Racial inequalities in dental service utilisation: exploring individual and contextual determinants among a sample of middle-aged Brazilian adults

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DECLARATION OF AUTHORSHIP

I, *Helena Mendes Constante*, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in this thesis.

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ABSTRACT

Dental service helps to alleviate and prevent pain and suffering and promote oral health. International evidence has shown that some racial/ethnic minority groups are less likely to use dental services compared to Whites. In Brazil, where individuals are classified according to their colour/race, researchers also observed colour/race inequalities in dental service, but evidence concerning this issue is scarce. Therefore, this thesis investigated the differences between Pardos (mixed) and Blacks compared to Whites in dental service utilisation in a national sample of 35 to 44-year-old Brazilian adults taking into consideration the role of individual-level and contextual-level characteristics. The final overall sample was 6,157 individuals nested in the 27 Brazilian State Capitals. Dependent variables were time since last dental visit, reason for the last dental visit, and type of service used. The main exploratory variable was self-reported colour/race (White, Pardo, or Black). Individual-level and contextual-level characteristics were considered covariates. The results showed that for the time since last dental visit, the individual-level characteristics fully explained the differences between groups. The same occurred for differences between Blacks and Whites for visits due to pain or extraction, and due to treatment. However, Pardos were 1.24 and 1.21 times more likely, respectively, to visit the dentist due to pain or extraction, and due to treatment compared to Whites even after the adjustment for individual and contextual-level covariates. Additionally, Pardos and Blacks were 1.24 and 1.69 times more likely, respectively, to visit the public dental service compared to Whites after the adjustment for all covariates. To conclude, colour/race differences in dental service utilisation were evident for middle-aged adults in Brazil. Individual-level characteristics, especially level of education and income, were more relevant to reduce differences compared to contextual-level characteristics, but these reductions were not sufficient to fully explain the inequalities observed for some of the investigated outcomes.

IMPACT STATEMENT

In countries where race or ethnicity are measured, almost all individuals classified as minorities are shown to have the worst oral health outcomes. In Brazil, for instance, evidence has shown a higher proportion of oral cancer, periodontal disease, dental caries, dental pain, and tooth loss in Pardos (mixed group) and Blacks compared to Whites. Consequently, as dental service attendance helps to alleviate suffering, restore oral structures, promote oral health and prevent oral diseases, it would be expected that these minorities were more likely to visit the dentist than Whites. However, Brazilian-based research has scarcely investigated this topic thoroughly.

The findings presented in this thesis are the first to analyse data from a national sample focusing on the relationship between race and dental service use among Brazilian adults. The results showed that these minority groups are more likely to visit the dentist due to pain or extraction and depend more on public dental services for oral care compared to Whites, even after considering the role of individual-level characteristics, such as level of education and income, and characteristics of the 27 Brazilian State Capitals. The results contribute to further the understanding on the determinants associated with racial inequalities in the time since last dental visit, the reason to visit the dentist, and the type of service used, which may help to reduce the higher burden of oral diseases among these minorities.

This thesis highlights to policymakers the importance of accessibility and quality of the public dental service, especially, for racial minorities in Brazil. The results also suggest that improving socioeconomic characteristics of racial minorities are particularly important to reduce dental service inequalities. Furthermore, the findings also encourage health professionals and government authorities to improve the promotion of preventive visits for these minorities, which may help to reduce cycles of emergency attendance due to pain or extraction.

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LIST OF ABBREVIATIONS

HDI	Human Development Index
OHT/FHP	Integration of dental teams into Family Health Programme
FHP	Family Health Programme
UK	United Kingdom
NICE	National Institute for Health and Clinical Excellence
USA	United States of America
NHS	National Health System
Medicaid	Source of funding in USA for medical and other health service for people from low income background.
PNSIPN	Comprehensive Health Care National Policy of Negro Population: A Unified Health System Policy (SUS – Brazil) ("*Política Nacional de Saúde Integral da População Negra" in Portuguese)*
PubMed	Public/Publisher MEDLINE (National Library of Medicine journals database)
SciELO	Scientific Electronic Library Online
LILACS	Latin American and Caribbean Center on Health Sciences Information ("*Literatura Latino-Americana e do Caribe em Ciências da Saúde*" in Portuguese)
IPEA	Brazilian Institute of Applied Economic Research
PNUD	Acronomyn in Portuguese for the United Nations Development Programme

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CHAPTER 1 INTRODUCTION

1.1 Overview

Racial and ethnic minority disadvantages are widespread affecting many different areas of life (Bhopal, 2014a, Nazroo, 2001). Evidence on health inequalities[1] among racial and ethnic groups have been reported in developed (Nazroo, 2003, Williams and Mohammed, 2009) and in developing countries (Chor, 2013). In Brazil, there has also been a growing discussion on the role of race as an important determinant of health (Kabad et al., 2012).

The study of racial inequalities in Brazil has been challenging not only due to the different anthropological and sociological aspects that informed the research on this topic (Sansone, 2003, Telles, 2003, Telles, 2002), but also the uniqueness of Brazilian classification system (de Carvalho et al., 2004, Telles and Lim, 1998, Bailey, 2008). First used around the abolition of slavery (1888), the classification of race was adopted by the Brazilian National Census with four categories based on the individuals´ ancestry (White, Pardo (mixed), Black (African), Caboclo (Indigenous)). Over the years, with the immigration of other ethnic groups from Europe (Italians, Dutch, Germans) and Asia (Japanese, Turkish, Chinese), the classification system was adjusted to these changes. Besides the inclusion of a category to address Asian descents (Yellow), the Government included skin colour as an aspect to consider in the self-classification system (Anjos, 2013).

By making use of this classification, Brazilian-based research shows that the remnants of lack of equitable rights among racial minorities compared to Whites during the three hundred years of slavery are still evident in different aspects of contemporary life. Evidence shows that compared to the White majority, Pardos and Blacks Brazilians have lower levels of education and income (Pinheiro et al., 2008),

[1] "Health inequality is the generic term used to designate differences, variations, and disparities in the health achievements of individuals and groups" (Kawachi et al., 2002).

worse health outcomes (Lopes, 2005, Lotufo and Bensenor, 2013, Oliveira et al., 2014, Barros et al., 2011, Chiavegatto Filho and Laurenti, 2013, Chiavegatto Filho et al., 2014) and higher mortality rates (Travassos and Williams, 2004, Batista et al., 2004, Martins, 2006, Araujo et al., 2009b, Antunes et al., 2013).

This unfair distribution of health is also shown in the oral health literature, where Pardos and Blacks are observed to have higher prevalence of dental caries (Boing et al., 2014), dental pain (Constante et al., 2012, Guiotoku et al., 2012), oral cancer (Antunes et al., 2013), tooth loss (Celeste et al., 2013), and periodontal disease (Vettore et al., 2013, Peres et al., 2007, Bastos et al., 2009a). Although more at risk of worst oral health outcomes, these colour/race minorities in Brazil seem to be less likely to use dental service (Fonseca et al., 2017b, Herkrath et al., 2018, Souza et al., 2012, Monteiro et al., 2016), less likely to visit the dentist for preventive reasons (Martins et al., 2008a), and more likely to use the public dental service (Pinto Rda et al., 2014, Oliveira et al., 2016, Fonseca et al., 2017a) compared to the Whites.

Besides the importance of dental care to alleviate pain and suffering, there are many benefits of having access to a dental service. Although dentists have a broader role of helping to reduce inequalities (Watt et al., 2014) and working towards implementing healthy public policies and surveillance actions (Aerts et al., 2004), a key role is to improve oral health and health promotion (Sheiham and Moyses, 2000). Thus, research highlighting the determinants of racial/ethnic inequalities has the potential to inform policy and actions to improve oral health for these minorities.

Internationally, evidence suggests the infrequent use of dental service has also been linked with minority groups such as immigrants and ethnic minorities (Arora et al., 2016, Wu et al., 2013), and these minorities are more likely to be problem-oriented dental attendees (Gilbert et al., 2002). In Brazil, studies conducted have considered this social characteristic as a predictor, and only one study solely focused on describing colour/race differences in the use of dental service (Souza et al., 2012). The authors analysed data from the national oral health survey conducted in 2003-04 and observed that for the elderly population even after considering the role of gender, socioeconomic and self-reported oral health characteristics, colour/race minorities were less likely to visit the dentist more recently than Whites (Souza et al., 2012).

Looking at the abovementioned Brazilian study, and others which will be later presented in this thesis, one of the main gaps observed was the use of Pardos and Blacks categories combined into one (namely Blacks), not showing differences for each of these groups compared to Whites. Also, most of the studies focused on the time since last dental visit neglecting other dental service characteristics such as reason to visit dental service and type of service use. Additionally, previous studies that observed differences between colour/race groups mainly focused on the role of individual-level determinants (Souza et al., 2012, Monteiro et al., 2016, Martins et al., 2008a, Pinto Rda et al., 2014), and only recently there was an interest in investigating the role of contextual-level determinants (Pinto Rda et al., 2016, Herkrath et al., 2018, Fonseca et al., 2017b). However, these recent studies did not focus their analysis on the differences between Pardos and Blacks compared to Whites.

Therefore, this thesis aimed to investigate the role of both individual and contextual-level determinants on the differences between Pardos and Blacks compared to Whites for the time since last dental visit, the reason to visit the dentist, and the type of service used in a national sample of 35 to 44-year-old adults in Brazil.

1.2 What to expect for the next chapters?

The second chapter in this thesis provides an understanding of how the Brazilian population is classified in terms of race in contrast to the systems used in other countries. Additionally, the chapter brings a brief history of the two minority groups (Pardos and Blacks) that are the focal point of this thesis and presents an overview of the socioeconomic, health, and oral inequalities between Pardos and Blacks compared to Whites. The final section of this chapter introduces the healthcare system in Brazil, with special focus on dental services.

The third chapter focuses on the main aim of this thesis. It presents an overview of evidence on the relationship between race/ethnicity and dental service utilisation from other countries, and then focuses on the empirical evidence of colour/race inequalities in dental service utilisation in Brazil.

An overview of the theoretical evidence that incorporated race/ethnicity to the existing health/dental service models is then highlighted in the fourth chapter, alongside with the conceptual model used for this research. This chapter also describes the objectives and hypothesis of this thesis. The next chapter focuses on the methods, mainly describing the dataset used, the variables, and the statistical approach performed.

The findings of this thesis are presented in the next two chapters. Chapter 6 presents the results from the regression analyses conducted, focusing on the effect of demographic, socioeconomic, and oral health-related characteristics on the differences between Pardos and Blacks compared to Whites in the three dental service outcomes. Chapter 7 presents the findings from the multilevel analyses, focusing on the effect of individual-level and contextual-level characteristics of the Brazilian State Capitals where Pardos, Blacks, and Whites were nested in to compare the inequalities between groups in the three outcomes.

The final chapter presents a summary of the findings and compares these with other relevant studies. This last chapter also includes the strengths and limitations of this study, policy implications, and recommendations for future research.

CHAPTER 2 BACKGROUND

2.1 Chapter overview

This chapter starts with the discussion on the study of race and ethnicity concentrating on concepts, history of Brazilian classification system, and measurements issues of colour/race in Brazil. This is followed by an overview of the Black history in the country and the current evidence on socioeconomic, health, and oral health status of Pardos and Blacks compared to Whites. The chapter ends with an introduction of the Brazilian healthcare system with a special focus on dental services.

2.2 Concepts of ethnicity and race

Ethnicity and race are complex and difficult to conceptualise and measure, mostly due to migration history, cultural differences, and socio-political implications (Bradby and Nazroo, 2009).

Ethnicity as a concept was formally introduced in 1936 to group individuals with the same origins (Malik, 1996, Bhopal, 2014b), same culture, traditions, and languages (Senior and Bhopal, 1994, Nazroo, 2001). It involves characteristics that may change over generations (Karlsen and Nazroo, 2006, Nazroo, 2001). For example, the second generation of immigrants could identify themselves as from the country they were born (e.g. British), or according to their parent's ethnic group (e.g. Pakistani), or either from a mixed ethnic group (e.g. in case the parents are from different ethnic groups).

Race is a much older concept. The anthropologist François Bernier acknowledged in his 1684 publication (Gossett, 1997) different human races. Nowadays, this concept is most commonly used to refer to the individual´s physical characteristics (Bhopal, 2014b). Although the understanding of race as a characteristic related to an individual’s genes (Steer, 2015) still exists, a more contemporary approach among epidemiologists is to investigate race as a social-political construct to discuss the distribution of diseases (Senior and Bhopal, 1994).

Although there has been evidence highlighting that the concepts of race and ethnicity have been used diffusely, and often as if they were synonymous (Miranda, 2010, LaVeist, 1994, Kabad et al., 2012), researchers have been very critical on its use by emphasizing their implication in health research (Sheldon and Parker, 1992, Senior and Bhopal, 1994, Williams, 1994, Bhopal and Donaldson, 1998, Lin and Kelsey, 2000, Mays et al., 2003, Travassos and Williams, 2004, Karlsen and Nazroo, 2006, Bhopal, 2014b). Furthermore, there is a consensus among experts that comparison between race and ethnicity in countries with different classification system should not be conducted. For instance, in the USA there is a mixed concept between race and ethnicity, as both questions are used to determine the population´s origins (Pratt et al., 2010). In the UK, the classification has focused on ethnicity mainly according to heritage (Baer et al., 2013). In Brazil, the National Census Bureau categorises the population by asking an individual to self-classify according to their skin colour (Travassos et al., 2011), but in some categories ancestry is also considered.

Finally, the complexity of the self-classification of colour/race, as currently used in Brazil, may differ not only due to the individual's understanding of the concept and how he/she perceive himself/herself, but it may also differ according to the colour/race of the interviewer. This complexity, the history, and the current self-classification system used in Brazil were explored in the next sub-sections.

2.3 Colour/race: the Brazilian conceptualisation of ethnicity and race

2.3.1 History of the colour/race classification in Brazil

In Brazil, the assessment of the population is officially made by the Brazilian Institute of Geography and Statistics (IBGE). As noted in Table 2-1, the National Census started in 1872 and, at that time, individuals were categorised into four races. Those who were considered mixed race were included in the category "*Pardo*", and those who had any indigenous features, were included in the category named "*Caboclo*". In 1890, the word "*Pardo*" was renamed to "Mestizo", but it continued to have the same definition. In 1940, the category "Yellow" was included, which is a reference to Asian/Oriental population. Lastly, since the 1991 Census there are a total of five categories: 1) White; 2) Black; 3) Pardo; 4) Indigenous; 5) Yellow.

In addition to this classification, the term used to define this characteristic also changed over time. The word "race" was used in the first two Census (1872 and 1890), then "colour" between 1940 and 1980, and finally from the 1991 Census onwards it was standardised the use of these two constructs together in a concept named "colour/race".

Different from other countries that assess ethnicity as a measure of ancestry (e.g. UK), in Brazil, this is not the case. Although indigenous populations are categorised separately, those with Asian lineage are expected to opt for a colour-based category ("Yellow"). In addition, the classification scheme for those with any African descent is not binary as it is in the USA, such as "White" and "Black". The category "Pardo" contributes to the idea that in Brazil the racial dynamic is continuous, such as a colour palette (Silva and Paixão, 2014).

Table 2-1 – History of the Brazilian National Census between 1872 and 2010. Adapted from Osório (2003) and IBGE (2008).

Census (Year)	**Word used to describe the concept**	**Who answered the question?**	**Categories**				
1872[1]	Race	Interviewer	White	Black	Pardo	*Caboclo*	
1890	Race	Interviewer	White	Black	Mestizo	*Caboclo*	
1900	Not included	-	-	-	-	-	-
1910	No census	-	-	-	-	-	-
1920	Not included	-	-	-	-	-	-
1930	No census	-	-	-	-	-	-
1940	Colour	Interviewer	White	Black/ Pardo [2]	-	-	Yellow
1950	Colour	Interviewee	White	Black	Pardo	-	Yellow
1960	Colour	Interviewee	White	Black	Pardo	Indigenous	Yellow
1970	Not included	-	-	-	-	-	-
1980	Colour	Interviewee	White	Black	Pardo	-	Yellow
1991	Colour/race	Interviewee	White	Black	Pardo	Indigenous	Yellow
2000	Colour/race	Interviewee	White	Black	Pardo	Indigenous	Yellow
2010	Colour/race	Interviewee	White	Black	Pardo	Indigenous	Yellow

[1] The abolition of slavery in Brazil happened in 1888. Thus, the first census to measure race (1872) happened to mainly measure the amount of slaves in the country (Anjos, 2013).

[2] In the 1940 Census there was no differentiation between Pardo and Black in the results presented, even though there was the option *Pardo* in the questionnaire.

In the last decades, the classification of colour/race in Brazil has been discussed by several researchers (Bastos et al., 2008b, Bastos et al., 2009b, Telles and Lim, 1998, Travassos et al., 2011, Maio et al., 2005, Sansone, 2003). The maintenance/exclusion of the category "Pardo" and the struggles of the Black community in Brazil towards the recognition of a Black identity are the main topics reviewed (Loveman et al., 2012, Piza and Rosemberg, 1998). Researchers consider that the skin colour aspect may 'soften' the difficulty in self-classification between those that do not see themselves as Black due to the Pardo category option (Loveman et al., 2012), which may give an opportunity for the interviewees to declare a lighter colour in their responses (Anjos, 2013). For activists of the Black

Movement, the intermediate category between “White” and “Black” helps to promote denial of “Blackness”, meaning that the more the population with any African ancestry describe themselves as “Pardo”, the more the Black community loses its identity.

2.3.1 Complexity of colour/race measurement in Brazil

2.3.1.1 Self-classification and interviewer-classification of colour/race

The self-reported question of skin colour was first introduced in the 1950 Census (IBGE, 2008), but from that time until nowadays the question also can be answered by a family member in case the individual is incapable of (Osório, 2003). In the Brazilian National Census, the questionnaire does not assess who answer the colour/race question, so it is impossible to distinguish which of the methods is used: self-classification (by the person or by a relative) or interviewer-classification (Osório, 2003). According to Telles and Lim (1998) and Pinto (1996), interviewers tend not to ask the colour/race question as instructed mainly because: 1) they consider to be an uncomfortable question; 2) they believe they know the participant´s answer; 3) the interviewer incorporates the automatization of the routine responses.

Evidence shows that there is an important difference between the two methods. For example, in a study conducted in national random sample in Brazil with over 5,000 individuals (Telles and Lim, 1998), the estimate of White vs non-White income inequality was greater when the interviewer-classification method was considered, and the authors believed that this is the method to use when research aims to determine racial inequality and racial discrimination. As discussed by Bastos et al. (2008b), in Brazil, the interviewers tend to “whiten” the population, particularly for those who are in a privileged socioeconomic position. In a study conducted in Southern Brazil with 2,975 individuals and 31 interviewers (Bastos et al., 2009b), Black female interviewers were 2.5 times less likely to classify men aged 40 years or older as Black, when compared to their counterparts. Additionally, researchers from this previously mentioned study also observed that individuals aged 40 years or more were 2.1 times more likely to classify themselves as Pardo, when interviewed by Black interviewers.

Finally, the self-classification method is believed to estimates the exposure to risk behaviours attributed to cultural factors. This is because the individual considers the colour of the skin along with other ancestry features, but it also may be influenced by the way the individual imagines to be seen by society (Longo and Campos, 2006, Laguardia, 2014, Bastos et al., 2008b). The interviewer-classification method might estimate the social exposure to health risks and discrimination (Laguardia, 2014) because it takes into consideration the physical appearance, which may include the way the individual speaks and the clothes he/she is wearing (Telles, 2003).

2.3.1.2 The complexity of the Pardo category

The Pardo category can be a result of the abovementioned measurement issues, but also miscegenation between all racial groups; however, this category is often combined with the Black category in the Brazilian literature. Some authors consider that when the goal is to discuss the issues behind the skin colour of the population, there is a need to divide the categories using both Black and Pardo (Travassos and Williams, 2004); however, if the aim is to discuss issues of the Black community, then a combination of both categories may be used.

In case both categories were combined, and the individual only had a binary option (White or Black) in the official method, Loveman et al. (2012) argued that those individuals that self-classified as Pardos and have higher income would choose

White instead of Black. Additionally, in the current Brazilian political conjuncture, which has incorporated racial and social quotas in their laws, not considering the Pardo category in the data collection would change the eligibility of these individuals who can benefit from the “Law of Quotas” (Brazilian Law Number 12.711/2012), which reserves 50% of all Federal and Technical Universities vacancies for those self-declared as Blacks, Pardos, and Indigenous. Lastly, there is a lack of understanding between the uses of the Pardo category separate or combined with the Black category as previously mentioned. In this sense, to understand the complexity of the disadvantages suffered by coloured minorities in Brazil careful consideration should be given, as inequalities can be overestimated or underestimated for each of those groups.

2.4 Overview of the history and current situation of Pardos and Blacks in Brazil

2.4.1 The Black history in the Brazilian context

As seen in the previous section, Brazil does not categorise its population with the concept of ethnicity; nevertheless, colonisation and migration are strong predictors of the country´s demographic composition. The country was ‘discovered’ in 1500 by Portugal explorers, and the Portuguese colonisation lasted until 1822 when Brazil declared its independence. During that period, Brazil was considered the country that most imported African slaves in the Americas (Silva and Paixão, 2014), and by 1800 it was considered that 67% of the Brazilian population was of African descent (Andrews, 2004, Silva and Paixão, 2014).

Figure 2-1 shows the distribution of population over the period between 1872 and 2010 of the Brazilian National Census. The White and Pardo population had at first (1872) almost the same proportion (38.1% for Whites, 38.3% for Pardos). Although they had different distributions throughout the years, in the last census (2010), the proportions are getting closer again (47.5% for Whites, 43.4% for Pardos). As the frequency of the Black population decreases (19.7% in 1872, to 7.5% in 2010), the frequency of the Pardo population increases, which may represent both an increase of miscegenation - [mass noun] the interbreeding of people considered to be of different racial types - or a change of direction on self-classification, meaning individuals may be considering themselves with a skin colour lighter than before.

