than 2 years to 3 years; more than 3 years; never saw a dentist). This variable was categorized as 'More than 1 year' (0) (for those who did not use dental services in the year prior to the interview) or 'In the last year' (1) (for those who used dental services up to 1 year).

Statistical analysis

Data were analyzed using the STATA 14.0 software (Stata Corporation, College Station, USA) and Mplus version 6.12. All analyses were performed considering the sample weight due to the complex sample. Preliminary analyses were done to describe the characteristics of the sample. The pathways between race/skin color and edentulism were analyzed through structural equation modeling (SEM) and adjusted for sex and age. Participants with missing data were excluded from analysis.

SEM was used to obtain a measurement model for a latent variable (enabling factors) and a structural model to estimates the magnitude of the effects among the pathways. The maximum likelihood estimator for complex samples with robust standard error was used. In the first stage, the latent variables were specified separately using confirmatory factor analytic models, considering all standardized factor loadings above 0.3. The second stage involved fitting the path analytic models, which included the latent constructs, to jointly estimate the standardized associations with edentulism. The results are provided as standardized coefficients (SC) and *p*-values. Fit indices and factorial loads guided the adjustment for the parsimonious model. Fit indices used were: root mean square error of approximation (RMSEA), which should have values ≤ 0.05 with their respective 90% CI; comparative fit index (CFI) with values ≥0.9; Tucker-Lewis index (TLI) also with values ≥0.9; and standardized root mean square residual (SRMR) with values ≤ 0.08.[17]

Ethics

The 2019 PNS data are available online for public access and use at the Brazilian Institute of Geography and Statistics (IBGE) official website. The study was approved by the National Research Ethics Commission

(3.529.376). Prior written informed consent was obtained from each participant.

Results

Among the participants, 36.8% were edentulous. Table 1 shows the characteristics of the sample, the prevalence of edentulism and the prevalence of sample characteristics of white and non-white individuals. Most participants were white (51.5%) and with a lower prevalence of edentulism. In relation to enabling factors, most individuals had a per capita family income higher than 1 MW and 46.4% had incomplete elementary education. Most participants also had an occupation and did not own a car. Moreover, most of the sample reported good self-perceived oral health, brushed their teeth three or more times a day, were non-smokers, and had not visited the dentist in the year prior to the survey. The prevalence of edentulism was higher among the less privileged individuals, including black individuals (Table 1).

Figure 2 shows the pathways analysis of the parsimonious model. The latent variable was related to enabling factors (family income, schooling, and car ownership) and the model had a good fit to the data: RMSEA = 0.000 (90%CI: 0.000–0.000), CFI = 1.000, TLI = 1.000, SRMR = 0.000. Edentulism was directly associated with enabling factors (SC: -0.168; $p < 0.001$), self-perceived oral health (SC: 0.093; $p < 0.001$), tobacco smoking (SC: 0.056; $p < 0.001$), and visits to the dentist in the year prior to the study (SC: -0.213; $p < 0.001$). Dental attendance, oral health perception, tobacco smoking, and race/skin color were related to enabling factors (SC: 0.525; $p<0.001$, SC: 0.158; $p < 0.001$, SC: -0.094; $p < 0.001$, SC: -0.301; $p < 0.001$, respectively). Oral health perception was directly related with (SC: 0.158; $p < 0.001$) enabling factors. Also, tobacco smoking was related to enabling factors (SC: -0.094; $p< 0.001$). In addition, race/skin color was associated with enabling factors (SC: -0.301; $p < 0.001$) in Brazilian older adults. There was a significant and inverse association between tobacco smoking and dental attendance (SC: -0.043; $p < 0.001$). Moreover, schooling and edentulism had a weak inverse association, as well as schooling and family income. Schooling and dental attendance also were weakly associated. The model was adjusted for sex and age (Figure 2).

Table 2 shows the standardized estimated effects of indicators in the initial and final structural models. The initial and final models presented good fit values, confirming the theoretical model used. The parameters of the parsimonious model were: RMSEA = 0.008 (90%CI: 0.004–0.011), CFI = 0.998, TLI = 0.994, and SRMR = 0.007 (Table 2).

Table 3 shows the effects of the variables on edentulism in the parsimonious SEM model. Race/skin color had only an indirect effect (SC: 0.081) on edentulism and the enabling factors pathway (SC: 0.051) was the one that best explained this association. Also, paths considering enabling factors through dental attendance, individual perceived need and tobacco smoking had a weak association with edentulism (Table 3).