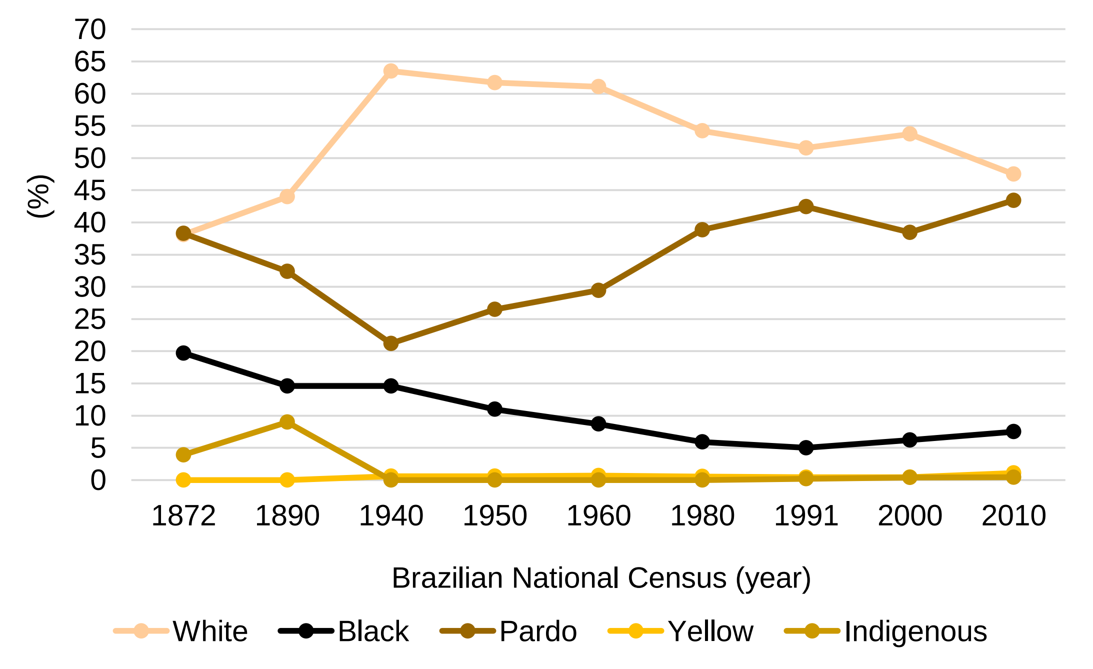

Figure 2-1 - Distribution of individuals according to colour/race over the period between 1872 and 2010 Brazilian National Census.

Data Source: This figure was translated from Portuguese to English, and it is an adaptation of the interactive graphs created by Brazilian National Census Bureau (IBGE). The original figure can be found in the following link: http://goo.gl/MG1F26

The latest Brazilian National Census (2010) revealed that over 50% of the population was self-classified as Black and Pardo, compared to 47.3% ten years before (2000), which represented around 97 million individuals. As it is understood that over half of the Brazilian population are self-classified as Black/Pardo, Brazil may be recognised as a country mostly populated by a minority group.

These minorities were considered a disadvantaged group since the beginning. By the end of 1800, Brazil had abolished slavery, but these individuals did not have an equal opportunity in the first Republican period (1889 – 1930) (Silva and Paixão, 2014). As the European immigrants started their lives in Brazil with many advantages such as industrial jobs and land grants, Blacks and Pardos were concentrated in the North and Northeast, considered the most deprived areas of the country (Silva and Paixão, 2014), and as showed in Figure 2-2 this is still a reality today.

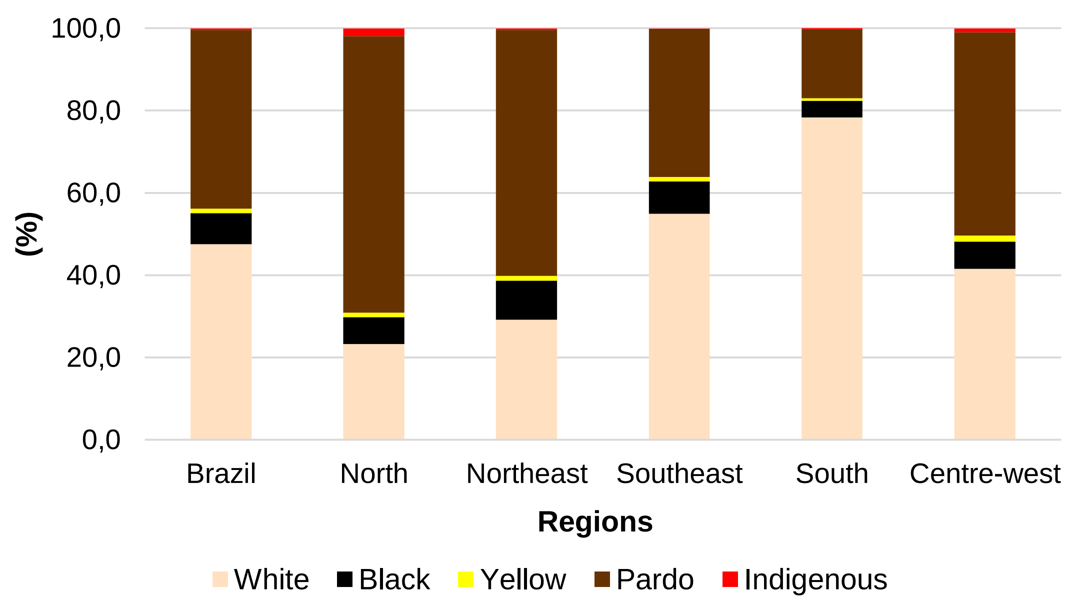

Figure 2-2 - Distribution of colour/race according to Brazilian Regions in the 2010 Brazilian National Census.

Source: IBGE. National Census Bureau, 2010

Brazil is divided into five regions, and the distribution of colour/race groups is unequal. According to data from the 2010 National Census, more than 50% of the Pardo population, and over 70% of the Black population lived in the North and Northeast region. Most White individuals are in the South and Southeast region.

The changes in the country's colour/race proportion and distribution started following the years of the slavery period. Brazil had immigrants from several countries, such as the Netherlands, Spain, Italy, Germany, Poland, Japan, and China. All these populations had a common feature: they were mainly White. The so-called "whitening" of the Brazilian population in the colonisation period is discussed among experts (Domingues, 2002, Schwarcz, 2011) as there might have been a Government intention to reduce the proportion of Pardos and Blacks in the country.

The Census data showed a remarkable declined in the proportion of Blacks in Brazil, especially between 1872 and 1940. These findings showed the disappearing of the Blacks, not only due to higher mortality rates but also due to the “whitening” of the population. According to Domingues (2002), as he discussed the publication of Ribeiro (1923), one example is in the city of Sao Paulo, whereas the coffee plantation was boosting the economy, data revealed that the European immigration was so intense, that in 1897 there were two Italian descendants for one Brazilian (Domingues, 2002). The European immigration was a solution for numerous problems in Brazil at the time (Munanga, 1999, Telles, 2002), but Pardos and Blacks continued to be worst off in many aspects of their lives compared to Whites.

2.4.2 Socioeconomic inequalities between colour/race groups

Pardos and Blacks have a historical economic disadvantage compared to Whites (Figure 2-3), and this income gap can also be observed when stratified by gender (Figure 2-4). The average monthly income of White men is much higher compared to others, and this did not change in the last 20 years (1995-2013). Pardo/Black women have earned almost half of what White women earned, and Pardo/Black men have earned less than White women.

Looking at the level of education, there are also considerable differences between the colour/race groups in the country (Figure 2-5). The illiteracy rate, which represents those who have difficulty to read and write a simple statement, has been more than two times higher amongst the Pardo/Black population than White population in the past decades (1995-2014).

For the population that was educated for 12 years or more, meaning that primary and high school were completed, the proportion of White population is more than two times higher than Pardo/Black (Figure 2-6). Although the proportion is increasing over time for both groups, the difference seems also to be increasing. The lower proportion of Pardos and Blacks from Higher Education in Brazil implies that these individuals cannot have equal access to the most prestigious occupations and higher paid jobs (Lopes, 2005).

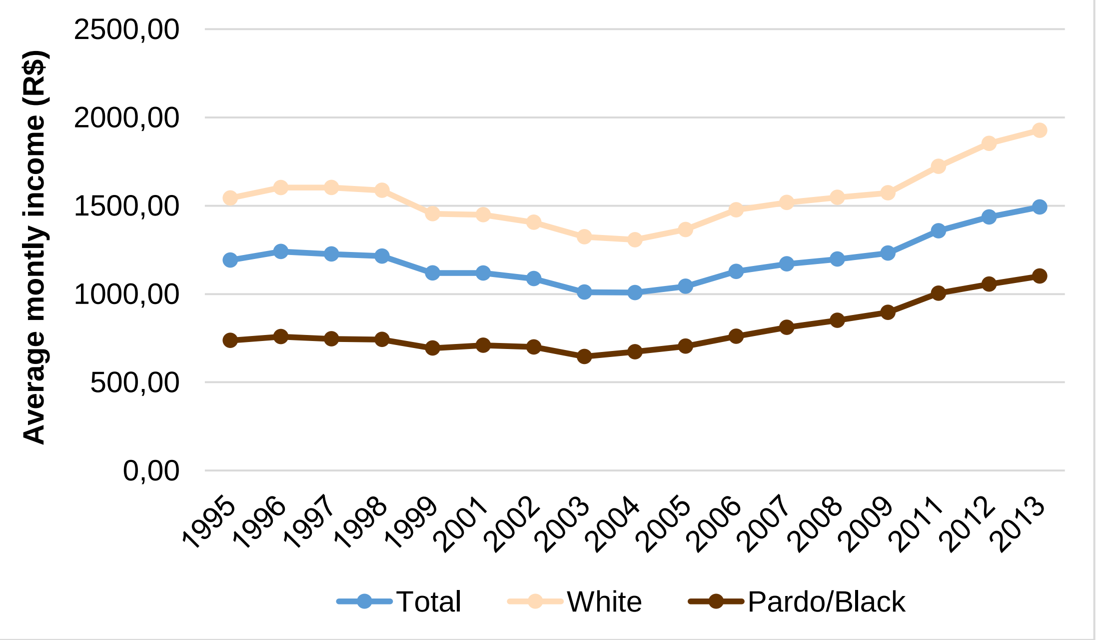

Figure 2-3 - Average monthly income in the main job of employed population aged 16 and older, by colour/race - Brazil, 1995-2013

Source: Institute of Applied Economic Research (IPEA) - http://goo.gl/qZarif

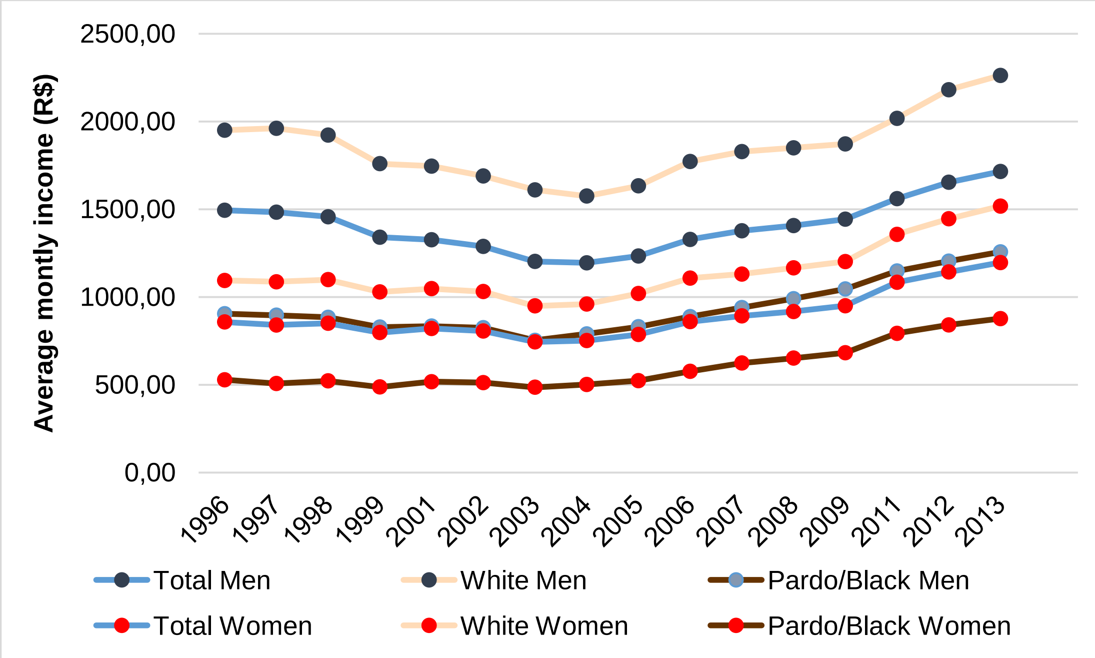

Figure 2-4 - Average monthly income in the main job of employed population aged 16 and older, by gender, colour/race - Brazil, 1995-2013.

Source: Institute of Applied Economic Research (IPEA) - http://goo.gl/qZarif

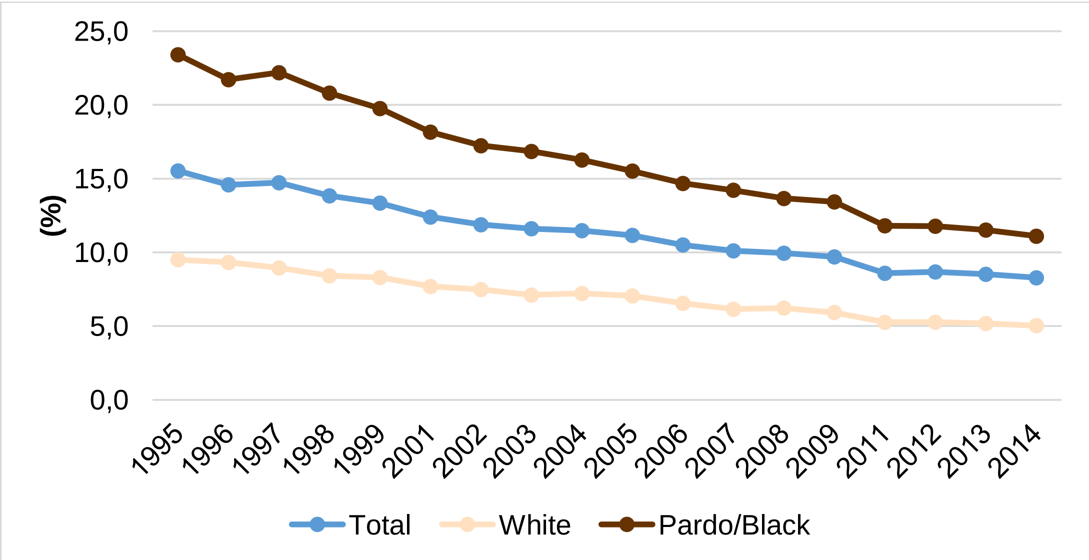

Figure 2-5 - Trend in the illiteracy rate for the Brazilian population by colour/race - Brazil, 1995-2014.

Source: Institute of Applied Economic Research (IPEA) - http://goo.gl/kbLe9T

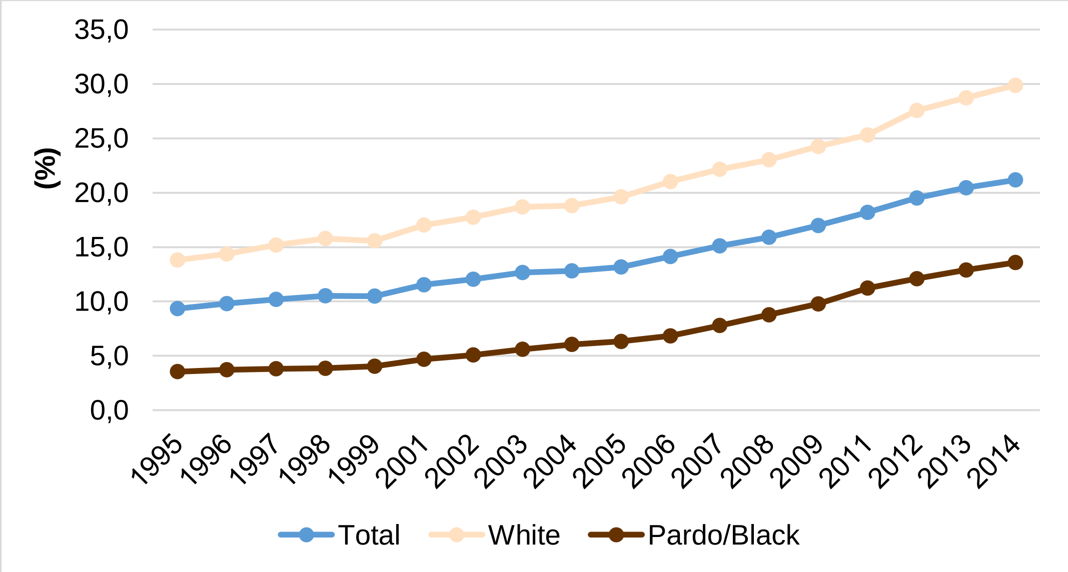

Figure 2-6 - Trend in the proportion of Brazilian population who studied 12 years or more by colour/race - Brazil, 1995-2014.

Source: Institute of Applied Economic Research (IPEA) - http://goo.gl/kbLe9T

Additionally, looking at a broader perspective of socioeconomic inequalities between colour/race groups, the Human Development Index from 2010 (PNUD, 2013) also shows the discrepancy between the Brazilian regions. The majority of the North and Northeast States in Brazil were categorised as in low development, in contrast with high development States (Figure 2-7). Comparing Figure 2-2 and 2-7, the States where most citizens belong to the Pardo and Black groups are those that most lack resources to provide long and healthy life, with a decent standard of living, as measured by the index.

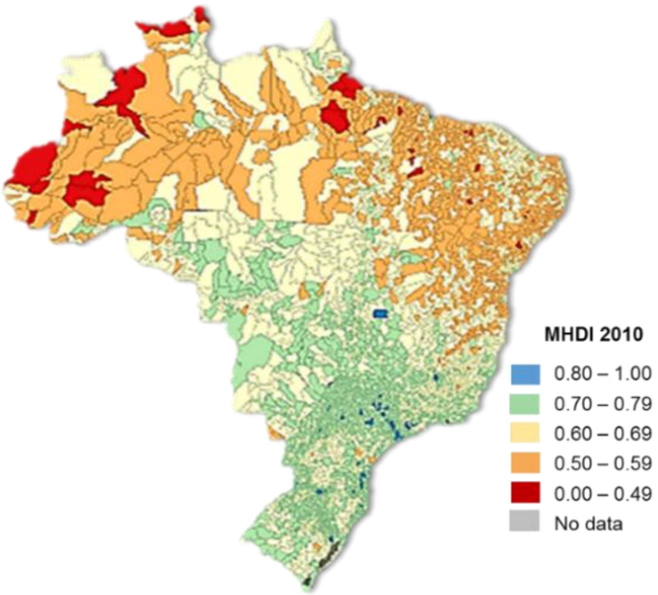

Figure 2-7 - Human Development Index by Municipalities in Brazil, 2010.

Note – The higher the value, the more developed a place is.
Source: http://www.atlasbrasil.org.br/2013/pt/mapa/

2.4.3 Health inequalities between colour/race groups

There are few studies conducted in Brazil that focus on health inequalities between colour/race groups, and the majority focused on comparisons of mortality rates between Blacks and Whites (Travassos and Williams, 2004). Data from the 2000 Census, showed that the Black and Pardo population had 6.34 and 5.96 fewer years of life, respectively, compared to Whites (Lopes, 2005). In a study with the 2010 data from the Brazilian mortality information system focused on individuals aged 30 to 69 years, death due to stroke was higher among Blacks compared to Pardos and Whites (Lotufo and Bensenor, 2013)

Besides having a higher chance of dying earlier than Whites, evidence shows that Pardos and Blacks also have higher prevalence of some chronic diseases, such as tuberculosis, cirrhosis, and hypertension, as well as worse self-rated health (Oliveira et al., 2014, Chiavegatto Filho and Laurenti, 2013, Barata et al., 2007, Barros et al., 2011, Barros et al., 2006)

The influence of contextual characteristics on the health of colour/race minorities is a topic that has received little attention in Brazil (Chor, 2013). Among the existing studies, one revealed that the North, Northeast, and Centre-west regions have the highest mortality rates due to homicide, and young, Black, and poor men, are considered a risk group (Reichenheim et al., 2011). Evidence also showed that the Northeast region also has higher maternal mortality rate than the South region, and it was observed that Black women had seven times higher odds of dying (275 per 100,000 live births) compared to White (43 per 100,000 live births) and Pardos (46 per 100,000 live births) (Chor and Lima, 2005, Martins, 2006) in these places.

While the South, Southeast, and Centre-west had the highest prevalence for the chronic disease measured with data from a Brazilian national sample in 2003, and Barros et al. (2011), the Northeast had the highest prevalence for tuberculosis, which is considered a disease prevalent in poorly resourced countries. Self-reported occurrence of falls and function limitation also had higher frequencies for elderly Blacks compared to Whites (Silva et al., 2012), and the place of residence and the conditions of households may be associated with these factors.

2.4.4 Oral health inequalities between colour/race groups

In the field of oral health, inequalities between Pardos and Blacks compared to Whites also exist and are exemplified by studies showing that these minorities have higher prevalence of dental caries (Liang et al., 2013, Boing et al., 2014), dental pain (Riley et al., 2003), oral cancer (Antunes et al., 2013), tooth loss (Celeste et al., 2013), and periodontal disease (Vettore et al., 2013, Peres et al., 2007).

In a study exploring the association between periodontal disease and skin colour, Peres et al. (2007) observed that Pardos and Blacks adults aged 35 to 44 years presented higher levels of periodontal disease even after the role of gender, socioeconomic characteristics, and geographical region was considered.

Periodontal disease has also been associated with colour/race in other studies in Brazil (Vettore et al., 2013, Bastos et al., 2009a), and dental caries, tooth loss, and dental pain were also associated with colour/race groups in adults aged 35 to 44 years (Guiotoku et al., 2012, Frazão et al., 2003). The authors highlighted that higher cost of treatment and the systematic exclusion of preventive dental care are possible reasons for these findings.

Considering the effect of contextual factors on oral health, Bastos et al. (2009a) reported that in the Southeast of Brazil, Black adolescents (15-19 years old) had a prevalence of periodontal pockets three times higher compared to Whites. However, in the Northeast, where there is a higher percentage of Black individuals, being Black was not considered a risk group for this outcome. This study helped to highlight that area-level in Brazil is an important factor to consider due to considerable differences in the proportion of non-White population.

Apart from region of living, other contextual characteristics such as Human Development Index, distribution of income, access to health care, and the integration of dental teams into Family Health Programme (discussed later on this thesis), seem to have an essential contribution to the distribution of oral health outcomes (Antunes et al., 2006, Peres et al., 2010, Peres et al., 2012c, Vettore et al., 2013, Antunes et al., 2003).

2.5 Introduction to the health and dental care system in Brazil

The next chapter highlights the evidence on the relationship between colour/race inequalities of dental service utilisation. In order to better understand dental service use in Brazil, this section gives an overview of the structure of the healthcare system in the country.

Brazilian National Health System (Susarla et al.) was established in 1988 with the goal to ensure universal access to health care actions and services, prioritising health care equity, without prejudice or privileges of any kind. Until this day, there is no cash/direct payment from the population, and the service remains free of charge. Since 1995, with the creation of the Family Health Program (FHP) the primary care was reorganised, and actions started to be family-centred with more focus on preventive care. This governmental programme (FHP) was implemented to deliver interdisciplinary health care to the Brazilian population (Macinko and Harris, 2015).

The FHP team is composed of a physician, a nurse, a nurse assistant, and four to six community health agents, and an oral health team (one dentist, plus an assistant and/or a dental technician). In 2014, there were 39,000 teams and 30,000 oral health teams, which together cover 62% of the population (Macinko and Harris, 2015). The oral health programme focuses on promotion and preventive actions in oral health, but also focus on improving patient satisfaction with the service.

In Brazil, there are currently two main types of dental services. Private dental service may be at a private dental office or a private hospital and can be paid by direct payment or by dental insurance. As for the public service, dentists are based on three levels of care: 1) Primary Care, for prevention, simple treatments and simple extraction; 2) Centre of Dental Specialty, for specialised and more complex treatments; 3) Public hospital, either in case of emergency, treatment of bedridden patients, or oral-facial surgical procedures.

To increase accessibility, improve availability and quality of dental service, in the early 2000s, the Brazilian Government created the largest public oral health care program named "*Brazil Sorridente*" (translated as Smiling Brazil). Although evaluation of the programme were discussed throughout the years (Junqueira et al., 2008, Nascimento et al., 2013, Moyses et al., 2013, Pucca Junior et al., 2010), a more intense debate happened in the program’s tenth anniversary and its goals were reassessed by some authors (Pucca et al., 2015, Scherer and Scherer, 2015, Chaves et al., 2017). They looked through the perspective of both population and professional and argued that much more work still needs to be undertaken especially regarding the availability of specialised services, training, and financing.

More specifically focused on colour/race, another policy is important to highlight. In 2007, after acknowledging that colour/race minorities were more at risk of worst health and oral health outcomes, the Brazilian Government launched a policy entitled “Comprehensive Health Care National Policy of Negro Population: an Unified Health System Policy (SUS – Brazil)” (approved translated title of the Portuguese version “*Política Nacional de Saúde Integral da População Negra” (PNSIPN)*), recognising the health needs of the minority racial groups and promoting health equity for individuals classified as Pardos and Blacks (Brasil, 2007).

Looking at general health service, evidence shows that compared to Pardos and Blacks, Whites have higher probability of visiting the health services more recently (Silva et al., 2011, Ribeiro et al., 2006). Moreover, in a study conducted in Southeast Brazil, White women were 1.14 times more likely to use health services than Black women (Chiavegatto Filho et al., 2015); and in a birth cohort study being young and Pardo/Black was a predictor of lower use in contrast with White (Dias-da-Costa et al., 2008). Furthermore, 71% of Pardo/Black visited the public health service in 2003, and the number was nearly the same in 2008 (67.3%) (Silva et al., 2011).

CHAPTER 3 EVIDENCE ON RACE/ETHNIC INEQUALITIES OF DENTAL SERVICE UTILISATION

3.1 Definition and importance of dental service utilisation

According to Travassos and Martins (2004) health service utilisation can be defined as *"any direct or indirect contact between an individual and the service, either with the institution or with the health professional".* Thus, the definition of dental service utilisation may follow the same description.

The role of dental professionals lays not only in alleviating pain and suffering, and restore structures, but also to promote oral and general health, and prevent diseases (Newman and Gift, 1992). It is important to study inequalities in dental service use to request Government action among those who are worst off in receiving the dental services required. Additionally, according to Gilbert et al. (2000), use of dental service is important because individuals that do not have access to this service, do not compensate the lack of professional care with self-care. Moreover, non-regular users are more likely to have harmful behaviours, such as smoking and use of non-prescription medication, to avoid dental problems. Furthermore, lack of access to dental service and to a quality service (which encompassed the abovementioned role of dental professionals) could result in further pain, tooth loss, and cycles of emergency attendance among minority racial/ethnic groups.

Although most studies about dental service utilisation assess race or ethnicity, only a few authors go beyond the use of this characteristic as a covariate and discuss in detail the inequalities between groups. Further sub-sections highlight some of these studies, and others that explore this characteristic in any extent, divided into the three outcomes investigated in this thesis, which are the most common measures of dental service utilisation: i) time since last dental visit; ii) reason to visit the dentist; iii) type of service used. Although difficulties in accessing dental service are also shown in other countries (Brasil, 2010a), the review focused mainly in evidence from UK and USA, where inequalities between minorities have been explored, especially between African American descents compared to Whites. After the overview of the international approach to the topic, the next section highlights the evidence of studies conducted in Brazil, later showing the gaps in the current literature.

3.2 International evidence on racial/ethnic inequalities in dental service utilisation

A recent systematic review and meta-analysis showed that from the 47 selected studies that investigated inequalities in dental service utilisation with representative population and considered inequalities between racial/ethnic groups, ethnic minorities and immigrants have lower use of dental service compared to majorities or native population. From the selected studies, 33 were derived from North America, followed by 6 studies from Scandinavia (Reda et al., 2018). The systematic review included studies that measured regular use or recent visit, as well as studies that measure preventive dental visits; however, studies that included emergency visits or visits due to a certain reason (as it will be explored in the next subsection) were excluded. Another conclusion from this review is that the amount of interest worldwide in studying racial/ethnic differences in dental service utilisation is lower compared to studies on gender difference (77 studies) and socioeconomic (175 studies), for example, showing that much more needs to be explored in terms of measuring and understanding racial/ethnic inequalities.

I. Time since last dental visit

Among all the dental service characteristics, the time since last dental visit is the most assessed. However, because there is not enough evidence to recommend the minimum interval between appointments (Davenport et al., 2003, Sheiham, 1980, Sheiham, 1977), there is not a standard categorisation for this outcome.

In the United Kingdom (UK), for instance, there is support from the National Institute for Health and Clinical Excellence (NICE) to promote dental visits every two years (Maxwell, 1992). Nevertheless, this abovementioned categorisation is not used by all studies looking at ethnic differences. One study that used this categorisation was based in a culturally diverse disadvantaged neighbourhood in South East London, and Al-Haboubi et al. (2013) observed that there was no difference between Blacks and Whites in visiting the dentist in the past two years even after the adjustment for gender, age, social grade, and place of living. However, the study showed that Asians were more likely to visit the dentist in the past two years compared to Whites, and the adjustments previously mentioned helped to attenuate the difference. In contrast, a more recent study assessed a different period (Arora et al., 2016), and the authors observed a lower proportion of Blacks and South Asians reporting to visit the dentist more than two times every year compared to Whites. However, conclusions from this last study should be considered with caution, as the data came from a much less ethnically diverse sample of England, Wales, and Northern Ireland (94.6% White, 1.7% Black, 4% Asians) compared to the first mentioned study conducted in South East London (71% White, 23% Blacks, 6% Asians). Additionally, no conclusions could be made in this last study regarding which determinants might affect the inequalities between groups, as the authors did not focus directly on dental service but assessed it as a covariate to measure oral health inequalities.

Some studies using qualitative methodology looked at ethnic minority views on dental service use in the UK, and observed that among participants with African descent living in the South region of London, the cost of the service and anxiety about environment and pain were considered possible barriers to regular dental service utilisation (Brasil, 2004a, Croucher and Sohanpal, 2006). However, a qualitative study among African American adults in the USA observed that having insurance to cover the service cost did not eliminate racial inequalities, mostly because of issues surrounding the coverage that was provided (Schrimshaw et al., 2011). The authors interviewed 118 adults and concluded that difficulties in finding a dentist that accepted the insurance, waiting period for the insurance to accept the treatment, and poor quality of care was the main reason for not visiting the dentist. Additionally, a second publication from the same sample showed that fear of dentist mistreatment and unsatisfactory hygiene standards among dentist who accepted insurance were also considered barrier among the African Americans interviewed (Siegel et al., 2012).

It seems that although the cost of service is an important determinant of dental service use among minorities, it might not fully explain the inequalities observed. A quantitative study conducted in the USA observed that non-Hispanic Whites aged 45 years or older with the ability to pay comfortably for dental service had higher odds of using the dental service in the past six months compared to African Americans that had the same ability (Gilbert et al., 2002). In accordance, in a more recent study in the same country, Okunseri et al. (2013b) conducted a retrospective research in individuals from age 12 to 34 and reported that Black individuals had lower odds over time of visiting the service compared to Whites, after considering the effect of education, income, and health insurance. Furthermore, variations between gender have also been observed among racial groups in the USA. For example, comparing the use of dental service in the preceding two years between racial groups among people aged 70 years and over, Dunlop et al. (2002) observed that after controlling for access factors (income, education, health insurance) Hispanic women were more likely to use dental service compared to White women, but no differences in among men were observed.

Lastly, some authors that investigated the time since last dental visit conducted studies to explore broader determinants. One study conducted in the USA investigated the role of racial diversity in a community amongst adults aged 18 to 64 years, but did not find this contextual-level characteristic to have an impact on dental service use in the past 12 months (Chi and Carpiano, 2013). The study, however, explored the relationship between racial diversity and dental service use, and did not present findings on inequalities between racial groups. In another study conducted in the USA, a racially diverse population (51 % African American and 44 % White) aged 18 and older was sampled and inequalities in dental service utilisation in the past two years between racial groups were investigated (Eisen et al., 2015). The authors observed that African Americans were, surprisingly, more likely to use dental services compared to Whites in this community, and they emphasised that both Black and White population lived in the same environment and had the same median income. This last study highlighted that residential segregation[2] is strongly related to race inequalities and it should be considered when studying this outcome.

II. Reason to visit the dentist

Inequalities in the reason to visit the dentist between racial/ethnic groups are also observed. In USA, a study conducted by Wu et al (2013) using data from a telephone survey in over 600,000 adults aged 50 years and older observed that looking at all racial groups (African Americans, Hispanics, Asians, American Indians/Alaskan Natives) only African Americans were less likely to visit the dentist for dental cleaning in the previous year compared to Whites. The study provided an excellent overview of the estimates on the USA national data for dental cleaning as the reason to visit the dentist among different racial groups over time; however, it did not consider the role of insurance, which was mentioned in the last section as a

[2] "Residential segregation refers to the physical separation of the races in residential contexts" (Williams and Collins, 2001).

possible barrier of dental service use, and the discussion lacked possible explanations for the findings on the differences between African American and White. Nevertheless, African Americans were the only group to maintain a significant difference with Whites after adjusting for socioeconomic, health, behavioural factors, as well as number of permanent teeth, indicating that for this minority group other pathways should also be explored.

Also in USA, a retrospective observational study conducted in over 29,000 individuals aged 18 to 60 years being treated in a dental training institution (Okunseri et al., 2007) observed that African Americans were less likely to have restorative treatment and more likely to have surgical procedures compared to Whites over a three-year period, even after adjusting for type of insurance and age. The authors argued that as these minorities tend to have the worst oral health outcomes and visit the dentist in emergency visits, they may be less likely to require preventive treatment.

This interpretation of racial minorities not requiring preventive treatment is an example of how discrimination might be embedded in the dental professional. As observed in the previous section, mistreatment or other adverse situations experienced by Black minorities could lead to less use of dental service, and therefore fewer preventive visits. The findings from the abovementioned study could be a reflection of lack of Governmental policies to ensure better oral health for racial minorities, but can be due to systematic discriminatory behaviour by the dental professionals (Madhan et al., 2012, Levett et al., 2009, de Freitas et al., 2006), as more explored in the general health service (Paradies et al., 2014).

There is evidence that lower levels of trust, racism, and discrimination in the health care system affects health service utilisation (Shavers et al., 2012b, Shavers et al., 2012a, Paradies et al., 2014, Klonoff, 2009, Smedley et al., 2002, White and

Chanoff, 2011). Minorities could choose not to go back to the service that did not welcome them as equals, and also fear of being mistreated again. Although there is robust evidence looking at association of racial discrimination and general health service compared to dental services, there is some evidence of racial/ethnic inequalities in the provision of dental procedures in countries such as USA, Australia, and Brazil (Santos, 2013, Jamieson et al., 2013, Okunseri et al., 2007, Cabral et al., 2005, Leite and Souza, 2010).

Another study conducted in USA agrees with the abovementioned debate by showing that visiting the dentist for emergencies was a pattern among African Americans (Boykin et al., 2009). The study followed 873 subjects aged 45 years or older for 48 months (85% response rate in the last follow-up) and observed that African Americans who visited the dentist for emergency visits were more likely to have revisited the dentist for negative reasons, such as for extractions, compared to non-Hispanic Whites.

Gilbert et al. (2002) also observed that African Americans were more likely to be problem-oriented dental attendees compared to non-Hispanic Whites. However, the discussion on racial bias was explored in another study using the same methodology used by Gilbert et al. (2002) – a prospective cohort study conducted in Florida, USA, with individuals aged 45 years or older (Gilbert et al., 2006). The authors observed that both races (non-Hispanic Whites and African-Americans) were more likely to have their teeth extracted in dental clinics where there were a higher proportion of African Americans as patients.

The abovementioned study showed that place of living might be especially important to understand the reason to visit the dentist, as accessibility and the relationship between patient-provider. In terms of contextual-level determinants, family-level characteristics may also play a role in racial differences. For example, a study observed that among Black families, caregivers that visited the dental service for preventive reasons had children with higher probability to visit due to the same reasons (Sohn et al., 2007). The results were observed even in low-income families, which highlights again the importance of the environment in the reason for dental visits.

III. Type of dental service used

Regarding the type of service used, there is some evidence on differences between race/ethnic groups. For example, the UK Government published the proportion of individuals who successfully booked an NHS dental visit over time (2011/12 to 2016/17) according to ethnic group, and showed that Black African never had 90% during the investigated period (UK, 2018). The figure showed that this minority group never reached the national average (at least 94%). In contrast, White British reached at least 95% over time. Also, in the UK, Arora et al. (2016) observed that dental appointments provided by the NHS were most commonly reported by all ethnic groups, compared to private service. However, the authors did not investigate the inequalities between the ethnic minorities and White population and did not discuss what were the possible reasons for the findings.

As in the UK, where dental appointments are partly subsided for the adult population by the National Health System, in the USA out-of-pocket expenditure also exists (Neumann and Quiñonez, 2014) and may be a barrier for dental service use by minorities. In a longitudinal study in the USA, Gilbert et al. (2002) observed that African Americans were more likely to use public dental service compared to Whites and the authors argued that the ability to pay for dental care was a key determinant for the finding. In accordance, other researchers observed that African Americans in USA most commonly visit low-cost dental services and are less likely to have dental insurance compared to Whites (Mead et al., 2008, Aday and Forthofer, 1992).

According to Schrimshaw et al. (2011), understanding characteristics related to dental insurance would help to explain the differences between Whites and African Americans in USA. Insufficient dental insurance coverage, finding a dentist that accepts the insurance, and waiting for the insurance approval for having the appointment may be some of the characteristics that could be investigated. Nevertheless, other barriers should be explored.

One study found that Black patients believe their appearance negatively affects receptivity in the health system (Johnson et al., 2004). Other studies suggested that these individuals have less confidence in their doctors (Musa et al., 2009, Boulware et al., 2003), and they show greater satisfaction with the service when cared by Black providers (LaVeist et al., 2003). The representativeness of dentists from a minority background seems to be an issue, but not in all countries. In the UK, for example, Newton and Gibbons (2001) observed that 14% of the dentists in the country were from an ethnic minority group, but it was not a concerning issue because in that year minorities represented only 6% of the country's population.

Ethnically diverse health professionals in a health care system is important to reduce inequalities because dentists from ethnic minorities seem to be more likely to accept patients from the National Health System (NHS) (Newton and Gibbons, 2001), which was also observed in USA with the Medicaid (Logan et al., 2014). Besides working more in low-cost services, African American dentists were observed to have 50% of their patients self-ascribed as African Americans (Mertz et al., 2017). Moreover, according to Mertz et al. (2017), Black dentists were not only underrepresented but also disproportionately distributed in the USA.

Although each country has their specific health system and particularities in the access of dental service may be different, there are similarities. Racial and ethnic minorities seem to rely more on public and low-cost dental service than the White majority. However, much more needs to be explored in terms of inequalities and the role of individual and contextual-level determinants.

3.3 Evidence on colour/race inequalities in dental service utilisation in Brazil

A search strategy was conducted in PubMed (Public National Library of Medicine journals database), SciELO (Scientific Electronic Library Online), and LILACS (Latin American and Caribbean Center on Health Sciences Information) to find publications in Brazil focused on dental service utilisation that considered colour/race characteristics in any extent. The search strategy and a flowchart showing the selection process is presented in the Appendices of this thesis (Table A-1 and Figure A-1). To this date, 136 publications were found not restricting the search by any filters, except controlling for publications using Brazilian data, and 28 papers were selected. A summary of their characteristics is presented at the end of this section (Table 3-1).

Most of the studies selected focused on adults and elderly population, had a cross-sectional design, and used interview-administrated questionnaires. Apart from studies conducted by Souza et al. (2012) and Guiotoku et al. (2012), all other studies used colour/race as a covariate and did not focus the analysis in underlying the determinants that may help to understand differences between groups in the use of dental service.

I. Time since last dental visit

The latest version of the "Comprehensive Health Care National Policy of Negro Population" report (Brasil, 2017), stated that the proportion of Pardos (38.2%) and Blacks (39.2%) who visited the dentist in the last 12 months were lower than Whites

(50.4%). The finding comes from the National Health Survey (IBGE, 2013) and it shows that the proportion is lower than the national average of 44.4%.

As in the international literature, Brazilian research also focused on the time since last dental visit, and as seen before there is no standard categorisation for this outcome. For instance, the Brazilian Institute of Applied Economic Research (IPEA) considered less than one year and a three-year period between visits to report dental service use and highlighted that differences between Whites and Pardos/Blacks are historically observed (Figure 3-1). Although the differences were overall constant over time, the White population were more likely to report recent visits, and the Pardo/Black population were more likely to report that their last visit was three years or over.

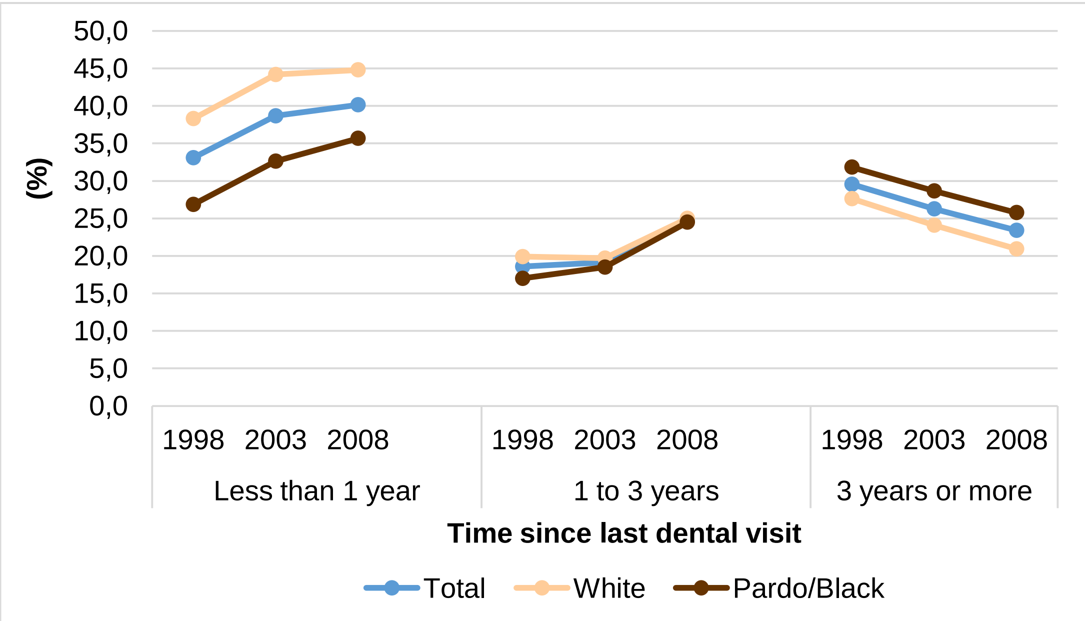

Figure 3-1 - Distribution of the time since last dental visit by colour/race according to a three-period survey conducted in Brazil.

Source: Institute of Applied Economic Research (IPEA) - http://goo.gl/hR0EIQ

The time since last dental visit in the previous year was the most investigated outcome (Martins et al., 2007, Martins et al., 2008a, Souza et al., 2012, Davoglio et al., 2009, Herkrath et al., 2018) among the selected Brazilian publication presented in Table 3-1, but other recall periods such as visits in the previous six months (Piovesan et al., 2011), and in the past two years (Ferreira et al., 2013) were also observed. The primary reference that investigated this outcome is the study conducted by Souza et al. (2012) in elderly aged 65-74 years using the national oral health survey SB Brazil 2002-2003. The authors combined Pardos and Blacks into one category named "Black" and observed that they were less likely (OR 0.62, 95% CI 0.53-0.72) to report visiting the dentist in the previous year compared to Whites. After controlling for sex and age, the authors observed a stronger association (OR 0.60, 95% CI 0.51 – 0.70), and further adjustments for the need of prostheses and pain did not change the results. However, after further considering the role of income and level of education part of the effect of colour/race on dental service utilisation was attenuated (OR 0.73, 95% CI 0.62-0.86). This study looked in depth at the relationship between colour/race and dental service utilisation. However, by combining the categories Black with Pardo, the authors did not present the actual estimate for each group compared to Whites. Nevertheless, the authors emphasised that differences between Blacks and Whites among the elderly population for the use of dental service in the last year were evident even after controlling for different demographic, oral health, and socioeconomic characteristics, and studies on individual and institution discrimination could help to understand this issue more deeply.

Besides Souza et al. (2012) study, other studies found evidence that minority colour/race groups are less likely to use dental service more frequently than Whites in Brazil (Martins et al., 2007, Martins et al., 2008a, Ferreira et al., 2013, Herkrath et al., 2018, Fonseca et al., 2017b). For instance, Martins et al. (2007) also analysed data from the elderly sample of SB Brazil 2002-2003, and observed that edentulous non-Whites (Pardos, Blacks, Yellow, and Indigenous) were less likely (OR 0.74, 95% CI 0.56-0.96) to visit the dentist in the last year compared to W*hite* edentulous, after adjusting for self-reported oral health and socioeconomic characteristics. However, no difference among the dentate sample was observed. Again, the combination of minorities into one category made it difficult to understand the difference between each minority compared to Whites. In contrast, a study analysing data from the elderly population of the survey SB Brazil 2010 reported the results for each colour/race group (Ferreira et al., 2013). However, the authors did not include colour/race into the adjusted analysis and provided no explanation to this exclusion. Nevertheless, the study investigated differences in the use of dental service for two years or less, compared to three years or more, and the descriptive analysis showed a significantly higher proportion of Pardos (68.0%) and Blacks (54.1%) reported to last visit the dentist three years or more compared to Whites (49.8%).