Discussion

The hypothesis of this study was accepted. The association between race/skin color and edentulism was mediated predominantly by enabling factors. These findings suggest that racial inequalities related to oral health occur through primary determinants rather than oral health behaviors, but by primary determinants. The manifestation of multiple systems of oppression linked to social structures that emerged throughout Brazilian history, such as political marginalization and economic exploitation of racial minorities, are the major driving forces behind oral health inequalities.[14,18] Racial issues are a complex and long-lasting social process that was shaped by slavery, and the reproduction of racial discrimination is a complex, socially patterned phenomenon that impairs dignity, well-being, and health.[18,19]

The indirect path that best explains the association between race/skin color and edentulism was the path with only enabling factors, which included limited financial resources. The materialist and the psychosocial theories are helpful in understanding how socioeconomic conditions influence health outcomes. The materialist theory implies that socioeconomic position and access to material

Table 1. Sample characteristics and prevalence of edentulism by race/skin color (White and Non-white) in older adults from the 2019 National Health Survey (Pesquisa Nacional de Saúde - PNS) (n = 22,357).

Variables	%	Prevalence of edentulism (95% CI)	Whites (95% CI)	Non-whites (95% CI)
Race/Skin Color				
White	51.5	34.5 (32.9–36.2)	–	–
Non-white	48.5	39.4 (38.0–41.0)		
Family Income				
Up to 1/4 of (MW)	2.2	33.2 (27.0–40.1)	29.6 (24.3–35.6)	70.3 (64.3–75.7)
More than ¼ up to ½ (MW)	8.0	43.5 (39.7–47.4)	29.3 (25.8–33.1)	70.7 (66.9–74.2)
More than ½ up to 1 (MW)	31.5	47.9 (46.0–49.7)	40.0 (38.0–42.0)	60.0 (58.0–61.9)
More than 1 up to 2 (MW)	31.9	38.6 (36.7–40.6)	52.2 (50.2–54.2)	47.8 (45.8–49.8)
More than 2 up to 3 (MW)	10.8	26.6 (23.7–29.7)	68.3 (65.3–71.1)	31.7 (28.9–34.6)
More than 3 up to 5 (MW)	8.2	18.3 (15.6–21.3)	72.3 (68.6–75.6)	27.7 (24.4–31.4)
More than 5 (MW)	7.4	11.1 (9.2–13.5)	80.5 (77.5–83.2)	19.5 (16.8–22.4)
Schooling				
Unschooled	16.8	56.7 (54.2–59.2)	30.7 (28.4–33.1)	69.3 (66.9–71.6)
Incomplete elementary school	46.4	44.3 (42.6–46.0)	48.2 (46.5–49.9)	51.8 (50.1–53.4)
Complete elementary school	6.8	28.4 (24.9–32.1)	57.1 (52.8–61.3)	42.9 (38.7–47.2)
Incomplete secondary school	2.7	25.8 (20.4–32.0)	52.2 (45.7–58.6)	47.8 (41.4–54.3)
Complete secondary school	14.6	20.1 (17.9–22.4)	61.7 (58.8–64.6)	38.2 (35.4–41.1)
Incomplete higher education	1.4	6.1 (3.9–9.9)	73.4 (65.0–80.4)	26.6 (19.6–35.0)
Complete higher education	11.3	9.4 (7.7–11.4)	76.7 (73.9–79.3)	23.3 (20.7–26.1)
Occupation				
No	25.6	23.3 (21.4–25.2)	52.4 (50.1–54.6)	47.6 (45.4–49.9)
Yes	74.4	41.5 (40.2–42.7)	51.1 (49.8–52.5)	48.9 (47.5–50.2)
Car ownership				
No	53.0	44.9 (43.6–46.3)	41.0 (39.6–42.4)	59.0 (57.5–60.4)
Yes	47.0	27.7 (26.2–29.2)	63.2 (61.5–64.9)	36.8 (35.1–38.5)
Oral health perception				
Poor	33.5	32.6 (30.9–34.3)	45.8 (43.9–47.7)	54.2 (52.3–56.0)
Good	66.5	39.0 (37.6–40.4)	54.3 (52.8–55.7)	45.7 (44.3–47.1)
Toothbrushing				
Not every day	0.5	46.0 (34.3–58.1)	42.8 (30.8–55.7)	57.2 (44.3–69.2)
Once a day	9.1	44.4 (41.1–47.8)	41.6 (38.4–44.9)	58.4 (55.1–61.6)
2 times per day	39.7	39.6 (37.9–41.4)	45.7 (44.0–47.4)	54.3 (52.5–56.0)
3 or more time a day	50.7	29.0 (27.5–30.6)	58.5 (56.8–60.3)	41.5 (39.7–43.2)
Smoking Habit				
No	88.6	36.0 (34.8–37.2)	52.2 (51.0–53.4)	47.8 (46.5–49.0)
Yes	11.4	43.3 (40.1–46.5)	45.4 (42.2–48.7)	54.5 (51.3–57.7)
Last dental visit				
One year or more	65.2	48.0 (46.7–49.3)	46.0 (44.6–47.4)	54.0 (52.6–55.4)
In the last year	34.8	15.9 (14.6–17.4)	61.6 (59.7–63.5)	38.4 (36.5–40.3)

Taking into account sample weight. 95 CI: 95% confidence interval. MW: Minimum wage.