In contrast, two other studies did not find differences between colour/race groups. Both were focused on different age groups compared to the abovementioned studies and were performed in two Southern Brazilian cities. One study was conducted in individuals aged 12 to 18 years in Gravataí (Rio Grande do Sul, Brazil) to investigate differences in dental visit less than one year (Davoglio et al., 2009), and other study was conducted among individuals aged 20 years or more in Pelotas (Rio Grande do Sul, Brazil) to investigate regular use of dental service (Camargo et al., 2009). In this last study, the authors mentioned that although the results were not shown, the inclusion of the level of education and income fully explained the differences between Pardos, Blacks, and other compared to Whites.

Although differences in the association may be due to the vast difference in the proportion of colour/race groups between Brazilian regions and differences in the organisation of dental service, studies had different categorisation for colour/race groups and the outcome. In the beforementioned studies, for instance, three different methods were used for colour/race (dichotomisation (White, non-White), grouping of lower sampled groups (Yellow and Indigenous), and presenting estimates for each group) and for the outcome (visits in the previous year, visits with other recall period, and regular visits). This shows that it is important to have a standard method for categorisation for both colour/race and outcome to better understand the differences in dental service utilisation among colour/race groups. Moreover, many of the studies used colour/race as a covariate without proper discussing its findings, which makes it difficult to assemble a theoretical pathway that links colour/race to the time since last dental visit.

Additionally, the studies had all cross-sectional designs and conducted logistic regression to determine the association between variables. Two recent studies conducted multilevel analysis to consider the role of contextual-level characteristics for this outcome. One study was conducted in adolescents aged 15 to 19 years living in São Paulo State (Fonseca et al., 2017b). The study considered all colour/race categories and investigated differences between those who visit two years or less and those who last visited for three or more years or those who never visited. The authors applied Poisson multilevel analysis and observed that, after adjusting for individual and contextual-level characteristics, Pardos (PR 1.30, 95%CI 1.13–1.50) and Blacks (PR 1.58, 95% CI 1.29–1.93) were more likely to have last visited the dentist three years or more or never visited compared to Whites. This was the first study that considered colour/race and use of dental service in a multilevel analysis, and the authors argued that the results could be due to the level of social and material deprivation that colour/race minorities face in Brazil. However, the authors used the term “Caucasian” when referring to the White population. This term has been long disregarded in the racial/ethnic literature (Bhopal and Donaldson, 1998) because it dated back to when individuals were categorised based on their biological features. As it was discussed in the second chapter of this thesis, there are many complexities in categorising the Brazilian population, and referring to the Caucasus region does not fit with the classification system used in the country.

Another study that used multilevel analysis for this outcome was a study conducted by Herkrath et al. (2018). The authors observed that among a national sample of adults aged 35 to 44 years, differences in the use of dental service less than a year between Black and Whites were fully explained after accounting for income, having health insurance, and being register in the Family Health Program. However, Pardos were more likely (OR 1.10, 95% CI 1.03-1.18) to visit the dentist less recently compared to Whites even further accounting for self-reported and clinically evaluated oral health. Despite being statistically significant, this association was rather modest.

Finally, as the majority of the studies used individual-level characteristics into their analytical models, both Souza et al. (2012) and Herkrath et al. (2018) emphasised the need to investigate macro-level determinants for the time since last dental visit, such as those related to access to dental service and institutional discrimination. Among the studies that focused on the time since last dental visit, the contextual-level characteristics investigated were level of fluoride in the water supply, ratio of dentist per population, coverage of Family Health Program team, and place of living (urban/rural). As stated by Herkrath et al. (2018) "*(…) individual socioeconomic characteristics, including schooling and income, (…) are by-products of the social context where people live*". Therefore, in the case of colour/race differences, even when estimates are fully explained by the level of education and income, the studies seem to suggest that further investigation for the effect of the social context should be conducted.

II. Reason to visit the dentist

Among the selected studies, seven investigated the reason to visit the dentist and considered colour/race as a covariate (Davoglio et al., 2009, Camargo et al., 2012, Soares et al., 2013, Martins et al., 2008b, Souza et al., 2018, Freddo et al., 2008, Machry et al., 2013).

Two studies found differences between colour/race groups. One was a study conducted in individuals aged 65-74 years using the national oral health survey SB Brazil 2002-2003 (Martins et al., 2008b), and the other focused on 5 year-olds sampled from the SB Brazil 2010 (Souza et al., 2018). The authors from the first study observed that non-White individuals were less likely (OR 0.68, 95% CI 0.54-0.84) to visit the service for routine visits compared to Whites (Martins et al., 2008b). The findings were observed after the adjustment for place of living, socioeconomic, psychosocial, and oral health characteristics, time since last dental visit, and type of service used. Although the results were poorly discussed, the authors mentioned that the level of education and income represent important barriers to preventive visits among the non-White population in the country. The authors did well to analyse dentate and edentate elderly individuals separately, and the differences between Whites and non-Whites were only observed among the edentulous sample. This shows the importance of improving access to dental care and oral health among those more prone to suffer from the burden of oral diseases. Nevertheless, as the authors did not provide the different stages for the hierarchical adjustments for the main association, it was not possible to understand which characteristics were important to attenuate the differences among the edentate individuals and which were essential to fully explain the differences among the dentate sample.

In contrast, the second study that found differences in colour/race groups for the reason to visit the dentist did show the sequential model adjustments (Souza et al., 2018). The authors observed that Black (OR 0.60, 95% CI 0.40-0.90) and Pardo (OR 0.58, 95% CI 0.43-0.78) children were significantly less likely to visit the service for check-up/prevention compared to White ones. Oral health characteristics were particularly important in reducing the difference between Blacks and Whites, compared to Pardos and Whites. Nevertheless, similarly to the first aforementioned study, this also considered contextual-level characteristics in their analysis. Both studies investigated the role of place of living as a determinant of reason to visit the dentist; however, neither considered nesting the sampled individuals into the corresponded cities by using more appropriate statistical techniques, such as multilevel analysis.

Although Souza et al. (2018) observed significant differences among children aged 5 years while using a national sample from Brazil, two studies conducted in the Southern State of the country found no difference in the reason to visit the dentist among children. The study conducted among children aged 1 to 5 years found no significant difference in the use for non-preventive reason in the unadjusted model (PR 1.40 (0.8–2.41) (Machry et al., 2013). The other study conducted in 5-year-olds measured the outcome differently from others by using three categories: i) visits due to prevention, ii) visits to solve problems, iii) never visited the dentist (Camargo et al., 2012). The authors did not find any differences among colour/race groups, but this paper, especially, is an example of the issue previously mentioned on not focusing on a standard use of colour/race groups and not presenting the outcome in a clear way. By analysing the outcome considering those who never visited the dentist, the authors lost the comparability for the reason to visit the dentist; and by considering the category "others" to include only 16 individuals self-ascribed as Yellow and Indigenous, they may have underestimated the effect of other categories.

Other two studies that investigated colour/race and reason to visit the dentist considering adolescents in their sample did not find differences between groups. One study was conducted in adolescents aged 12 to 18 years in Southern Brazil (Davoglio et al., 2009), and the authors assessed differences between preventive and curative visits. Although it was observed a higher proportion of Whites (46.3%) compared to non-Whites (43.6%) in visits for preventive reason, this difference was small and showed to be non-significant in neither of the regression models. Similar results were observed in a study conducted among a sample with a mean age of 14 years, and the authors observed that non-Whites had a higher proportion (51.3%) who reported to visit for curative reasons compared to Whites (48.9%), but it was not statistically significant in the unadjusted model (Freddo et al., 2008).

Finally, it can be observed in Table 3-1 that none of the selected studies that investigated the reason to visit the dentist focused on an adult sample. Although a study focused on individuals aged 15 years and older conducted in two cities in a Northeast State in Brazil (Soares et al., 2013) showed that individuals aged 35 and older were more likely to have visited the dentist for extraction in the previous year, there was no indication on how the younger sample could differ from the older in terms of colour/race inequalities. Nevertheless, the authors included analysis between Blacks and non-Blacks in both unadjusted and adjusted model but found no difference between groups.

III. Type of service used

Among the selected studies, ten focused on the type of service used and considered colour/race as a covariate. One study focused on adolescents (Piovesan et al., 2011), seven were conducted among adults (Peres et al., 2012b, Pinto Rda et al., 2014, Guiotoku et al., 2012, Miranda and Peres, 2013, Soares et al., 2015, Pinto

Rda et al., 2016, Monteiro et al., 2016), and two among elderly (Oliveira et al., 2016, Fonseca et al., 2017a).

The study conducted on adolescents aged 12 years was situated in Santa Maria, Southern Brazil. The authors investigated differences between public and private dental service and had initially observed that non-Whites were more likely (PR 1.23, 95% CI 1.09-1.39) to visit the public dental service compared to Whites. However, differences were not statistically significant after adjusting for demographic, household income, level of education of parents, and self-reported and clinically evaluated oral health status (Piovesan et al., 2011). Although the hierarchical adjustment of the analysis was not presented, it seems that for this age group parents/carer socioeconomic characteristics are particularly important. One hypothesis could be that although public dental service in Brazil is free of charge, it has its problems regarding access; thus, when adjusting for the ability to pay for the service, public dental service might not be the main choice, as private dental service has higher availability rate in the country (Chaves et al., 2017).

Socioeconomic characteristics were also important in the difference between colour/race groups in the use of public dental service among adults. However, in a study conducted among adults (35 to 44 years old) who lived in the State of Minas Gerais (southeast region) socioeconomic characteristics help to attenuate the differences between colour/race groups, but did not fully explain them (Pinto Rda et al., 2014). The authors used three colour/race categories in their analysis (White, Dark-skinned blacks (Pardos and Blacks), and others (Indigenous, Yellow)), and observed that Dark-skinned blacks were more likely (OR 2.41, 95% CI 1.29-4.50) to use dental public services compared to Whites even after adjusting the analysis for socioeconomic characteristics, city size, and self-assessed oral health. The authors emphasised the importance of social factors to reduce racial differences, and that the public health system has shown to be highly important for these minorities following governmental initiatives to reduce social exclusion.

Nevertheless, this abovementioned study was the only among the seven who focused on adults that found any difference between colour/race groups. The unique result might be because the authors categorised colour/race from the official five categories to three categories (White, Pardo/Black, and Others). Other authors used other three different methods: *i*) considered only White, Pardos, and Black; *ii)* apply a binary categorisation (White/non-White, Black/non-Black, Caucasian/non-Caucasian); *iii)* or presented results for all five categories (White, Pardo, Black, Yellow, Indigenous). Additionally, the study from Pinto Rda et al. (2014) applied regression analysis in a sample of adults from Minas Gerais (Southeast State) using solely individual-level characteristics to investigate the determinants of the type of service used. Another study conducted by the same leading author (Pinto Rda et al., 2016), apply multilevel analysis using the same sample and did not find similar results.

The latter study from Pinto Rda et al. (2016) observed that differences between non-White and White Brazilians were fully explained by individual and contextual-level characteristics. The authors focused the analysis on one of the 26 States in Brazil (Minas Gerais, Southeast Brazil) and allowed the outcome to vary among three levels (individual, neighbourhood, and cities). Additionally, they highlighted that one of the main determinants of use of public dental service was a contextual-level characteristic focused on structured public services networks. Indeed, this may be exemplified by two recent studies in Brazil conducted in the city of Sao Paulo (Southeast Brazil) applying geospatial analysis which have shown that public dental services close to residencies of colour/race minorities were more distant to a high-frequency public transportation, compared those close to Whites (Yuen et al., 2018, Yuen et al., 2017).

The comparison between the two aforementioned studies conducted in Minas Gerais is interesting because it shows how a different approach in the statistical analysis might present different understanding of colour/race inequalities in the type of service used. Apart from Guiotoku et al. (2012) and (Peres et al., 2012b), all other studies applied regression analysis and were focused on a specific location, not using a national sample of adults in Brazil. Peres et al. (2012b) analysed data from a telephone-based survey conducted in all 27 Brazilian States with a considerable sample (n=54,367) of adults aged 18 and older. The authors observed that private dental service was the most used by all minorities, followed by dental plan, and public service. Pardos (16.9%) and Blacks (15.9%) had higher proportions than Whites (9.0%) for public dental service. Unfortunately, the authors did not present appropriate statistical analysis for this outcome. Similarly, only an exploratory analysis was conducted in a study using data from the Brazilian oral health survey from 2002-2003 (SB Brazil 2002-3) among a sample of 35-44-year-olds (Guiotoku et al., 2012). Similarly, Pardos and Blacks also had higher proportions in the use of public dental service compared to Whites.

Although other studies found no difference between colour/race groups, looking at Table 3-1, it is challenging to compare the studies that investigated the inequalities of type of service use among adults to understand colour/race inequalities. Among the studies that conducted regression analysis, Miranda and Peres (2013) use all five categories of colour/race and investigate differences between public and private dental service; in contrast, Soares et al. (2015) compared Black with non-Black individuals in four different categories of the outcome (no access, use of primary care, use of private service, or use of primary and secondary care); Monteiro et al. (2016) classified individuals in Caucasians and non-Caucasians and compared differences between use of public and private service.

In contrast, the two studies conducted in the elderly population used the same categorisation for the outcome (public versus private dental service), but colour/race categorisation was also used differently. The first study was conducted among individuals aged 65 to 74 years in Monte Carlos, Southeast Brazil, and showed that after accounting for level of education and income differences between White and Yellow compared to Blacks, Pardos, and Indigenous were no longer observed (Oliveira et al., 2016). This study was especially unique due to the way the authors categorised colour/race, which was not seen in any of the other publications in all three dental service utilisation characteristics. The second study was conducted among individuals aged 65 years and older in São Paulo (city of São Paulo State, Southeast), and the authors showed that Whites were less likely (OR 0.82, 95% CI 0.71-0.95) to visit the public dental service compared to non-Whites (Fonseca et al., 2017a). Interestingly, when compared to the other studies, they were the only to consider the two dental service characteristics (time since last dental visit, and reason to visit the dentist) as determinants of the type of service used. The differences were observed even after the adjustment for socioeconomic, self-reported and clinically evaluated oral health, and dental service-related characteristics. Similar to other authors, they argued that reducing socioeconomic inequalities and discrimination is very important to reduce colour/race inequalities in dental service use.

Table 3-1 – Characteristics of the studies using Brazilian data that measured dental service utilisation and considered colour/race differences to any extent. The studies were included by publication date.

N	Authors (year)	Study/ City	Sample size / age group	Colour/race distribution	Term used	Measures of dental service utilisation	Distribution of outcome according to colour/race	Covariates used	Main results after adjustments	How were the results discussed?
1	(Martins et al., 2007)	SB Brazil 2002-2003 / Brazil	n= 5,009 / 65-74y	Non-White (50.6%) White (49.4%)	Race	Time since the last dental visit (<1 year vs ≥ 1 year)	Use <1 year among dentate: White 58%, Non-White 42% / among edentulous: White 60%, Non-White 40%	Education, access to oral health information, self-report satisfaction with oral health and chewing, income, dental and gums pain in the past 3 months, use of prothesis, periodontal treatment, number of teeth extracted	NSD for dentate. Among edentulous: non-Whites had lower odds (OR 0.74) then Whites.	Only mentioned the need for other studies
2	(Martins et al., 2008a)	Southeast sample of SB Brazil 2002-2003, Brazil	n=1,014/ 65-74y	Non-White (42,4%), White (57.6%)	Race	Time since the last dental visit (<1 year vs ≥ 1 year)	Use <1 year among dentate: White 58%, Non-White 42% / among edentulous: White 57%, Non-White 43%	Education, place of residency, income, reason for dental visit, dental pain in the last 6 months, self-reported need for treatment, periodontal status, self-reported satisfaction with teeth/mouth, self-reported impact of oral health on social interactions and speaking abilities	NSD for dentate. Among edentulous: non-Whites had lower odds (OR 0.53 - MS) then Whites.	The results were not mentioned
3	(Martins et al., 2008b)	SB Brazil 2002-2003 / Brazil	n= 5,009 / 65-74y	Non-White (50.6%) White (49.4%)	Skin colour	Reason to visit the service	Routine visit: White (66%), non-White (34%); Problems: White (44%), non-White (56%)	Place of living (urban/rural), time since last dental visit, type of service used, information on prevention, education, income, self-reported need for prothesis, need for dental treatment, periodontal health, self-rated chewing, relationship, self-reported pain	Among dentate, non-whites were less likely (OR 0.68) to go for routine visits compared to Whites	Mentioned that equivalent results were observed among African Americans, and socioeconomic characteristics play a key role

Table 3-1 – (continued) Characteristics of the studies using Brazilian data that measured dental service utilisation and considered colour/race differences to any extent. The studies were included by publication date.

N	Authors (year)	Study/ City	Sample size / age group	Colour/race distribution	Term used	Measures of dental service utilisation	Distribution of outcome according to colour/race	Covariates used	Main results after adjustments	How were the results discussed?
4	(Freddo et al., 2008)	Original / Gravataí (South)	n= 2.282/ mean age 14 y	White (52.6%), non-White (47.4%	Skin colour	Non-adequate use of dental service (visits >1 year) / Reason to visit the dentist (curative – yes/no)	Non-adequate use: White (29.4%), non-White (33.0%) / Curative visits: White (48.9%), non-White (51.3%)	NSD in the unadjusted analysis		The results were not discussed
5	(Camargo et al., 2009)	Original/ Pelotas (South)	n=2,957 / ≥ 20y	White (75.6%), Black (13.6%), Pardo (7%), Others (3.8%)	Skin colour	Regular use (Regular = occasional visits due to a problem or not, or explicit report of regular use)	White 35.4%, Black 26.4%, Pardo 25.0%, Others 19.5%	Sex, age, education, income, marital status, type of service used, self-reported satisfaction with oral health, self-reported need for dental treatment, received information on prevention, agreement if dentist recommended more treatment than needed, believe that everyone losses teeth with age, and that saving front teeth is more important than back	Skin colour was not shown in the adjusted analysis because p-value after adjustment was 0.32	It was mentioned that income and education fully explained the results of skin colour differences.
6	(Davoglio et al., 2009)	Original/ Gravataí (South)	n= 1170 / 12-18y	White (52.6%), Non-white (47.4%)	Skin Colour	Time since the last dental visit (<1 year vs ≥ 1 year) / reason to visit the dentist (preventive vs. curative)	70.6% White and 60.0% Black visited annually / 46.3% White and 43.6% Black visited for preventive reasons	Sex, social class, type of service used, understood by parents, number of close friends, discriminated against, difficulty in sleeping, loneliness, suicidal attempt, sugar consumption, smoking status, alcohol status, drugs status	NSD in neither unadjusted or adjusted analysis	The results were not discussed

Table 3-1 – (continued) Characteristics of the studies using Brazilian data that measured dental service utilisation and considered colour/race differences to any extent. The studies were included by publication date

N	Authors (year)	Study/ City	Sample size / age group	Colour/race distribution	Term used	Measures of dental service utilisation	Distribution of outcome according to colour/race	Covariates used	Main results after adjustments	How were the results discussed?
7	(Araujo et al., 2009a)	Original /Pelotas (South)	n=3,393/ 10-19y, 20-59y, and >60y	10-19 y: White/Yellow (77.9%), Pardo/ Black/ Indigenous (22.1%); 20-59y: White/ Yellow (81.2%), Pardo/ Black/ Indigenous (18.8%); >60y: White/ Yellow (85.3%), Pardo/ Black/ Indigenous (14.7%)	Skin colour	Time since the last dental visit (<1 year vs ≥ 1 year)	Visits in <1 year: 10-19 y: White/Yellow (54.8%), Pardo/Black/ Indigenous (42.9%); 20-59y: White/Yellow (55.3%), Pardo/Black/ Indigenous (46.5%); >60y: White/Yellow (37.9%), Pardo/Black/ Indigenous (33.0%)	Gender, social class, level of education, marital status, self-report dental problem, satisfaction with oral health	NSD in the adjusted analysis	The results were not discussed
8	(Piovesan et al., 2011)	Original/ Santa Maria (South)	n= 792 /12y	White (77.8%) Non-white (22.2%)	Skin colour	Time since last dental visit in 6 months / type of service used	49.3% White and 40.7% non-white visited in the previous 6 months / 58.2% White and 72.0% non-white visited the public service	Sex, household income, mother's and father's education, DMF, self-rated oral health	not associated after adjustment	The results were not mentioned
9	(Machado et al., 2012)	Original / Porto Alegre (South)	n= 3,391 / >20y	White (77.7%), non-White (21.3%)	Skin colour	Regular use (occasional visits due to a problem or not, or explicit report of regular use)	White (25.9%), non-White (25.3%)	The regression analysis performed did not include skin colour		The results were not mentioned

Table 3-1 – (continued) Characteristics of the studies using Brazilian data that measured dental service utilisation and considered colour/race differences to any extent. The studies were included by publication date.

N	Authors (year)	Study/ City	Sample size / age group	Colour/race distribution	Term used	Measures of dental service utilisation	Distribution of outcome according to colour/race	Covariates used	Main results after adjustments	How were the results discussed?
10	(Guiotoku et al., 2012)	SB Brazil 2002-2003 / Brazil	n=12,811 35-44y	Blacks (9.6%), Pardos (44.4%), Whites (46.0%)	Colour/race	Type of dental service used	Public service: Blacks (56.8%), Pardos (53.3%), Whites (41.6%); Other: Blacks (39.6%), Pardos (43.1%), Whites (56.8%)	No regression analysis was performed to the type of service used		The study focused on oral health and racial differences, discussion focused on overall exclusion of minorities, socioeconomic and policy related issues
11	(Peres et al., 2012b)	Vigitel 2009 (telephone interview) / Brazil	n=54,367 / ≥18y	White (36.8%), Pardo (55.3%), Black (7.9%)	Colour/race	Type of dental service used (private, dental plan, public)	Private service (67% White, 60% Pardos and 64% Blacks). Dental plan (24% Whites, 23.2% Pardos and 20.1% Blacks). Public service Pardos 16.9%, 15.9% Blacks and 9% Whites)	No regression analysis was performed to the type of service used		Institutional discrimination was mentioned as possible explanation
12	(Souza et al., 2012)	SB Brazil 2002-2003 / Brazil	n= 5,108 / 65-74y	White (50.4%), Black (49.6%)	Race	Time since the last dental visit (<1 year vs > 1 year)	Visit > 1 year: White 78.7%, Black 85.8%	Sex, age, self-reported need for prothesis, dental pain, education, and income	Blacks were less likely to visit in the last year (OR 0.73). Sex and oral health did not change the estimates, but it was attenuated by income and education	Race was the main exploratory variable of the study; thus, the results were appropriately discussed

Table 3-1 – (continued) Characteristics of the studies using Brazilian data that measured dental service utilisation and considered colour/race differences to any extent. The studies were included by publication date.