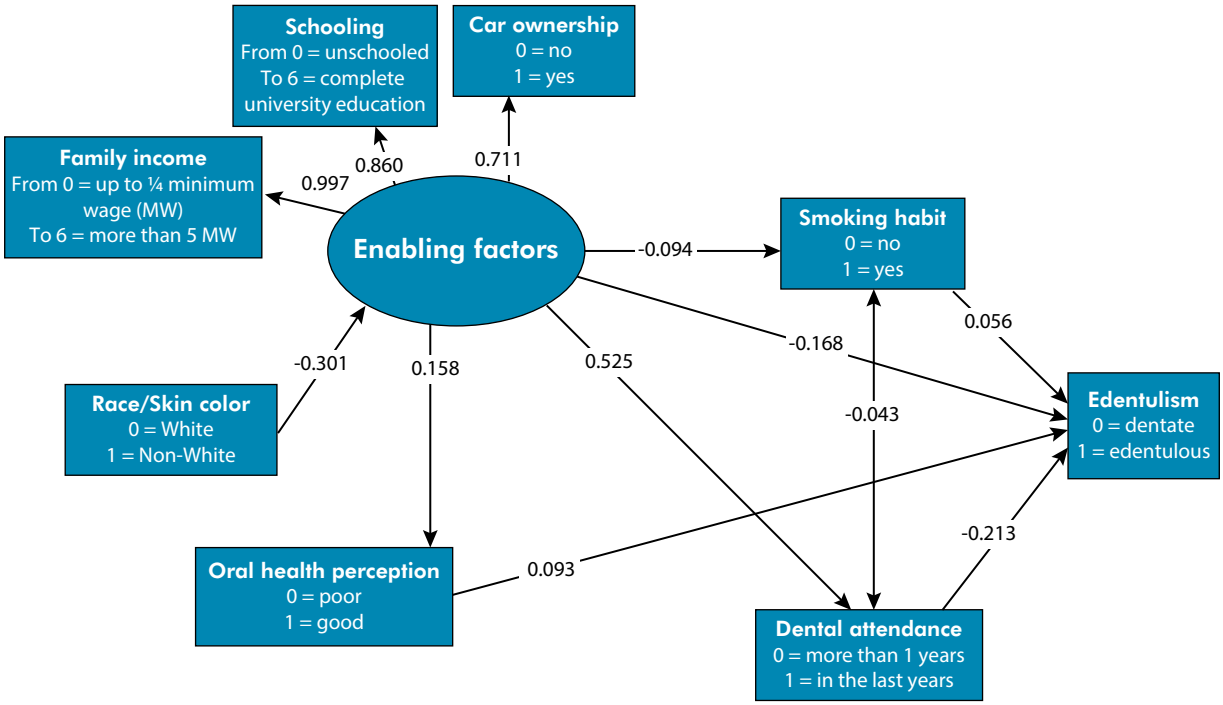

Figure 2. Pathway analysis of the association between race/skin color and edentulism in Brazilian older adults.

and structural conditions affect health status. The psychosocial theory suggests that the perceptions of social status influence health status.[20,21] Notwithstanding, compared to white people, racial minorities have lower income, lower levels of education, and less purchasing power.[22,23] Thus, different enabling factors of racial minorities can generate inequalities in oral health, due to the different availability of economic resources and access to structural conditions, such as access to dental care and the psychosocial response to relative social status.

The findings of this study demonstrated that enabling factors negatively impacted perceived need by mediating the relationship between race/skin color and edentulism. The enabling factors can reflect the emotional and social meanings of inequalities, which can influence behaviors and coping strategies.[24] Furthermore, health beliefs and perceptions are rooted in social and cultural contexts and the response to the self-rated oral health question may be the product of a multitude of experiences.[5] Therefore, some studies have observed a relationship between race and self-reported oral health outcomes,[23,25,26] and ethnic differences in perceived oral health may reflect clinical oral health problems.[5]

This study also showed that enabling factors impacted dental visits and this also mediated the relationship between race/skin color and edentulism. Some empirical evidence points to racial inequities in access to and quality of oral health care among older people. Data from the 2017 US National Center for Health Statistics indicated that older black people are more likely to have an unmet dental need than white people due to the cost of dental care.[27] Another North American study – in which most analyzed individuals were older than 60 years – identified that the probability of African American patients receiving a tooth-preserving treatment (compared to tooth extraction) was lower than among white patients.[28] A 2003 study with older Brazilians found that 3.8% of white older people reported never having visited a dentist in their lives while this percentage was 7.8% for blacks.[29] Our results corroborate these findings, as they indicate that the relationship between race/skin color and edentulism is partly explained by the lower access to dental care among black people and that the socioeconomic inequalities are the starting

Table 2. Standardized estimated effects of indicators in initial and final structural models.