N	Authors (year)	Study/ City	Sample size / age group	Colour/race distribution	Term used	Measures of dental service utilisation	Distribution of outcome according to colour/race	Covariates used	Main results after adjustments	How were the results discussed?
13	(Camargo et al., 2012)	Pelotas Birth Cohort Study / Pelotas (South)	n=1129 mothers of 1303 children / 5 y	White (66.6%), Mixed (19.7%), Black (12.3%), Others (1.4%)	Skin colour	Reason for the first visit to the dentist	Apart from White, all other groups visited more to solve problems	Sex, education, income, mother´s age, mother´s reason to visit, antenatal exams, age child started to brush their own teeth, day care status, fear of dentist, pain in the past 6 months, decayed tertiles, self-rated oral health of child by mother, need for dental treatment	NSD in the adjusted analysis	The results were not mentioned
14	(Ferreira et al., 2013)	SB Brazil 2010 / Brazil	n= 6702 / 65-74y	White (54.7%), Black (13.6%), Pardo (29.8%), others (1.8%)	Skin colour	Time since the last dental visit (≤ 2 year, ≥ 3 years)	Visits ≥ 3 years: 49.8% White, 65.2% Blacks, 54.1% Pardo, 68.0% Others	Skin colour were not part of the regression model		The results were not mentioned
15	(Soares et al., 2013)	Original/ Salvador (Northeast)	n=682 /≤ 35y, >35y	Non-black (58,1%), Black (41,9%)	Ethnicity	Use was measuring tooth extraction in the last year	Tooth extraction in Non-black 39.5%, Black 60.5%	Social program beneficiary, sex, age, education	No statistical difference in the regression	The authors referred to Souza et al. (2012) while commenting that “ethnicity” may be a limited factor for dental service use

Table 3-1 – (continued) Characteristics of the studies using Brazilian data that measured dental service utilisation and considered colour/race differences to any extent. The studies were included by publication date.

N	Authors (year)	Study/ City	Sample size / age group	Colour/race distribution	Term used	Measures of dental service utilisation	Distribution of outcome according to colour/race	Covariates used	Main results after adjustments	How were the results discussed?
16	(Miranda and Peres, 2013)	Original/ Florianópolis (South)	N=1,720 / 20-59y	White (89.5%), Pardo (5.7%), Black (4.4%), Yellow (0.2%), Indigenous (0.2%)	Skin colour	Time since the last dental visit (<1 year vs ≥ 1 year), Type of service (private, public)	Visit < 1 year: White (67.3%), Pardo (58.8%), Black (68.5%). Private service: White (85.6%), Pardo (8.6%), Black (3.6%); Public service: White (78.9%), Pardo (10.1%), Black (9.0%)	Level of education, income, visits from the community agent in the past year, health insurance, self-report need for dental treatment	Skin colour was not shown in the adjusted analysis because p-value after adjustment was >0.25	Only mentioned that the results were different from other studies
17	(Machry et al., 2013)	Original/ Santa Maria	n=478 /12-59months	White (79.3%), Non-white (20.7%)	Skin colour	Lifetime visit /reason for the last visit / type of service	No distributional table was presented	Skin colour was not part of adjusted model		The results were not mentioned
18	(Silva et al., 2013)	Original / Pelotas (South)	n=489 / >60y	White (71.2%), non-White (28.8%)	Ethnicity	Time since last dental visit (<3 years, 3 years or more)	3 years or more: White (57.8%), non-White (61.3%)	Ethnicity was not part of adjusted model		The results were not mentioned
19	(Soares et al., 2015)	Original /Salvador (Northeast)	n=1,290 / ≤35y,>35y	Non-black (58.9%) Black (41.1%)	Skin colour	Type of dental service used	Black: No access 9.3%, 32.6% Primary care, 39.4% Private, 18.7% Primary + Secondary (CEO) care	A series of regression analysis, but only showed the unadjusted and fully adjusted models, NSD between Blacks and Whites		Although Souza et al. (2012) did not measure discrimination, the authors referred to her work to discuss the issue

Table 3-1 – (Continued). Characteristics of the studies using Brazilian data that measured dental service utilisation and considered colour/race differences to any extent. The studies were included by publication date.

N	Authors (year)	Study/ City	Sample size / age group	Colour/race distribution	Term used	Measures of dental service utilisation	Distribution of outcome according to colour/race	Covariates used	Main results after adjustments	How were the results discussed?
20	(Pinto Rda et al., 2014)	SB Brazil 2010 Minas Gerais	n=1,102 / 35-44y	45% White (only information available)	Colour/race	Type of service used (public, private)	Public: White (37.6%), Black (16.2%), Others (46.2%); Private: White (48.5%), Blacks (7.2%), Others (44.3%)	Education, number of people in the household, income, size of town, self-reported need for dental treatment, self-reported satisfaction with teeth/mouth, toothache, need for prosthesis, oral health status clinically evaluated, time since last dental visit	Blacks were more likely (OR 2.41) than Whites to visit the public dental service; socioeconomic, and oral health characteristics were important to attenuate the differences	The authors argued that social factors might be important determinants to explain the findings
21	(Oliveira et al., 2016)	Original / Monte Carlos (Southeast)	n= 480 / 65-74y	White (33.2%) Yellow (1.2%) Indigenous (0.5%), Black (20.8%), Pard (44.2%)	Race/ ethnicity	Type of dental service (public, other)	Public: White (18.8%), Yellow/ Black/ Pardo/ Indigenous (52%)	NSD in the unadjusted analysis		The results were not discussed
22	(Pinto Rda et al., 2016)	SB Brazil 2010 Minas Gerais	n=1,100/ 35-44 y	Not declared	Colour/race	Type of service used (public, private)	33.9% White and 66.1% non-white use the public dental service once in life	No statistical difference in Model 1 of Multilevel mixed-effect Poisson regression, and it was not part of other models		It was mentioned the lack of statistical significance

Table 3-1 – (Continued). Characteristics of the studies using Brazilian data that measured dental service utilisation and considered colour/race differences to any extent. The studies were included by publication date.

N	Authors (year)	Study/ City	Sample size / age group	Colour/race distribution	Term used	Measures of dental service utilisation	Distribution of outcome according to colour/race	Covariates used	Main results after adjustments	How were the results discussed?
23	(Monteiro et al., 2016)	ISA-Capital / São Paulo State	3,357 in 2003, and 3,271 in 2008 / >20 y	2003: Caucasian (67.4%), non-Caucasian (32.6%); 2008: Caucasian (62.2%), non-Caucasian (37.8%)	Ethnicity	Time since the last dental visit (<1 year vs ≥ 1 year); Type of service use (private, public)	<1 year: 2003 (Caucasian 51.3%, non-Caucasian 37.2%); 2008 (Caucasian 57.2%, non-Caucasian 41.5%) / Public: 2003 (Caucasian 5.2%, non-Caucasian 7.2%); 2008 (Caucasian 4.7%,non-caucasian 11.4%)	Education, income, house conditions, health plan	Non-caucasians were consistently (OR 0.5) less likely to use the service in the previous year compared to Caucasians / NSD for the type of service use	The authors associated the results for the time since last dental visit to higher proportion of caucasians being in the upper socioeconomic status
24	(Fonseca et al., 2017b)	Original / São Paulo (Southeast)	n= 5,394 / 15-19y	Not reported	Ethnicity	Time since the last dental visit (<2 years, >2 years or never use)	<2 years: Caucasian (87.4%), Asian (82.1%), Native Brazilian (71.4%), Mulatto (81.9%), Black (78.4%)	Income, fluoride content, dentist per population ratio, dental care index, coverage by FHS team, sex, person room ratio, dissatisfaction with oral condition, payment model for last dental visit, periodontal status	Mulatto (PR 1.30) and Black (PR 1.58) were more likely to have last seen a dentist for 3 years or more, compared to Caucasian	The authors argued that level of social and material deprivation might be one of the causes
25	(Fonseca et al., 2017a)	Original / São Paulo (Southeast)	n= 5,234 / >65 y	White (69.9%), non-White (30.1%)	Race/ethnicity	Type of service used (public, private)	Public: White (35.1%), non-White (44.3%); Private: White (64.9%), non-White (55.7%)	Socioeconomic, toothache, time since last dental visit, reason to visit the dentist, dental calculus, endodontics, dentures, self-rated satisfaction with dental health	Whites were less likely (OR 0.82) to visit the public dental service compared to non-White	The authors mentioned Souza et al. (2012) findings and the effect of socioeconomic and discrimination

Table 3-1 – (Continued). Characteristics of the studies using Brazilian data that measured dental service utilisation and considered colour/race differences to any extent. The studies were included by publication date.

N	Authors (year)	Study/ City	Sample size / age group	Colour/race distribution	Term used	Measures of dental service utilisation	Distribution of outcome according to colour/race	Covariates used	Main results after adjustments	How were the results discussed?
26	(Carreiro et al., 2017)	Original/ Monte Carlos (Southeast)	n=2,582 / >18y	Black/Pardo (72.1%), White/Yellow (27.9%)	Colour/race	Regular use (Regular = regular visits yes/no and visits due to prevention/cleaning regularity)	Black/Pardo (35.5%), White/Yellow (36.7%)	No statistical difference in the unadjusted model, and colour/race was not part of adjusted model		The results were not mentioned
27	(Souza et al., 2018)	SB Brazil 2010 / Brazil	n=7,241 / 5y	White (48.3%), Black (9.6%), Yellow (2.2%), Brown (39.1%), Indigenous (0.7%)	Skin colour	Reason to visit the dentist (check-up/prevention: yes/no)	Check-up/prevention: White (56.1%), Black (36.4%), Yellow (47.5%), Brown (42.1%), Indigenous (15.2%)	Income, living in a State capital, self-report need for treatment, satisfaction with teeth/mouth, impact of oral health on quality of life, presence of dental caries and dental pain	Black (0.60) and Brown (0.58) were less likely to visit the service for check-up/prevention than Whites. Covariates reduce more for Blacks	The authors mentioned that income might explain the results, and minorities have worst oral health they need curative treatment
28	(Herkrath et al., 2018)	2013 Brazilian National Health Survey	n= 26,480 / >18y	White (47.2%), Black (10.0%), Yellow (1.5%), Pardo (40.8%), Indigenous (0.5%)	Race/skin colour	Time since the last dental visit (<1 year vs ≥ 1 year)	Visits > 1 year: 43.5% White, 54.9% Black, 39.3% Yellow, 52.0% Pardo, 47.8% Indigenous	Multilevel analysis: age, sex, education, social network, income, health insurance, register at Family Health Programme, self-reported satisfaction with dental health, eating difficulties due to oral problems, missing teeth	Pardos were 1.11 times more likely than Whites to visit >1 year. Income, insurance, and registration in FHP attenuated the estimates	The authors mentioned the lack of studies underlying colour/race differences and that racism might play a role in these inequalities

NSD – no statistical difference / MS – marginally significant

3.4 Summary and gaps in the current evidence

Several studies have shown an association between ethnicity/colour/race and dental service utilisation both in Brazil and other countries. More specifically in Brazil, studies have shown that the non-White population seems to be less likely to visit the dentist in the previous year (Souza et al., 2012), to visit due to preventive reasons (Souza et al., 2018, Martins et al., 2008b), and visit the private dental service compared to Whites (Pinto Rda et al., 2014, Fonseca et al., 2017a).

Among the studies that applied more advanced statistical analysis, such as regression and multilevel, socioeconomic characteristics, such as level of education and income, was common determinants of dental service utilisation. However, some studies continued to observe colour/race inequalities in the dental service outcomes even after these characteristics were considered into their statistical models. Thus, as suggested by some authors, the context of living and health services structure may also play a keen role in further reducing differences between colour/race groups.

Three main gaps were observed: 1) lack of appropriate use of colour/race classification and standardisation of the outcomes categorisation to allow comparison between studies; 2) the majority of the studies only considered the role of individual-level characteristics and did not explore characteristics related to area-level that might help to reduce the inequalities; 3) with the exception of one study, all others did not have colour/race inequalities as main focused; thus, there is a shortage of substantial discussion on the topic.

As inequalities in dental service utilisation between Pardos and Whites, and Blacks and Whites were observed, there is a need to standardised the use of these categories. The studies in the field of dental service use in Brazil presented their results, mainly, in two forms: 1) combining the Pardo and Black groups into one and presenting a binary categorisation of White and non-White; 2) considering analysing differences for all five groups, including a very low parentage of Yellow and Indigenous population. The first form and other combinations, such as those combining White with Yellow, or Indigenous with Pardo and Black, make comparisons between studies difficult and problematic. Therefore, there is a need to investigate the categories separately to obtain a more accurate estimate of the dental service use between groups.

Similarly, comparisons between studies was also a challenge for the outcomes. It was observed several different forms of categorisation. For the time since last dental visit, it was investigated different recall periods such as visits in the last year, in the previous two years, or previous three years. For the reason to visit the dentist, researchers compared preventive reasons versus other reasons, as well as preventive versus curative reason, and curative reasons versus others. For the type of service used, it was explored differences between public and private, public compared to private and dental plan, and different forms of public dental service compared to private service and dental plan.

Additionally, only three, and recent studies, explored contextual-level characteristics using multilevel analysis. Two looked into the time since last dental visit (Fonseca et al., 2017b, Herkrath et al., 2018), and one focused on the type of service used (Pinto Rda et al., 2016). Therefore, there is also a need to explore this approach for the reason to visit the dentist, as well as performed multilevel analysis using a Brazilian national sample for the other two outcomes.

Furthermore, among the selected studies, only a few studies address the results in their discussion by trying to underly possible explanation for their findings. Currently, there is only one study that solely focused on colour/race differences in the use of dental service in Brazil and explored the association by looking into the role of individual-level determinants, such as socioeconomic and oral health characteristics (Souza et al., 2012). The study focused on the elderly population and only presented data for the time since last dental visit. Thus, there is a need to discuss in depth the analysis for other outcomes while looking into individual and contextual-level determinants and pathways to tackle colour/race inequalities.

Although the role of individual-level characteristics was explored in depth for the time since last dental visit by Souza et al. (2012), the current evidence for the reason to visit the dentist is weak, and much work needs to be conducted to investigate differences in use of preventive dental service among colour/race groups and to explore the role of individual-level and contextual-level characteristic in colour/race inequalities for this outcome. Similarly, the two studies that used national data to explore the inequalities in the type of service use did not conduct advanced statistical analysis, and only presented colour/race data as descriptive. It is important to use national-level data when exploring colour/race inequalities due to the current diversity of the country's population across States.

In summary, there is a need to better understand the role of individual-level characteristics while considering the area-level effect and explore contextual-level characteristics using appropriate statistical analysis, such as multilevel analysis.

CHAPTER 4

CONCEPTUAL MODEL, AIM AND OBJECTIVES

4.1 Overview of existing models of health and dental service utilisation that acknowledge race/ethnicity

After acknowledging in the previous chapter the empirical research that analysed at some extent the relationship between colour/race and dental service use, it is clear that there is a lack of agreement on which characteristics are important to reduce or even eliminate racial inequalities. Moreover, studies with methodological ability to explore the causes of the observed inequalities, such as longitudinal, were rare. Thus, looking into the theoretical approach of health service utilisation that considered race or ethnicity as a determinant is essential.

Theoretical models that aimed to identify the path to health service utilisation started to be developed in the 1950s. One of the first was the "Health Belief Model" (Janz and Becker, 1984), followed by the well-known "behavioural model" (Andersen and Newman, 1973), which provided a range of possibilities to other researchers (Dutton, 1986, Cooper et al., 2002, Evans and Stoddart, 1990).

The model proposed by Andersen and Newman (1973) focused on individual factors, divided into predisposing factors, enabling factors, and illness levels, and it highlighted what could influence health service utilisation. This model has been used broadly especially because of its easy implementation. However, in 1995, Andersen updated the model (Andersen, 1995) by adding the individual's behavioural practices towards health and the health user's satisfaction as a result of using the health service. Nevertheless, for this thesis, the reference model was the one proposed by Andersen and Davidson (1997) (Figure 4-1).

This model is an expanded version of the original model but had ethnicity as one of the main focused. The authors described ethnicity as an exogenous variable, which may influence the distribution of the dental care system, for example. Through the primary determinants of oral health, minority ethnic groups may report worst personal practices towards oral health, and have a different approach to dental service utilisation, such as using it more for treatment instead of preventive reasons. All of this and other determinants described in the model, may influence directly or indirectly dental and perceived health status, and patient satisfaction with the service.

This aforementioned model has a major advantage because the authors named the categories in a broader group that can fit other characteristics not considered by the authors during the model conceptualisation. For instance, the models proposed by Dutton (1986) and Cooper et al. (2002) considered the health professional and family characteristics as key to racial/ethnic differences in health service utilisation. The health professional characteristics such as demographic, training, experience, and attitudes can be fitted in the “dental care system” as features of the service provided. This is important, because according to Dutton (1986) Black children that are treated by Black physicians had significantly more frequent check-ups. Additionally, family characteristics could be considered as an “external environment” determinant. Cooper et al. (2002) reported that family’s involvement in care, their level of education and income, preferences and attitudes towards care are incredibly important for services equity, especially for the type of service used and for the reason to visit the service.

Additionally, evidence shows that many other factors are associated with racial and ethnic differences in health service use (Okunseri et al., 2013a). The review conducted by Okunseri et al. (2013a) observed that age, gender, level of education, income, the understanding of the health-disease process, health beliefs, and cultural traditions towards health are some of the individual factors that may help to explain the health service utilisation differences by ethnic group.

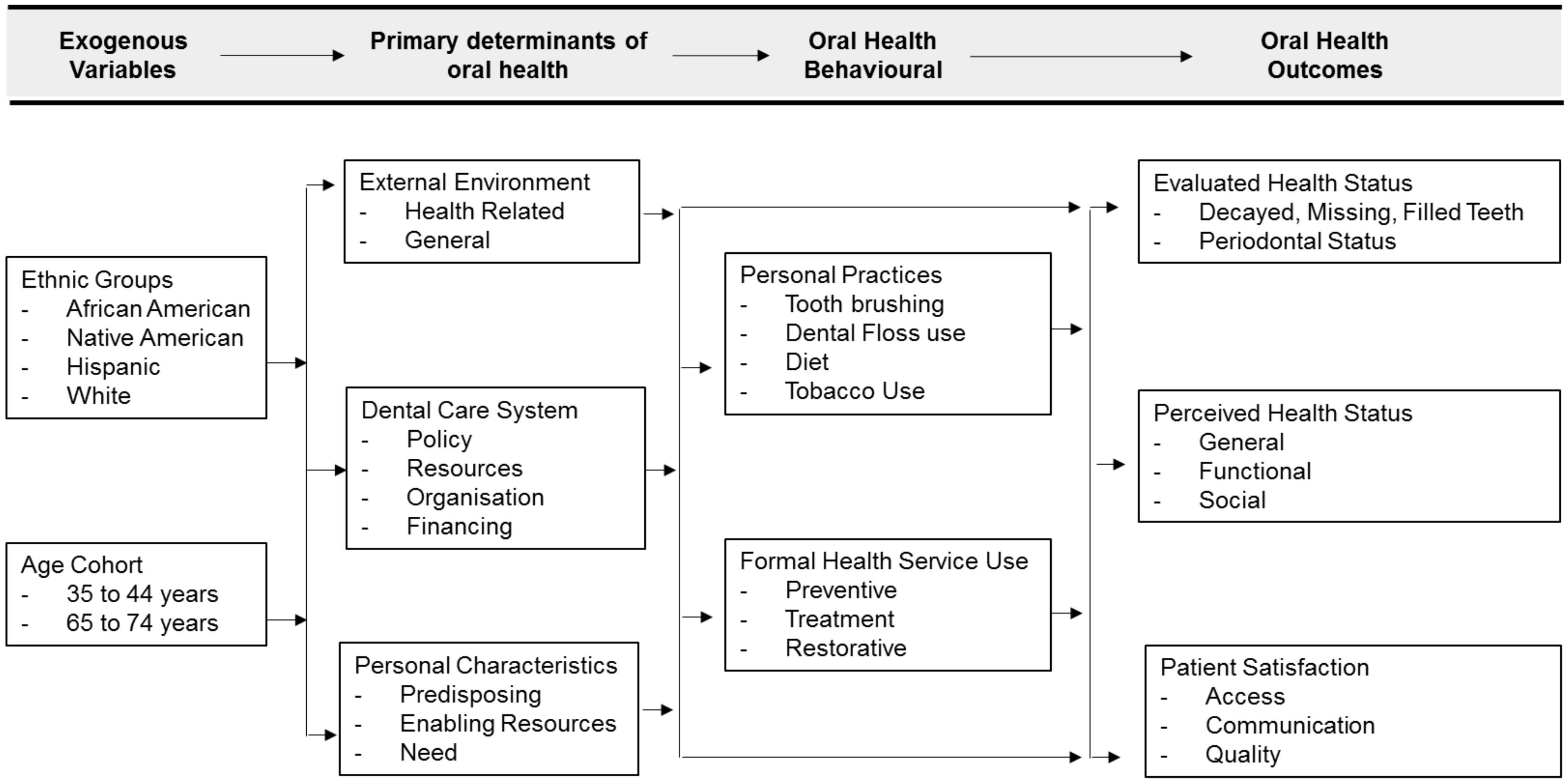

Figure 4-1 - Adaptation of the conceptual framework addressing ethnicity, aging, and oral health outcomes designed by Andersen and Davidson (1997).

Moreover, in the contextual level, health policies, the availability of health services, financial and organisation of the system, and even the health provider characteristics are some of the factors that influence health service use. The myriad of potential barriers was also demonstrated in other reviews focused on race/ethnic differences in health service utilisation (Elster et al., 2003, Szczepura, 2005, Beach et al., 2006). There is a mutual understanding among these studies that inequalities exist independent of socioeconomic characteristics, and much more quality research needs to be conducted to better understand the causes and how to eliminate the differences observed.

4.2 Conceptual model used for this research

The model depicted in Figure 4.2 underlines the pathway that links contextual-level and individual-level characteristics to the use of dental services focusing on colour/race.

The left-hand part of the model focused on contextual factors, which were considered the more distal determinants of dental service utilisation and were divided into three major components. The first presented information on socio-demographic structure of a given place that may predispose the use of dental services. For example, if a community is composed of older individuals, this could represent higher prevalence of missing teeth and periodontal disease, which are age-related, and may differ the approach to dental service use and provision of different prevention programmes. Additionally, racial/ethnic composition of a given place is also considered at this stage, because some oral health diseases have higher prevalence in minority racial/ethnic groups and this could represent higher demand for dental service in areas with higher composition of racial/ethnic minorities. Moreover, areas where the population are more racially integrated have been considered as a positive factor for racial inequalities in dental service utilisation (Eisen et al., 2015).

A second contextual component was the socio-environmental structure of a community that might be harmful or helpful to population health and, consequently, use of health services. Living in an area with a higher quality of life, and lower levels of psychosocial stressors (such as violence, and discrimination) are linked with better health (Nazroo, 2003, Chor and Lima, 2005), and health behaviours (Krug et al., 2002). Living in a more developed area is also linked with better oral health (Peres et al., 2010, Peres et al., 2012c, Bastos et al., 2009a). Lower development areas were observed to have lower use of dental services (Tchicaya and Lorentz, 2014), and higher use of public dental services (Pinto Rda et al., 2016), in contrast with more developed areas. Additionally, research shows that when low-income adults move into a more affluent area they benefit from the availability of the resources that may improve oral health (Sanders et al., 2008). In fact, the unequal distribution of resources, measured through the Gini coefficient, was observed to be inversely associated with dental service utilisation in several countries (Bhandari et al., 2015).

The third and final component of the contextual characteristics was dental care structure, which covers characteristics related to policy financing, organisation, and availability of resources for dental services. Implementation of oral health preventative programmes, along with the distribution of dental services and dental personnel, for example, can be included in this component, as they were observed to improve oral health preventive knowledge (Lee et al., 2014, Borrell et al., 2004), use of dental service, and positive health behaviour (Hart, 1971, Peres et al., 2012c).

The individual factors are divided into four major components. The first is the demographic characteristics, which are the biological imperatives that may influence the likelihood of using dental services, such as age and sex. In Brazil, for example, there is strong evidence that females are more likely to use the dental service compared to men (Brasil, 2004b, Brasil, 2005, Brasil, 2010c), and visits to the dentist in the previous year are inversely associated with age (Brasil, 2012b). The socioeconomic characteristics are the second component, which are characteristics that determine the status of an individual within a community and have been previously linked with the use of dental services such as level of education (Camargo et al., 2009, Guiney et al., 2011), income (Listl, 2011, Gilbert et al., 2002), and family composition (Manski and Magder, 1998),

The third component is health beliefs and behaviours that influence the use of dental service, such as their own satisfaction with oral health (Araujo et al., 2009a, Afonso-Souza et al., 2007), as well as personal health practices such as diet intake, tobacco use, and tooth brushing, that may lead to oral diseases, such as dental caries and periodontal disease. The fourth component is the oral health status, which relates to conditions that the individual recognises as a reason/ the need to visit the dentist (self-reported oral health), and conditions that the health professionals recognise as requiring visits (professionally evaluated oral health). Finally, as in the Andersen and Davidson (1997) model, colour, race, or ethnicity are considered as a separate factor (exposure factor) to dental service utilisation outcomes.

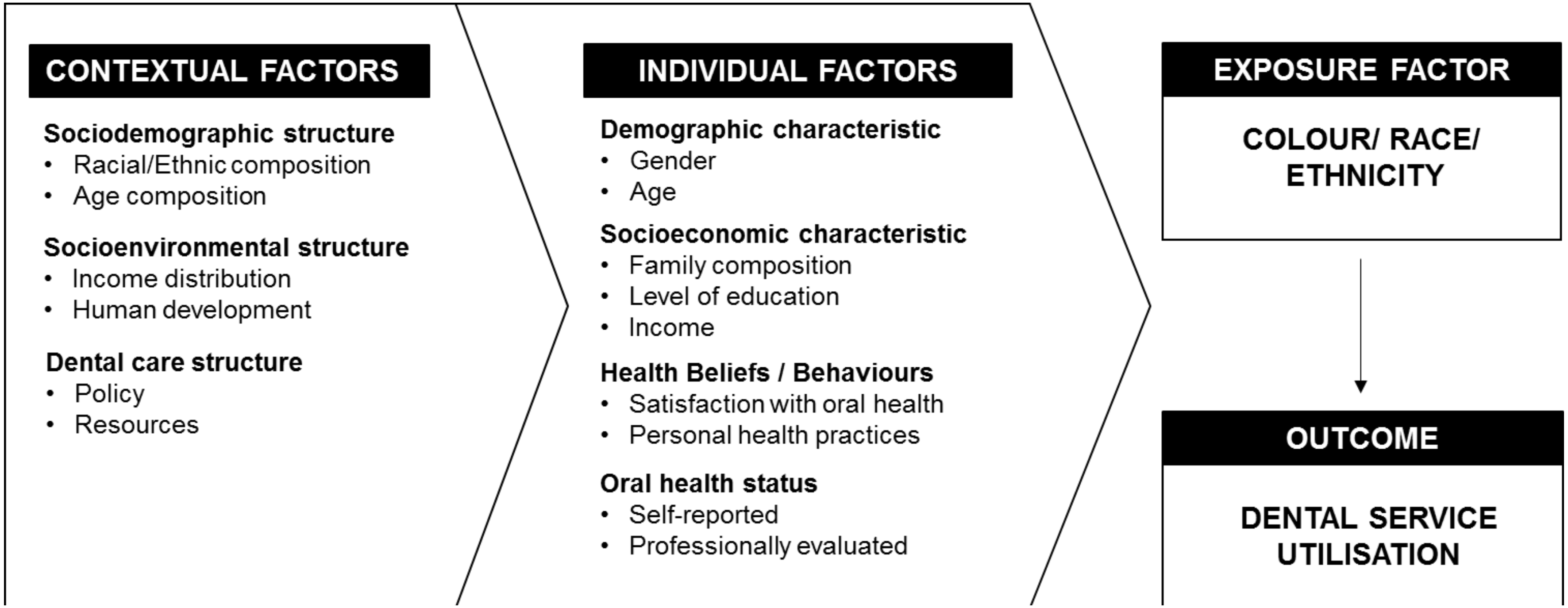

Figure 4-2 - Conceptual framework of the contextual and individual characteristics affecting dental service utilisation by different colour/race/ethnic groups

4.3 Aim and Objectives

The overall aim of this thesis is to investigate the differences between colour/race groups in the use of dental service, in a national sample of 35 to 44-year-old adults in Brazil. The specific objectives and hypotheses of this thesis were:

Objective 1: To investigate the association between colour/race and the three dental service utilisation outcomes (time since last dental visit, reason to visit the dentist, and type of service used) in a national sample of 35 to 44-year-old adults in Brazil.

> Hypothesis: Colour/race is associated with the three outcomes. Individuals self-classified as Pardos and Blacks are less likely to report to visit the dentist in the previous year, to visit due to preventive/check-up reasons, and to visit the private dental service compared to Whites.

Objective 2: To investigate the extent to which individual-level characteristics (sex, level of education, income, self-reported and clinically evaluated oral health) contribute to differences between colour/race groups in the three dental service utilisation outcomes in a national sample of 35 to 44-year-old adults in Brazil.

> Hypothesis: The differences between Pardos and Blacks compared to White in the three dental service outcomes are attenuated by the individual-level characteristics.

Objective 3: To investigate the extent to which individual-level characteristics and contextual level characteristics (colour/race composition, Human Development Index, Gini Coefficient, level of integration of dental team with family strategy programme, and dentist per population rate) contribute to differences between colour/race groups in the three dental service utilisation outcomes while taking into account a multilevel approach in a national sample of 35 to 44-year-old adults in Brazil

> <u>Hypothesis:</u> The differences between Pardos and Blacks compared to Whites in the three dental service outcomes are attenuated by the individual-level and contextual-level characteristics.

CHAPTER 5

METHODS

5.1 Chapter Overview

This chapter describes the data and the statistical methods used to address the aims and objectives of this thesis. This study is based on the secondary analysis of the latest Brazilian oral health survey (SB Brazil 2010), and additional data were derived from the Brazilian Census of 2010, the Department of Informatics of the Public Health System (DATASUS), the Department of Primary Care, and from the United Nations Development Programme (PNUD, in Portuguese), which were all linked with the SB Brazil 2010 dataset based on the capital where the respondents lived at the time of the interview.

5.2 Data

5.2.1 Individual-level data: the Brazilian national oral health survey

The latest epidemiological survey on oral health in Brazil was conducted in 2010 and had 37,519 individuals examined. The survey entitled “SB Brazil 2010” had both oral examinations and questionnaire application. The former was performed to assess the prevalence and severity of dental caries, periodontal disease, tooth loss; the latter were used to collect data on the socioeconomic condition, as well as the use of dental services and perception of health. More information about the data collected in the SB Brazil 2010 survey can be found elsewhere (Roncalli, 2010, Roncalli, 2011).

5.2.1.1 SB Brazil 2010 - design, selected sample, and target population

SB Brazil 2010 was a cross-sectional survey designed to have a representative sample of the Brazilian population. In the same year of the survey, a National Census showed that the Brazilian population comprised 190,755,799 individuals

(IBGE, 2011). Table 5.1 presents a description of population size according to the Census data, and the sample size of SB Brazil 2010 according to the target age groups of the survey.

Table 5-1 - Description of the population estimated by the Brazilian National Census Bureau (IBGE 2010), and the sample used in the SB Brazil 2010, by age group.

Age group (years)	Population (IBGE 2010)	%	Sample* (SB Brazil 2010)	%**
5	2,931,988	5.0	7,150	7.4
12	3,402,242	5.8	7,122	7.3
15 – 19	16,990,872	28.9	5,292	28.6
35 – 44	26,897,943	45.7	9,543	37.5
65 – 74	8,582,446	14.6	7,426	19.2
Total	58,805,491	100.0	36,533	100.0

**   Refers to the data available for analysis*

*** Proportion of individuals estimated considering the effect of the design and the complex sample (survey)*

5.2.1.2 SB Brazil 2010 - sampling design and sample size

The SB Brazil 2010 survey had a multi-stage sampling design. The sampling process started by considering each of the 26 State Capitals and the federal district - where the country´s capital is based - as domains, as well as each of the five regions, which resulted in 32 domains. Figure 5.1 presents each capital and region part of the survey. Each domain was divided into 30 primary sampling units (PSU). For the State Capitals, the PSU were the census tracts; for the regions, the PSU were selected cities.

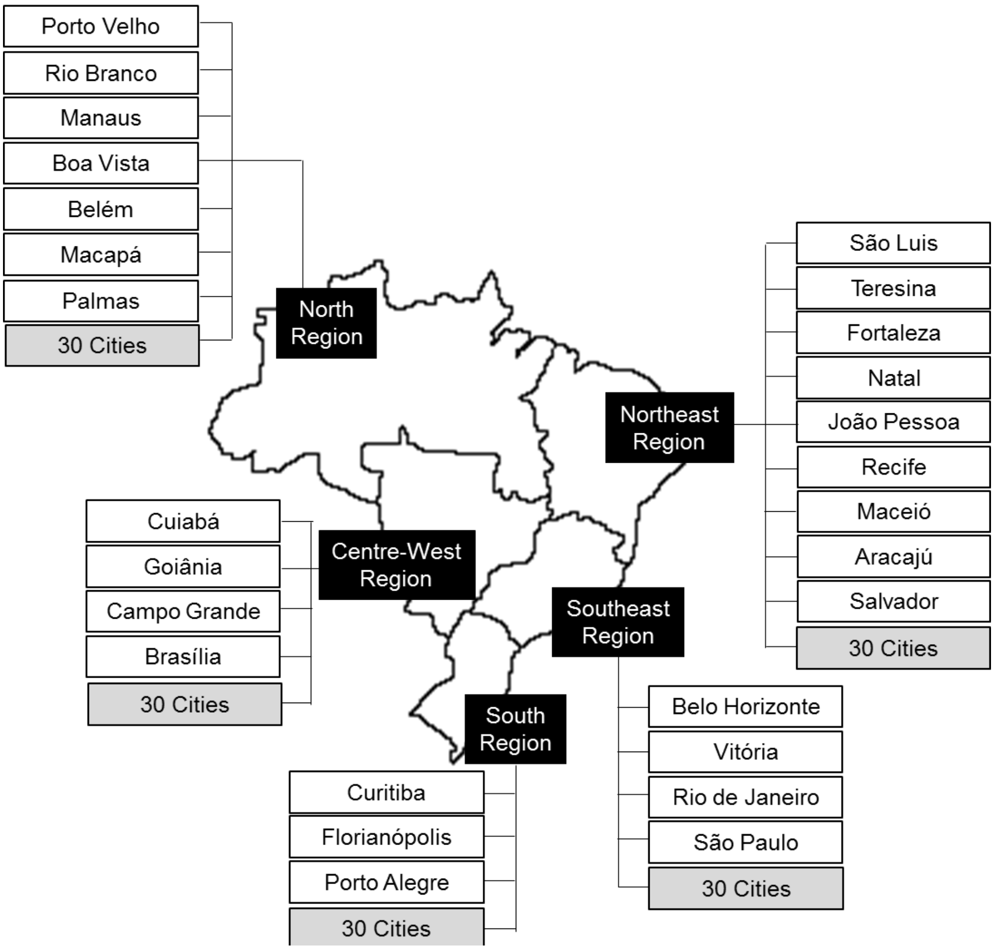

Figure 5-1 - Map of the sample process composition of SB Brazil 2010 survey. Adapted from Brazil (2009).

In each domain, all five age groups (5, 12, 15-19, 35-44, 65-74 years old) were selected to be part of the survey (Figure 5.2). The sampling selection process for the Brazilian State Capitals was conducted in two stages: census tracts, and the household. For the Brazilian regions (selected to represent the non-capital cities) there were three stages: to select the cities, the census tracts (two in each selected cities), and the household. The census tracts and the cities were selected using a similar approach - conglomerate sampling with probability proportional to size approach (Roncalli et al., 2012).

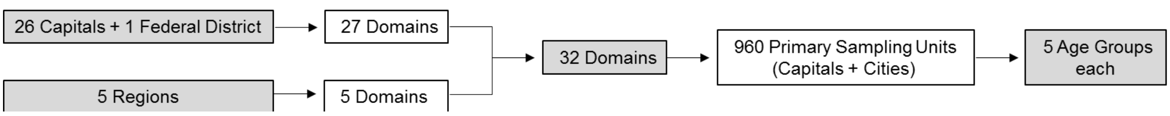

Figure 5-2 - Sample process composition of SB Brazil 2010.

Figure 5.3 represents the distribution of the 177 locations (27 State Capitals and 150 non-State Capitals cities) distinguished by the actual size of the population in Brazil estimated by IBGE in 2009; full details PSU selection and final sample size calculation can be found elsewhere (Roncalli et al., 2012, Brasil, 2009).

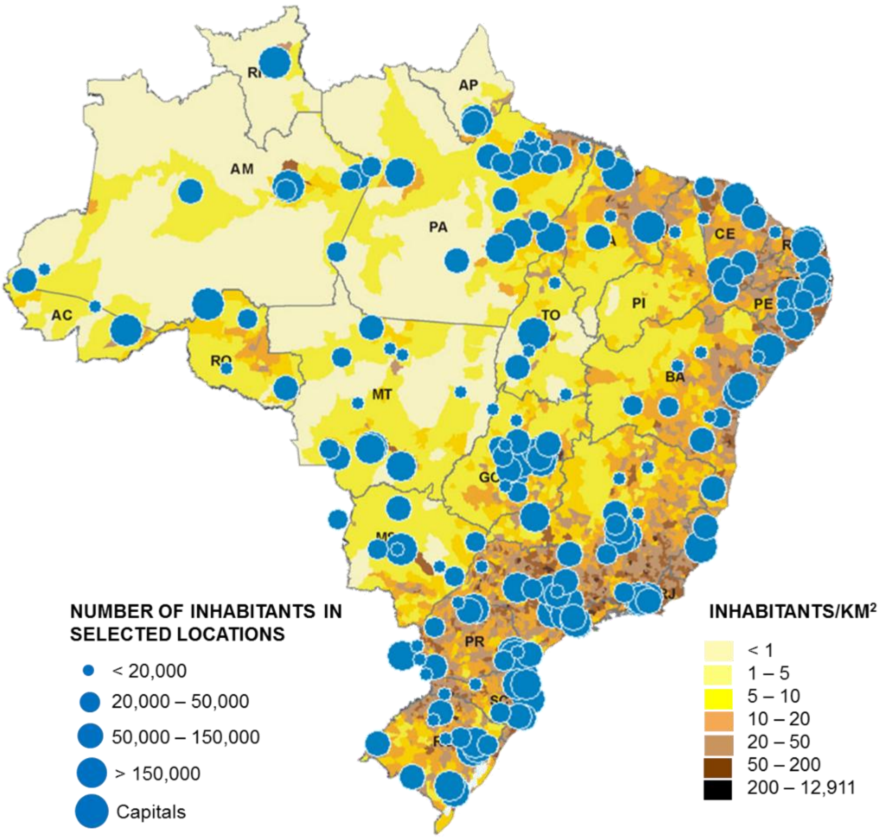

Figure 5-3 - State Capitals and randomly selected non-capital cities according to population size. Adapted from Brazil (2010b).

After selecting the cities and the number of individuals to be examined, it was necessary to establish the secondary sampling units (SSU). The households selected were those with the highest likelihood of residents in the eligible age groups, and in those selected households all eligible subjects that were in the target age groups were invited to participate in the survey.

5.2.1.3 SB Brazil 2010 - training and calibration of examiners

The field teams were composed of dentists - employees of the Municipal Health Department - who participated in the survey as clinical examiners - and of selected interviewers, who applied the questionnaire. A 16-hour training programme was conducted followed by calibration exercises that resulted in kappa coefficients of 0.65 or higher.

5.2.1.4 SB Brazil 2010 - ethics committee and approval

The survey was approved in Brazil by the National Committee on Ethics in Human Research (CONEP) (Number 009/2010, Record 15498). For the data collection, each individual involved received all information relevant to the survey according to the guidelines established by Brazilian Resolution 196/96, which deals with ethical aspects of scientific research involving human subjects. After the verbal agreement, the participant was asked to sign the consent agreement.

5.2.1.5 Participants from SB Brazil 2010 selected to be part of this study

Only individuals aged 35 to 44 years were included in this thesis. This age bracket is considered by the World Health Organization as a standard age group for surveillance of oral health conditions in adults (WHO, 2013). The focus of this research is to investigate the use of dental service, and according to WHO (2013) "*By using data for this age group, planners and decision-makers can assess (…) the general effects of oral health care provided*." Additionally, this study focused the analysis on the difference between colour/race groups and, as observed in the literature, individuals self-ascribed as Pardos and Blacks aged 35 to 44 years have higher prevalence of dental caries, dental pain, and periodontal disease (Vettore et al., 2013, Peres et al., 2007, Guiotoku et al., 2012), which are the main predictors of dental service use. Although adolescents (15 to 19 years old) and adults (35 to 44 years old) seem to have a similar use of dental service regarding the time, the reason, and the type of service used (Brasil, 2004b), adults as a working population have more control of the use of dental service; particularly in Brazil, they are the last group to retain many natural teeth while in the older group (65 years old and over) excessive tooth loss may further influence the pattern of dental attendance (Brasil, 2004b).

5.2.1.6 Data from SB Brazil 2010 used for this study

The SB Brazil 2010 survey collected the data using an interviewer-administrated questionnaire and clinical exams. The variables used in this study are described according to their roles in the analyses.

a) Dependent variables

The outcomes were the variables related to dental service utilisation, namely:

- Time since last dental visit

This variable is based on the question “When was your last dental visit?” which had the following options: 1) less than a year; 2) one to two years; 3) three or more years. The categories 2 and 3 were later combined, in line with other studies (Souza et al., 2012, Martins et al., 2007), to estimate the difference between those who visited the dentist less than a year before the interview from those adults who last visited the dental service over a year.

- Reason for the last dental visit

This variable is based on the question “What was the reason for the last dental visit?” which had the following options: 1) prevention/check-up; 2) pain; 3) extraction; 4) treatment; 5) others. This was later categorised in: 1) “prevention//check-up”; 2) “pain or extraction”; 3) “treatment”. Individuals that reported “others” were included in the category “treatament” as it refered to any other procedure conducted in a dental practice. Visiting the dentist due to pain or extraction were combined into one category because these could suggest visits related to acute symptomatic reasons.

- Type of dental service used

This variable is based on the question “Where was your last dental visit?” which had the following options: 1) public service; 2) private service; 3) use of health plan; 4) others. This was later dichotomized into “public service" and "private service”. The category “others” was combined with “public service”, because in Brazil apart from public primary care, “others” may express the secondary care, such as the dental service at the universities or at the Centre of Dental Specialty, for example. The “use of health plan” category was combined with the “private service” because individuals who have a health plan, which may also be called as dental plan, will visit a private dentist.

b) Main explanatory variable

Colour/race was measured according to the categories used by the Brazilian Institute of Geography and Statistics (IBGE). A total of five categories were given as options: 1) White; 2) Black; 3) Yellow; 4) Pardo; 5) Indigenous. Often the results of other research conducted in Brazil, following the question used by IBGE, combine the classification of Pardo and Black in one category. This happens, partially, because in some areas of the country there is a lower proportion of individuals who identify themselves as Black, such as in the South, but also because they have similar condition regarding the lack of social and economic resources. Nevertheless, in this research it was considered the analysis of the categories Pardo and Black separately, as recommended by other authors (Bailey, 2008, Loveman et al., 2012, Travassos and Williams, 2004). Individuals self-classified as Indigenous or Yellow were not considered in this analysis due to the small frequencies in each of these categories.

c) Covariates at individual-level

- Sex

Sex was a binary variable. In the SB Brazil 2010, interviewers classified participants as female or male after considering their appearance. This characteristic was considered for the analysis because there is evidence that females are more likely to use the dental service compared to males (Brasil, 2004b, Brasil, 2005, Brasil, 2010c).

- Level of education

As described in the literature review, the level of education has an important role in both oral health (Boing et al., 2014, Schwendicke et al., 2015) and dental service utilisation (Guiney et al., 2011). There is evidence that higher levels of education are associated with healthier habits, such as visiting the dentist for preventive reasons (Camargo et al., 2009). In the SB Brazil 2010, the following open question was used to measure the level of education: "Until what grade did you study?" For this research, in line with other studies focusing on dental service utilisation in Brazil (Machado et al., 2012, Camargo et al., 2009), the level of education was categorised into: 1) 0 to 4 years (which corresponds to the first part of primary education in Brazil); 2) 5 to 8 years (which corresponds to the second part of primary education); 3) 9 to 11 years (which corresponds to high school); 4) 12 or more years (which corresponds to the following years of education, such as academic and technical degrees).

- Family income

The question "In the last month, how much in Brazilian *Reais* (R$), including salary, government allowance, pension, rent, retirement, and other earnings, did your family earned together?", had the following options: 1) less than R$250.00; 2) R$251-

R$500 3) R$501- R$1500; 4) R$1501- R$2500; 5) R$2501- R$4500; 6) R$4501- R$9500; 7) more than R$9500. In line with another study which used the same dataset (Vettore et al., 2013), the variable was categorized into 4 categories: 1) less than R$500.00; 2) R$501.00 to 1,500.00; 3) 1,501.00 to 2,500.00; 4) more than 2,501.00. The first and second categories of the original variables were grouped together to correspond to those individuals that earned one minimum living wage or less; in 2010 the minimum living wage was R$ 510.00, which corresponded to £96.90 according to a rate of £0.19 to R$1.00.