Pathway	Standardized coefficients	
	Initial model	Final model
Edentulism		
Dental visit	-0.18 (p < 0.00)	-0.21 (p < 0.00)
Toothbrushing	-0.02 (p = 0.06)	-
Smoking Habit	0.05 (p = 0.14)	0.06 (p < 0.00)
Oral health perception	0.12 (p < 0.00)	0.09 (p < 0.00)
Enabling factors	-0.24 (p < 0.00)	-0.17 (p < 0.00)
Dental attendance		
Enabling factors	0.45 (p < 0.00)	0.52 (p < 0.00)
Oral health perception	0.02 (p = 0.82)	-
Race/Skin color	0.01 (p = 0.23)	-
Toothbrushing		
Enabling factors	0.30 (p < 0.00)	-
Oral health perception	0.10 (p < 0.00)	-
Race/Skin color	-0.02 (p < 0.00)	-
Smoking habit		
Enabling factors	-0.10 (p < 0.00)	-0.09 (p < 0.00)
Oral health perception	0.00 (p = 0.79)	-
Race/Skin color	0.00 (p = 0.90)	-
Oral health perception		
Enabling factors	0.16 (p < 0.00)	0.16 (p < 0.00)
Race/Skin color	-0.02 (p = 0.07)	-
Enabling factors		
Race/Skin color	-0.38 (p < 0.00)	-0.30 (p < 0.00)
Dental attendance ↔ Toothbrushing £	0.05 (p < 0.00)	-
Dental attendance ↔ Smoking habit £	-0.04 (p < 0.01)	-0.04 (p < 0.00)
Model fit		
RMSEA (90%CI)	0.044 (0.041–0.046)	0.008 (0.004–0.011)
CFI	0.932	0.998
TLI	0.796	0.994
SRMR	0.026	0.007

Taking into account sample weight; Adjusted for sex and age. RMSEA: root mean square error of approximation; CI: confidence interval; CFI: comparative fit index; TLI: Tucker-Lewis index; SRMR: standardized root mean square residual. £: correlated factors.

Table 3. Standardized coefficients for effects of race/skin color on edentulism.

Variables	Standardized coefficients
Total indirect effect	0.081
Via enabling factors	0.051
Via enabling factors à oral health perception	-0.004
Via enabling factors à smoking habit	0.002
Via enabling factors à dental attendance	0.034

Taking into account sample weight; Adjusted for sex and age.

point of this difference. The results of the present study also indicated that racial inequities in access to dental care among older adults persist almost 20 years after the implementation of the National Oral Health Policy in Brazil.

The relation between race/skin color and edentulism was also mediated by enabling factors via tobacco smoking (variable from the "Oral Health Behavior" pathway). There is a lack of evidence on the importance

of racial inequalities in oral health behaviors. A study with data from the 2013 PNS found that blacks reported brushing their teeth less frequently.[30] Results of the 2013 PNS also showed that the prevalence of tobacco smoking in black Brazilians was the highest among all categories of race/skin color.[31] However, both studies were essentially descriptive and did not consider the possible confounding effect of crucial variables, such as income. It is well known that smoking is more prevalent among socioeconomically underprivileged classes. This behavior pattern can be a mechanism to cope with the stress generated by personal difficulties, including economic needs and living in an underserved environment.[32] The findings support this association and the link to inequalities in edentulism. Differences of the impact of smoking exposure attributable to race/skin color on edentulism are explained by socioeconomic inequities, since race/skin color does not determine predisposition to unhealthy habits.

This study has some limitations referring to data collected in the 2019 PNS. The cross-sectional design limits causal inferences, highlighting the need for prospective studies. In addition, this study was based entirely on self-reported data, meaning that recall bias may have occurred. However, this is not expected to be significant, as self-reported data are considered valid oral health measures.[33] Also, populations living on the street and in nursing homes were excluded from the survey; these groups have little or no access to oral health services, which may indicate a worse scenario than that presented in this study. This study has some strengths, including the use of a national high-quality information source and a sample that is representative of Brazilian older adults living in private households. To the authors' knowledge, no study has assessed the pathways that explain the association between race/skin color and edentulism, which should be taken into account when planning and implementing oral health policies and programs.

Conclusion

In conclusion, the findings of this study suggest that the association between race/skin color and edentulism in Brazilian older individuals is mediated by socioeconomic variables. This study contributes to the understanding that racial inequities in oral health are associated with worse socioeconomic position in black older Brazilians. Prevention and rehabilitation actions that address edentulism among older Brazilians should take into account racial differences in the distribution of resources, with priority given to disadvantaged groups.

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