- Oral health measures

Both subjective and clinical oral health measures were assessed in the SB Brazil 2010 survey. The subjective measures used for this thesis were: 1) self-reported satisfaction with teeth/month; 2) self-reported dental pain; 3) self-reported need for dental treatment. The clinically evaluated oral health measures were presence of decay, missing, and filled teeth.

Evidence shows that self-reported satisfaction with teeth/mouth is associated with the use of dental service, and the use of services for check-up in adulthood in Brazil (Araujo et al., 2009a, Afonso-Souza et al., 2007). However, both satisfaction and dissatisfaction with oral health were observed to be associated with dental service utilisation (Camargo et al., 2009, Martins et al., 2007). Although the participants were asked “In relation to your teeth/mouth, are you: 1) very satisfied; 2) satisfied; 3) neither satisfied nor unsatisfied; 4) unsatisfied; 5) very unsatisfied”, the variable final categorisation was: 1) satisfied; 2) neither satisfied nor unsatisfied; 3) unsatisfied. The category “neither” was considered in its original form, in line with another study (Ferreira et al., 2013).

Another subjective measure was self-report of dental pain. Participants answered the following question: ‘In the last 6 months, did you have a toothache?’ The possible answers were “Yes” or “No”. Self-reported dental pain is a proxy of dental visits (Lacerda et al., 2004). Individuals are more likely to visit the dentist when there is a great need, such as the case of dental pain (Wan and Yates, 1975).

The need for dental treatment was also considered as a covariate. The participants were asked a Yes/No question: “Do you believe you currently need dental treatment?”. As theorised by Andersen and Davidson (2007), perceived need is a proximal determinant of health service access; need for treatment is a social phenomenon, and it regards on how individuals view their own health, including how they experience the response to illness, and pain, for example. In fact, individuals that report the need to have their teeth treated are more likely to visit the dentist more recently than their counterparts (Ferreira et al., 2013).

The three normative measures used in this study were assessed through the DMFT Index (number of decayed, missing, filled teeth) based on the 1997 World Health Organization diagnostic criteria (WHO, 1997). The decomposition of the DMFT was chosen to better understand the relationship of its components with the use of dental service. Those individuals that, at the time of the clinical evaluation, had any decay teeth and/or filled teeth with active dental caries, were categorised as having decay teeth. Those individuals that had any tooth loss due to dental caries, or any filled teeth due to dental caries, were also categorised as having missing and filled teeth, respectively.

5.2.2 Contextual-level data

5.2.2.1 Summary of Brazilian geography

Brazil is situated in South America, and it is the largest country in both South and Latin America due to its area of over eight thousand square kilometres. The country is divided into five regions: North, Northeast, Central-West, Southeast, and South.

Each region is divided into States, and the country has a total of 26 States and a Federal District, where the country's capital is based. Apart from the 27 State Capitals, the country has over 5,500 municipalities. The population in mostly comprised in the Northeast and Southeast regions. In contrast, the North and Centre-West regions, which comprised around 64% of the Brazilian area, are populated by only 15%.

5.2.2.2 Covariates at contextual-level

- Colour/race composition across Brazilian State Capitals

The colour/race composition across Brazilian State Capitals was obtained through the 2010 National Census (IBGE, 2011). The dataset provided the absolute number for each colour/race for all the State Capitals. In line with other study on dental service utilisation accounting for colour/race composition in Brazil (Pinto Rda et al., 2016), to obtain a number that would allow comparison between State Capitals, the percentage of non-white residents was calculated by adding the sum of the absolute number of Pardos and Blacks individuals for each capital, and dividing by the total population in each capital for the same year. The proportion of Pardos and Blacks among the 27 State Capitals ranged from 14.5% to 80.1%. The data was later divided into tertiles, where 14.5% to 53.0% were considered low, 53.9% to 68.8% were moderate, and 68.8% to 80.1% were classified as high.

- Human Development Index across Brazilian State Capitals

According to the 2010 Human Development Index (PNUD, 2013), the majority of the North and Northeast states in Brazil were categorized as in low development, in contrast with high development states (PNUD, 2013). Lower values of Human Development Index were associate with higher proportions of tooth extractions in southern Brazil (Fernandes and Peres, 2005), and also associated with non-use of dental service in low Human Development Index countries in Europe (Tchicaya and Lorentz, 2014). The Human Development Index ranges between 0 (zero) and 1, which 1 represents a place where the population have a heathy live, with access to knowledge, and opportunity to have a have a good standard of living. Human Development Index can be interpreted by five different bands of development, such as: 1) very low, if the Human Development Index ranges from 0 to 0.499; 2) low, if it ranges from 0.500 to 0.599; 3) middle, if it ranges from 0.600 to 0.699; 4) high, if it ranges from 0.700 to 0.799; 5) very high, if it ranges from 0.800 to 1. In 2010, all the Brazilian State Capitals presented a Human Development Index of high or very high, ranging from 0.721 to 0.847. Therefore, to compare the small differences between the State Capitals' indexes, the data was divided into tertiles, where 0.721 to 0.754 were considered low, 0.759 to 0.799 were moderate, and 0.805 to 0.847 were classified as high. Information regarding the Human Development Index was gathered from the United Nations Development Programme (PNUD), through the website *http://www.atlasbrasil.org.br/* for the year 2010.

- Gini coefficient across Brazilian State Capitals

The Gini coefficient is a measure of the degree of concentration of the household income per capita of a given population and in a given geographic space. It ranges from 0 to 1, where 0 is considered the most equal distribution of income throughout the households of a given place. In 2010, the Gini coefficient ranged from 0.5474 to 0.6894 across the 27 State Capitals, and the data was also divided into tertiles, where 0.5474 to 0.6037 were considered low, 0.6106 to 0.6284 were moderate, and 0.6287 to 0.6894 were classified as high. This type of categorisation has been used previously in oral health literature when using Gini coefficient as measure of inequality (Singh et al., 2016). Information on the Gini coefficient for capital was gathered from the IBGE dataset for the year 2010.

- Integration of oral health teams into the Family Health Program across Brazilian State Capitals

Evidence shows that non-use of dental service in Brazil among adults is associated with the level of integration of oral health team into Family Health Program (OHT/FHP) (Martins, 2014). Accordingly, as the OHT/FHP has been associated with periodontal disease (Vettore et al., 2013) and non-dental service use (Martins, 2014), and as there is a connection between these with colour/race, the OHT/FHP may play a role in shaping and understanding colour/race inequalities in the use of dental service.

The equation to obtain the percentage of population coverage by oral health teams into the Family Health Program (OHT/FHP) is presented in Figure 5.4. The absolute number of oral health teams working in the Family Health Program was obtained from the Department of Primary Care for the year 2010. The dataset gives two types of oral health teams. Type 1 is composed of a dentist, and a dental assistant, and type 2 is composed of a dentist, a dental assistant, and a dental technician. The sum of the two types was obtained, in order to get a final number of oral health teams implemented by the Government in each State Capital. The number 3,450 that appears on the equation represents the number of people in a total of one thousand families, which is the number of families that must be covered by the Family Health Program.

$$\frac{\textbf{(Number of OHT/FHP at a determined place) x 3,450}}{\textbf{Size of population at the same place and time}} \quad \textbf{x 100}$$

Figure 5-4 - Equation used to obtain the percentage of population coverage by oral health teams. Adapted from http://189.28.128.100/dab/docs/geral/nota_esb.pdf

The data obtained ranged from 0.6 to 88.2. The data was later divided into tertiles, where 0.6 to 10.3 were considered low, 11.8 to 28.5 were moderate, and 33.0 to 88.2 were classified as high.

- Dentist per population rate across Brazilian State Capitals

Brazil is considered the country with the highest number of working dentists in the world (WHO, 2018). According to the Department of Informatics of the Public Health System (DATASUS), in 2008, Brazil had over 200,000 dentists, and over 90,000 of those were working in one of the 27 State Capitals. The distribution of dentist per population may help to reduce the geographical inequalities of dental service use (Tchicaya and Lorentz, 2014). As observed in Brazil, places with poorer infrastructure of services – which included the amount of dentist working in public and private sector – had lower use of dental services (Pinto Rda et al., 2016). Thus, the number of dentists was obtained by the Department of Informatics of the Public Health System (DATASUS) for the year 2008. In order to obtain the number of dentists per population across the Brazilian State Capitals, the number of population for each State Capital was obtained by the estimated population calculation from the IBGE dataset.

The data ranged from 86 to 529 dentists per 100,000 individuals and was later divided into tertiles. Values from 86 to 146 were considered low, 153 to 237 were moderate, and 247 to 529 were classified as high.

5.3 Analytical approach adopted for this research

For statistical analysis, data were entered into the statistical software Stata 13.0 (Stata Corporation, College Station, USA). All bivariate and regression analyses were adjusted for the effect of the design and the complex sample.

5.3.1 Description of the sample

5.3.1.1 Description of the analytical sample

Descriptive analysis was performed for each variable used, both at the individual and contextual-level. The frequencies of each individual-level variable were presented along with the 95% confidence interval.

The analytical sample was composed of individuals that reported to have visited the dentist at least once in their lifetime. Therefore, those who had never visited a dentist (n=801) were excluded from the main analyses. Looking at the main characteristics of this excluded group, there was a higher proportion of Whites (43.2%) and Pardos (41.2%) and a lower proportion of Blacks (15.6%). The majority in this group were women (58.2%), with eight years or less of education (54.9%), earned less than R$1,500.00 (79.0%), had no dental pain in the past six months (82.7%), reported to need dental treatment (64.1%), and had decayed (66.3%), missing (82.3%), and filled teeth (53.5%). In terms of geographical regions, 34.7% lived in the North, 30.4% in the Northeast, followed by those living in the Southeast (13.8%), the Centre-west (12.4%), and the South (8.7%) regions (Appendix Table A-2).

5.3.1.2 Dealing with missing data

The percentage of missing data was described, and logistic regression was performed to estimate the odds of missingness for each individual-level variable.

5.3.2 Bivariate Analyses

Cross-tabulation and chi-squared tests were conducted to explore the distribution of the individual-level characteristics according to colour/race groups and the outcomes, and the distribution of dental service utilisation characteristics according to characteristics at the contextual-level was also performed.

5.3.3 Regression models

Logistic regression analyses were conducted, to assess the association between colour/race and dental service utilisation characteristics at the individual-level. Two types of logistic regression were performed according to the nature of the outcome: 1) binary logistic regression for the analysis of the time since last dental visit and the type of service used, estimating its odds ratio (OR) between colour/race groups; 2) multinomial logistic regression for the analysis of the reason to visit the dentist, estimating the relative risk ratio (RRR) between colour/race groups. The regression coefficient of a logistic regression determines that the log odds of the outcome per one unit increase in the value of the independent variable. By exponentiating this coefficient, one would get the odds ratio, which mathematically represents the odds that the outcome will occur among an exposure, divided by the odds in the absence of that exposure. Both OR and RRR are measures of association. However, in the multinomial logistic regression the relative risk ratio is calculated because now there are more than two categories; thus, the denominator for RRR is a baseline outcome.

Figure 5.5 represents the analytical framework used for the analysis of the association between colour/race and the dental service utilisation at the individual-level. For all outcomes, the strategy for adjustments in the regression model followed the order (top to bottom) illustrated in the figure.

After the unadjusted model was performed (Model 1), the individual-level covariates were added. Self-reported dental pain and self-reported need for dental treatment were included together in Model 6, because they both relate to conditions that the individual recognises as requiring treatment. The same happened for the three normative measures of oral health (Model 7), because they are considered part of the professionally evaluated oral health status.

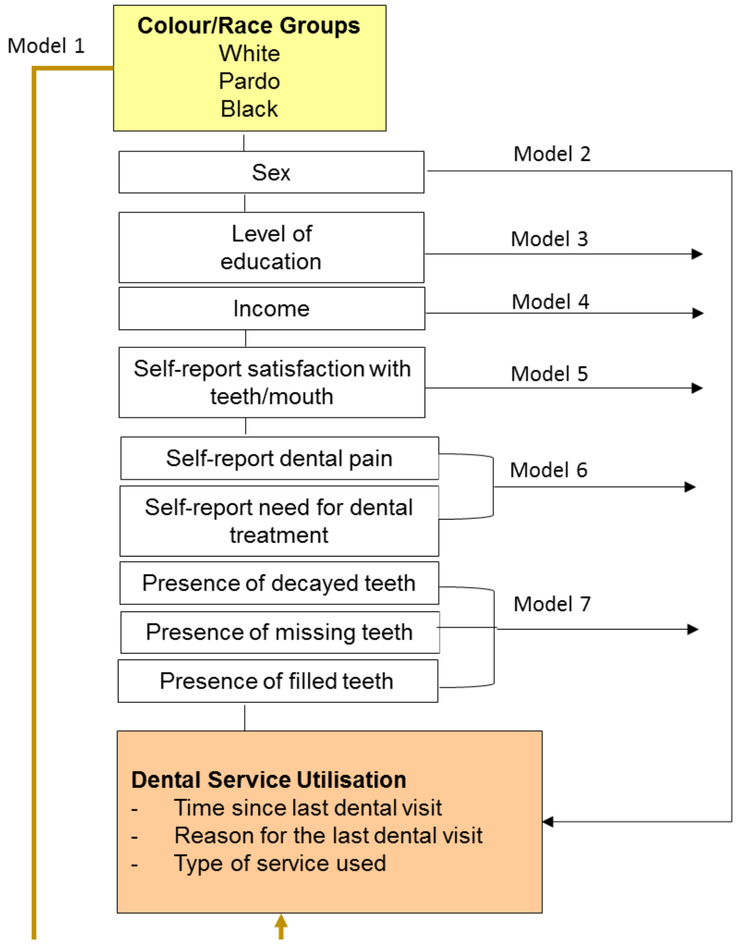

Figure 5-5 - Analytical framework performed to estimate the association between colour/race groups and dental service utilisation outcomes, throughout the regression analysis.

5.3.4 Multilevel models

A multilevel analysis was carried out to investigate the extent to which the individual and contextual-level characteristics previously mentioned contribute to differences between colour/race groups in the use of dental service when accounting for capital-level differences. The multilevel analysis was performed with MLwiN multilevel modelling software (MLwiN 2.36) on Stata, through the command *.ssc install runmlwin*, which allows the use of MLwiN package (Leckie and Charlton, 2013).

For this part of the study, the analysis had to be restricted to only those subjects of SB Brazil 2010 dataset who lived in one of the 27 State Capitals, and who had complete data for all investigated variables. This restriction allows inferences because the sample of SB Brazil 2010 was only representative for these 27 locations.

Multilevel analysis was employed due to its ability to provide estimates in complex models with multiple levels (Goldstein, 2003). There were two distinct levels assessed. The first level was the individual-level, this was related to the dataset from SB Brazil 2010. The second level was the area-level, and this was related to characteristics of the capital where the respondent of SB Brazil 2010 lived at the time of the interview. At this level, it was considered the contextual-level characteristics for each of the 27 State Capitals as previously described.

The analysis consisted of fitting four models and Figure 5.6 presents the analytical framework used for the multilevel analysis as described below:

The null model (Model 1): is also called the variance component model, and it produces the variance of the outcome from fitting a multilevel logit model considering no explanatory variables. Thus, the first step of this multilevel analysis was to run three null models, one for each outcome, to examine the variability of the outcomes between clusters. To test the significance level, the software gives the likelihood ratio test (LRT), and an adaptive quadrature with 7 integration points by default. To test if the 7 integration points were adequate or more than adequate, each model was refitted with a larger number (15) and a smaller number (2) of quadrature points. The default test was preferred when the sets of refitted model parameters were the same. The variance partition coefficient (VPC) was also calculated. The VPC helps to quantify the percentage of residual variation of the outcome is attributable to unobserved characteristic at the second-level (in this case, State Capitals). To calculate the VPC the estimate of the random-effect parameter is divided by sum of the same estimate in addition to 3.29, which is the variance for a standard logistic distribution.

Inclusion of colour/race characteristic (Model 2): The main exploratory variable (colour/race) was the first to be added. The results allowed to understand if the distribution of colour/race was similar or not across the 27 places and if the addition of the main exploratory variable reduced the between-State Capitals variance of the outcome. The estimates for the comparison between Pardos and Blacks with Whites were measured, allowing State Capitals differences for each outcome.

Adjustments for individual-level characteristics (Model 3): at this stage the individual-level variables were added one at a time, in accordance with the analytical model presented previously (Figure 5.5). The same procedure performed in Model 2 occurred, such as observing the modification of the between-State Capitals variance of the outcome, and the VPC calculation.

Adjustments for contextual-level characteristics (Model 4): After fitting Model 3, the next step was to fit a model adding the contextual-level variables one at a time, as illustrated in Figure 5.6. This model helped to identify the contextual-level factors that explained the variability of the outcomes across the 27 State Capitals. After fitting this model, the likelihood ratio test measured the significance of the coefficients of the variables, and the VPC was calculated to quantify the proportion of total residual variance that remained unexplained at capital-level.

5.3.5 Additional Analyses

In line with findings in the literature and the conceptual models that considered the influence of socioeconomic characteristics on the relationship between race/ethnicity and use of dental service, interaction and stratification analyses on level of education and income were performed. No interaction and no significant influence during the stratification analyses were found for the three investigated outcomes in regards to the aforementioned analysis (See Appendices Tables A-3, A-4, A-5). Additionally, analyses of the effect of State Capitals on the three investigated outcomes using ‘caterpillar plots’ were conducted in line with recommendations by Leckie and Charlton (2013) (Appendices Figures A-2, A-3, A-4). For the time since last dental visit, nine State Capitals were significantly above or below the average in the null model. This number was reduced to one State Capital (namely Rio de Janeiro) after accounting for individual and contextual-level characteristics. For the reason to visit the dentist, eleven State Capitals were above or below average in the null model, and this number decreased to four (Manaus, Porto Velho, Rio Branco, and Rio de Janeiro) after adjusting for individual and contextual-level characteristics. Lastly, for the type of service used, the null model showed that 13 State Capitals were significantly above or below average for the use of public dental service, and this number was reduced to three (Porto Velho, Goiânia, and João Pessoa) after controlling for all covariates.

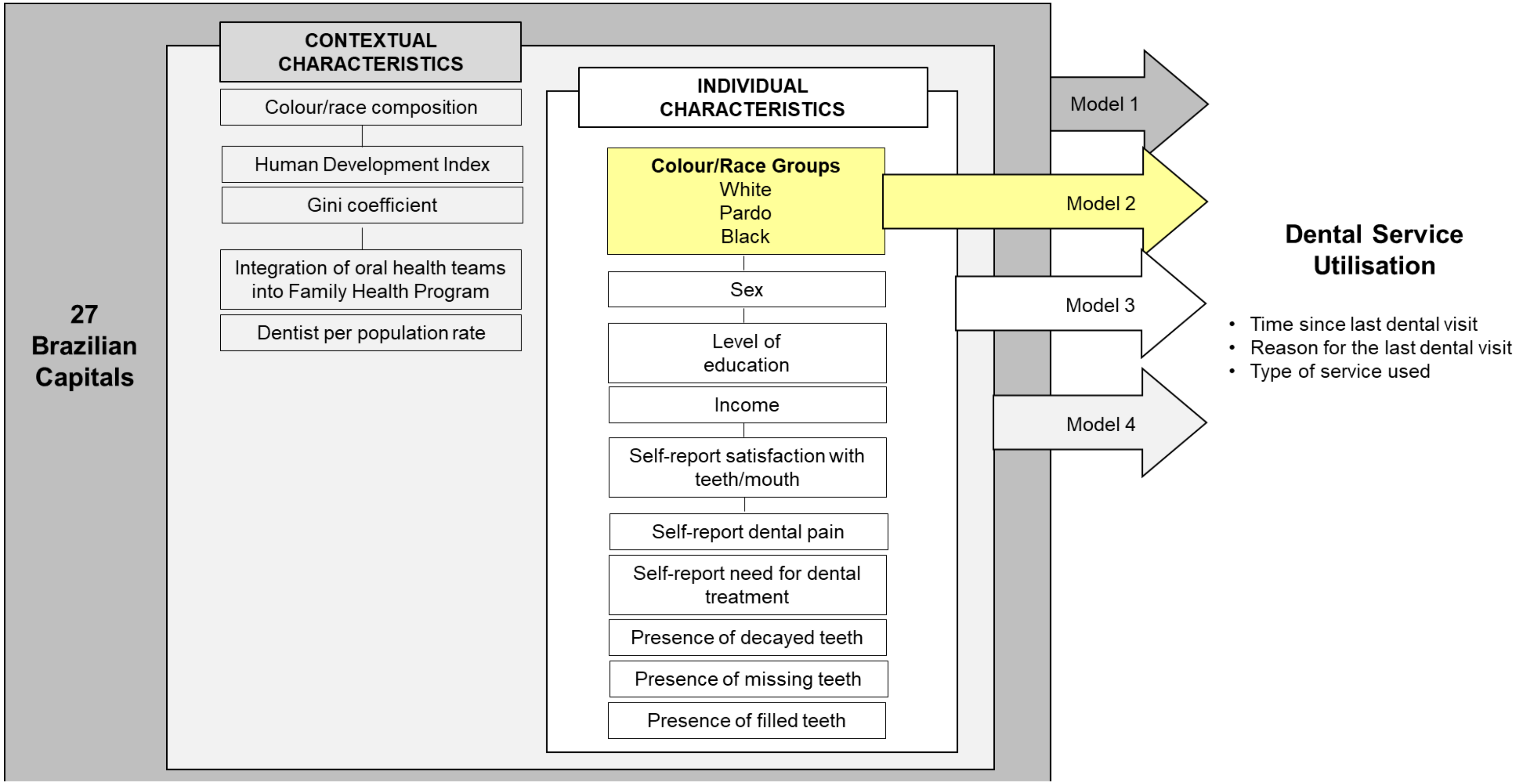

Figure 5-6 - Analytical framework performed in order to investigate the extent to which the contextual-level characteristics contribute to differences between colour/race groups in the use of dental service, considering the adjustments for individual-level characteristics.

CHAPTER 6

The role of individual-level characteristics in the relationship between colour/race and dental service utilisation

6.1 Chapter Overview

This chapter addressed the first and second objectives of this thesis. Firstly, the association between colour/race and the three dental service utilisation outcomes as described in the method section were investigated. Secondly, the extent to which individual-level characteristics contribute to differences between colour/race groups (Pardos and Blacks compared to Whites) in the same outcomes was investigated. The chapter was divided into four parts. The first part described the sample in terms of its analytical and missing sample (*section 6.2*). The second part showed the results of the bivariate analyses (*section 6.3*), which sought to describe whether the individual-level characteristics were distributed differently according to colour/race groups, and according to the dental service utilisation characteristics. The third part and fourth part are presented together according to each outcome (*section 6.4*). The third part focused on looking into the role of each individual-level characteristics separately in regression models containing colour/race variable and the outcome. Finally, the fourth part focused on the results from the multivariable analysis pertaining to objective 1 and 2, which explored the association between colour/race and dental service utilisation and considered the role of individual-level characteristics using a hierarchical model.

6.2 Description of the sample

6.2.1 Description of the analytical sample

The sample of adults in the SB Brazil 2010 was comprised of those who were 35 to 44 years old at the time of the interview (n=9,779). Because this thesis focused on individuals that used dental service at least once in their lifetime, a total of 801 were excluded from the initial analysis – 715 never visited, 1 had been considered as non-applicable for the question, and 85 did not know/did not want to report. As presented in Figure 6.1, after excluding individuals that were not part of the scope of the analysis, data was available for 8,755 White, Pardo, and Black individuals.

Additionally, data analysis was restricted to those with complete data for all variables investigated, and the overall sample size was 8,089 adults. The analysis of the missing data for the overall sample was presented in the following section. Moreover, because there were separate analyses for each of the three outcomes, different sample sizes were used. Analysis of missing data was also conducted for those cases.

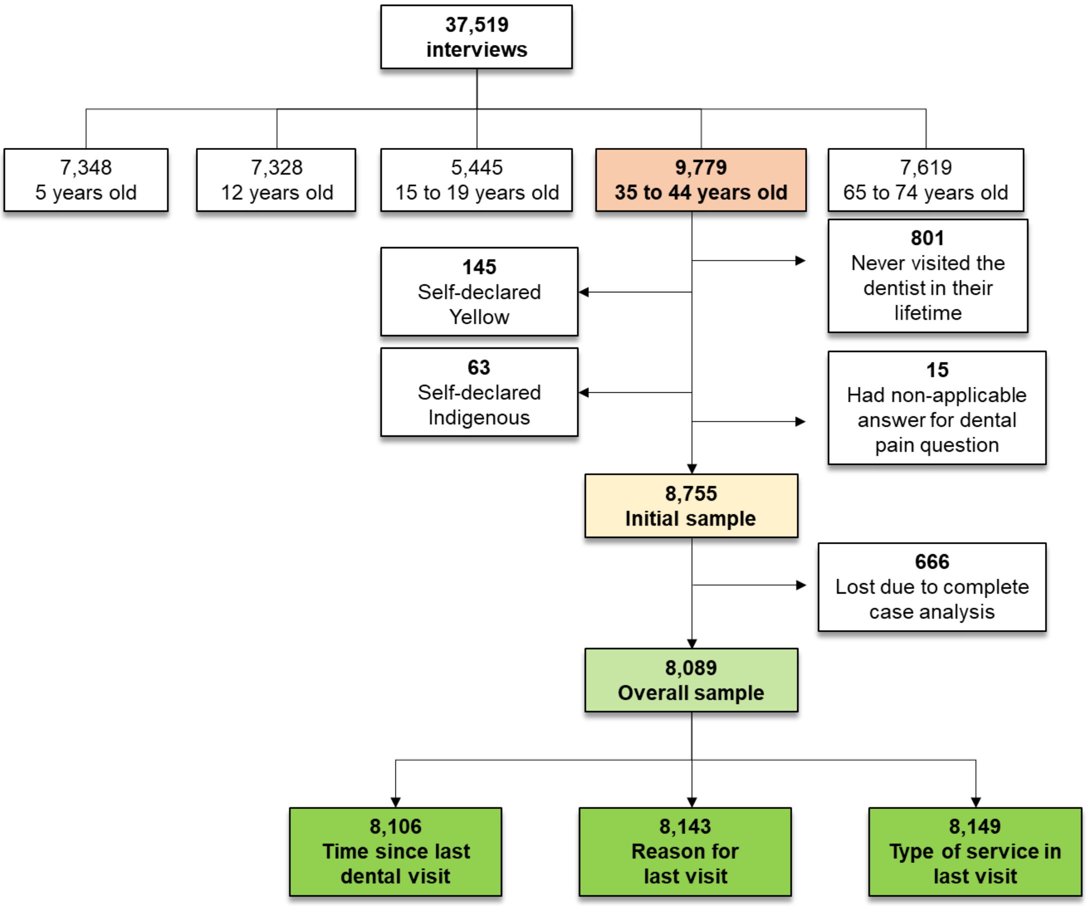

Figure 6-1 - SB Brazil 2010 survey sample and analytical sample for the present study.

Table 6.1 shows the distribution of the overall sample (n=8,089) according to the main explanatory variable (colour/race), and the covariates (individual-level characteristics). Half of the sample self-classified as White (50.3%), and more than half were women (64.0%), educated at least for nine years (63.0%), and earned less than R$1,500.00 (65.0%), which was less than three minimum wages in 2010.

With regards to the self-reported characteristics, 40.8% were satisfied with their teeth/mouth. Dental pain in the previous six months was reported by 28.6% of the participants, and self-reported need for dental treatment was reported by 78.2%. In terms of clinically evaluated oral health, 47.0% had no decayed teeth, 19.3% had no missing teeth, and almost 15% had no filled teeth.

As previously mentioned, the analytical sample size for each outcome was different. However, because, overall, they have similar distribution compared to Table 6.1, the distribution tables of colour/race and covariates for the three different sample sizes were presented in the Appendices (Table A-2, A-3, and A-4).

Table 6-1 - Description of colour/race and individual-level characteristics in the 35-44-year-old sample of SB Brazil, 2010.

Characteristics	**n**	**%**	**95% CI**
Colour/Race			
White	3,514	50.3	46.5 - 54.0
Pardo	3,753	39.1	35.4 - 43.0
Black	822	10.6	8.9 - 12.6
Sex			
Male	2,716	36.0	32.8 - 39.3
Female	5,373	64.0	60.7 - 67.2
Level of education (years)			
≤ 4	1,282	19.3	16.5 - 22.5
5 – 8	2,238	27.7	24.9 - 30.8
9 - 11	2,596	30.4	27.8 - 33.2
≥12	1,973	22.6	18.6 - 27.1
Income (R$ - Brazilian *Reais*)			
≤ 500.00	1,101	11.4	9.3 - 13.8
501.00 – 1,500.00	4,035	53.6	49.2 - 57.9
1,501.00 – 2,500.00	1,611	21.4	18.8 - 24.2
≥ 2,501.00	1,342	13.7	10.9 - 17.1

Table 6-1 (continued) - Description of colour/race and individual-level characteristics in the 35-44-year-old sample of SB Brazil, 2010.

Characteristics	n	%	95% CI
Self-reported satisfaction with teeth/month			
Satisfy	3,220	40.8	37.8 - 43.8
Neither	1,477	20.8	18.6 - 23.2
Not satisfy	3,392	38.4	35.3 - 41.6
Self-reported dental pain			
No	6,043	71.4	67.7 - 74.8
Yes	2,046	28.6	25.2 - 32.3
Self-reported need for dental treatment			
No	1,652	21.8	19.5 - 24.3
Yes	6,437	78.2	75.7 - 80.5
Presence of decay teeth			
No	3,292	47.0	43.8 - 50.2
Yes	4,797	53.0	49.8 - 56.2
Presence of missing teeth			
No	1,141	19.3	16.9 - 22.0
Yes	6,948	80.7	78.0 - 83.2
Presence of filled teeth			
No	1,508	14.9	12.8 - 17.3
Yes	6,581	85.1	82.7 - 87.2
Total	**8,089**	**100.0**	

Nonetheless, the distribution of the dental service utilisation characteristics is presented in Table 6-2. Among the participants, half of the sample (50.0%) reported their last dental visit happened last than a year, 78.7% visited the dentist due to pain or extraction or treatment, and 61.5% visited the private dental service.

Table 6-2 - Description of the dental service utilisation characteristics in the 35-44-year-old sample of SB Brazil, 2010.

Variables	n	%	95% CI
Time since last dental visit (n=8,106)			
< 1 year	4,169	50.0	47.0 – 53.0
≥ 1 year	3,937	50.0	47.0 – 52.9
Reason for the last dental visit (n=8,143)			
Prevention/check-up	1,787	21.3	19.1 – 23.6
Pain or extraction	2,651	30.9	28.2 – 33.8
Treatment	3,705	47.8	45.2 – 50.5
Type of service used (n=8,149)			
Private service	4,792	61.5	56.9 – 65.9
Public service	3,357	38.5	34.1 – 43.1
Total		**100.0**	

6.2.2 Description of the missing data

From the overall sample (n=8,755) prior to the exclusion due to complete case analysis, 7.6% were lost due to missing values for one or more variables included in the analysis. The characteristics of missingness for this sample size were described in Table 6.3. Pardos were less likely (OR 0.62, 95% CI 0.40 - 0.96) to be missed than Whites, those who studied 9 to 11 years were less likely (OR 0.53, 95% CI 0.34 - 0.81) to be missed than those who studied four years or less, and those who had filled teeth were less likely (OR 0.64, 95% CI 0.42 - 0.97) to be missed compared to those who had no filled teeth. For all other categories of the investigated variables, there were no significant differences in terms of missingness compared to the reference category.

The distribution of missingness with the respective sample size of each outcome were presented in the Appendices (Table A-5, A-6, and A-7). Overall, the sample size used for each outcome had similar distribution than Table 6.3, but there was significant difference between presence of filled teeth for the reason to visit the dentist and type of service sample sizes. Nevertheless, the distribution of missingness for each outcome is presented in Table 6.4, which shows there were no significant differences in terms of missingness for any of dental service characteristics.

Table 6-3 - Distribution of missingness, and its odds ratio according to the overall sample of colour/race and individual-level characteristics in 35-44-year-old sample of SB Brazil, 2010.

Variables	**n missing**	**Missingness (%)**	**OR**	**95% CI**	**p-value**
Colour/Race					
White	277	7.3	1		
Pardo	315	7.7	0.62	0.40 - 0.96	0.034
Black	74	8.3	0.94	0.53 - 1.67	0.836
Total	666	7.6			
Sex					
Male	260	8.7	1		
Female	406	7.0	0.87	0.59 - 1.29	0.497
Total	666	7.6			
Level of education (years)					
≤ 4	132	9.3	1		
5 – 8	195	8.0	1.21	0.73 - 2.03	0.455
9 - 11	159	5.8	0.53	0.34 - 0.81	0.003
≥12	139	6.6	0.73	0.43 - 1.22	0.228
Total	625	7.2			
Income (R$ - Brazilian *Reais*)					
≤ 500.00	60	5.2	1		
501.00 – 1,500.00	249	5.8	1.03	0.57 - 1.86	0.914
1,501.00 – 2,500.00	84	5.0	0.87	0.41 - 1.83	0.716
≥ 2,501.00	78	5.5	1.05	0.48 - 2.31	0.896
Total	471	5.5			
Self-reported satisfaction with teeth/month					
Satisfy	289	8.2	1		
Neither	118	7.4	0.88	0.54 - 1.43	0.609
Not satisfy	223	6.2	0.69	0.42 - 1.13	0.139
Total	630	7.2			
Self-reported dental pain					
No	505	7.7	1		
Yes	128	5.9	1.07	0.69 - 1.66	0.753
Total	633	7.3			
Self-reported need for dental treatment					
No	133	7.5	1		
Yes	371	5.4	0.63	0.34 - 1.15	0.135
Total	504	5.9			
Presence of decay teeth					
No	202	5.8	1		
Yes	300	5.9	1.30	0.85 - 2.00	0.221
Total	502	5.8			
Presence of missing teeth					
No	61	5.1	1		
Yes	441	6.0	1.18	0.73 - 1.90	0.503
Total	502	5.8			
Presence of filled teeth					
No	163	9.8	1		
Yes	339	4.9	0.64	0.42 - 0.97	0.037
Total	502	5.8			
Total missing overall	**666**	**7.6**			

OR – odds ratio

Table 6-4 - Distribution of missingness, and its odds ratio according to the dental service characteristics in 35-44-year-old sample of SB Brazil, 2010.

Variables	n missing	Missingness (%)	OR	95% CI	p-value
Time since last dental visit					
< 1 year	273	6.1%	1		
≥ 1 year	306	7.2%	1.08	0.72 - 1.60	0.711
Total	579	6.7%			
Reason for the last dental visit					
Prevention/check-up	144	7.5%	1		
Pain or extraction	186	6.6%	0.72	0.39 - 1.30	0.278
Treatment	254	6.4%	0.68	0.37 - 1.25	0.217
Total	584	6.7%			
Type of service used					
Private service	367	7.1%	1		
Public service	215	6.0%	0.88	0.60 - 1.31	0.542
Total	582	6.7%			

6.3 Bivariate Analyses

6.3.1 Distribution of colour/race groups according to individual-level characteristics.

Results presented in Table 6-5 show that among the overall sample there were fewer Pardos and Blacks who reported to have higher levels of education and higher family income, compared to Whites. There were more Whites (44.5%) who reported to be satisfied with teeth/mouth, compared to Pardos (36.4%) and Blacks (39.6%). In contrast, self-reported dental pain in the last six months and the need for dental treatment was lower for Whites compared to Pardos and Blacks. Although almost half of the White respondents had decayed teeth (48.5%), presence of decayed teeth was higher for Pardos (57.1%) and Blacks (59.3%) respondents. Presence of missing teeth was also higher for Pardos (87.0%) and Blacks (80.2%), compared to Whites (75.9%); however, presence of filled teeth was higher for Whites (88.1%), compared to Pardos (82.7%) and Blacks (80.0%).

Table 6-5 - Distribution of colour/race in the overall sample according to individual-level characteristics in the 35-44-year-old sample of SB Brazil, 2010.

Characteristics	White (n=3,514)		Pardo (n=3,753)		Black (n=822)	
	%	**95% CI**	**%**	**95% CI**	**%**	**95% CI**
Sex						
Male	34.7	30.8 - 38.8	37.1	32.1 - 42.3	38.2	31.2 - 45.7
Female	65.3	61.2 - 69.2	62.9	57.7 - 67.9	61.8	54.3 - 68.8
Level of education (years) ***						
≤ 4	14.5	11.3 - 18.5	24.2	20.5 - 28.4	23.8	17.1 - 32.1
5 – 8	25.7	22.1 - 29.6	29.5	25.7 - 33.7	30.6	24.3 - 37.9
9 - 11	30.7	27.4 - 34.2	32.3	28.0 - 36.9	22.2	16.7 - 28.8
≥12	29.1	23.9 - 34.9	14.0	10.8 - 17.8	23.4	16.6 - 32.0
Income (R$ - Reais) ***						
≤ 500.00	9.0	7.0 - 11.5	12.6	9.5 - 16.4	18.1	12.0 - 26.4
501.00 – 1,500.00	46.3	40.7 - 51.9	61.7	56.6 - 66.6	58.2	50.3 - 65.8
1,501.00– 2,500.00	26.7	23.4 - 30.3	16.4	12.6 - 21.0	14.5	10.2 - 20.2
≥ 2,501.00	18.1	13.9 - 23.2	9.3	6.9 - 12.6	9.2	5.3 - 15.3
Self-reported satisfaction with teeth/month *						
Satisfied	44.5	41.3 - 47.8	36.4	32.1 - 40.9	39.6	31.5 - 48.3
Neither	21.0	18.3 - 23.9	21.4	18.0 - 25.3	17.8	13.6 - 22.9
Not satisfied	34.5	31.0 - 38.2	42.3	37.9 - 46.8	42.7	34.3 - 51.5
Self-reported dental pain *						
No	74.4	69.7 - 78.6	67.8	64.0 - 71.4	70.5	62.4 - 77.5
Yes	25.6	21.4 - 30.3	32.2	28.6 - 36.0	29.5	22.5 - 37.6
Self-reported need for dental treatment *						
No	25.4	22.2 - 28.9	16.9	13.0 - 21.7	22.8	16.4 - 30.7
Yes	74.6	71.1 - 77.8	83.1	78.3 - 87.0	77.2	69.3 - 83.6
Presence of decay teeth **						
No	51.6	47.1 - 56.0	42.9	38.6 - 47.3	40.7	32.6 - 49.2
Yes	48.5	44.0 - 52.9	57.1	52.7 - 61.4	59.3	50.8 - 67.4
Presence of missing teeth ***						
No	24.1	20.7 - 27.8	13.1	10.1 - 16.8	19.8	13.4 - 28.4
Yes	75.9	72.2 - 79.3	87.0	83.2 - 89.9	80.2	71.6 - 86.7
Presence of filled teeth **						
No	11.9	9.8 - 14.5	17.3	14.5 - 20.7	20.0	13.4 - 28.6
Yes	88.1	85.5 - 90.2	82.7	79.4 - 85.5	80.0	71.4 - 86.6
Total	**100.0**		**100.0**		**100.0**	

[1] Overall p-value - Pearson chi-square with correction of Rao and Scott (1981)
p-value *<0.05, **<0.01, ***<0.001

6.3.2 Distribution of dental service utilisation outcomes according to colour/race and individual-level characteristics

The focus of this part of the thesis was to show the distribution of dental service utilisation outcomes according to colour/race groups and individual-level variables. For each outcome, respective sample size was used.

First, the bivariate association between dental service outcomes and colour/race was presented in Table 6-6. As observed, White individuals were more likely to visit the dentist in the previous year (53.8%) than Pardos (46.4%) and Blacks (45.5%). Although visits to the dentist due to treatment was the most reported reason for all groups, White individuals were more likely to visit dental service for prevention/check-up (26.4%), compared to Pardos (15.3%) and Blacks (18.6%), and Pardos (36.5%) and Blacks (39.5%) were more likely to report visits due to pain or extraction compared to Whites (24.7%). For all colour/race groups, the majority reported visiting the private service; however, the use of this type of service was higher for White individuals (67.9%), in contrast with Pardos (56.2%) and Blacks (51.1%).

Table 6-6 - Distribution of dental service utilisation characteristics according to colour/race in the 35-44-year-old sample of SB Brazil, 2010.

Characteristic	**White**		**Pardo**		**Black**	
	%	**95% CI**	**%**	**95% CI**	**%**	**95% CI**
Time since last dental visit (n=8,106)*						
< 1 year	53.8	49.6 – 57.9	46.4	41.9 – 50.9	45.5	37.6 – 53.6
≥ 1 year	46.2	42.1 – 50.3	53.6	49.1 – 58.0	54.5	46.3 – 63.4
Reason for the last dental visit (n=8,143)***						
Prevention/check-up	26.4	23.6 – 29.4	15.3	12.2 – 19.1	18.6	12.6 – 26.7
Pain or extraction	24.8	21.5 – 28.3	36.5	32.8 – 40.3	39.5	30.6 – 49.0
Treatment	48.8	45.4 – 52.3	48.2	43.8 – 52.5	41.9	32.2 – 52.3
Type of service used (n=8,149)***						
Private service	67.9	62.5 – 72.9	56.2	50.7 – 61.5	51.1	44.2 – 58.0
Public service	32.1	27.1 – 37.5	43.8	38.5 – 49.3	48.9	42.0 – 55.8
Total	**100.0**		**100.0**		**100.0**	

[1] Overall p-value - Pearson chi-square with correction of Rao and Scott (1981)
p-value *<0.05, **<0.01, ***<0.001

Second, Tables 6.7, 6.8, and 6.9 present the distribution of covariates for each outcome. It is important to understand how individual-level variables relate to the dental service characteristics, because they might be possible confounders in the relationship between colour/race and dental service utilisation.

Table 6.7 presents the distribution of the time since last dental visit according to the individual-level characteristics. A higher proportion of females (53.1%) visited the dentist in the previous year compared to males (46.3%). The higher the level of education, the higher the proportion of individuals who visited the dental service in the previous year. Individuals that earned R$1,501.00 or more (i.e. more than three Brazilian minimum wages in 2010) also had higher proportions of more recent visits than those who earned R$1,500.00 or less.

Table 6-7 - Distribution of the time since last dental visit according to individual-level characteristics in the 35-44-year-old sample of SB Brazil, 2010 (n=8,106).

Variables	< 1 year		≥ 1 year	
	%	**95% CI**	**%**	**95% CI**
Sex *				
Male	46.3	42.5 – 50.1	53.7	49.9 – 57.5
Female	53.1	48.5 – 55.6	47.9	44.4 – 51.5
Level of education (years) ***				
≤ 4	42.6	36.4 – 49.0	57.4	51.0 – 63.6
5 – 8	43.7	39.7 – 47.8	56.3	52.2 – 60.3
9-11	51.1	46.5 – 55.7	48.9	44.3 – 53.5
≥12	62.6	56.5 – 68.4	37.4	31.6 – 43.5
Income (R$ - Reais) ***				
≤ 500.00	47.2	39.9 – 54.6	52.8	45.4 – 60.1
501.00 – 1,500.00	42.8	39.7 – 46.0	57.2	54.0 – 60.3
1,501.00 – 2,500.00	56.7	51.6 – 61.6	43.3	38.4 – 48.3
≥ 2,501.00	70.1	62.3 – 76.9	29.8	23.1 – 37.7
Self-reported satisfaction with teeth/month ***				
Satisfy	56.1	52.3 – 59.9	43.9	40.1 – 47.7
Neither	51.7	45.3 – 58.0	48.3	42.0 – 54.7
Not satisfy	42.6	38.6 – 46.7	57.4	53.3 – 61.3
Self-reported dental pain				
No	48.3	45.0 – 51.6	51.7	48.4 – 55.0
Yes	54.4	47.9 – 60.7	45.6	39.3 – 52.1
Self-reported need for dental treatment ***				
No	61.2	56.2 – 65.9	38.8	34.1 – 43.8
Yes	46.9	43.8 – 50.0	53.1	50.0 – 56.2
Presence of decayed teeth ***				
No	56.7	52.8 – 60.5	43.3	39.5 – 47.2
Yes	44.1	40.3 – 47.9	55.9	52.1 – 59.7
Presence of missing teeth **				
No	58.4	51.6 – 64.9	41.6	35.1 – 48.4
Yes	48.0	44.8 – 51.2	52.0	48.8 – 55.2
Presence of filled teeth ***				
No	35.4	28.6 – 42.8	64.6	57.2 – 71.4
Yes	52.6	49.3 – 55.8	47.4	44.1 – 50.7

[1] Overall p-value - Pearson chi-square with correction of Rao and Scott (1981)
p-value *<0.05, **<0.01, ***<0.001

A higher proportion of individuals who visited the dentist in the previous year were also observed between those satisfied with their teeth/mouth, and those who reported no need for dental treatment, compared to their counterparts. A higher proportion of respondents with no decayed teeth and no missing teeth reported to visit the dentist in the previous year, compared with subjects with decayed and missing teeth; however, those who had filled teeth had higher proportion of individuals who reported visiting the dentist in the previous year (52.4%), compared to those who did not have any filled teeth (35.4%).

Focusing on the reason for the last dental visit, for almost all groups, visiting the dentist due to treatment presented the most reported reason. Table 6-8 shows that the higher the level of education and income, the higher the proportion of those who visited the dentist for prevention/check-up, and the lower the proportion of individuals who reported visits due to pain or extraction. These were also observed for levels of satisfaction with teeth/mouth, as those more satisfied had higher proportion visiting for prevention/check-ups compared to those not satisfied. Subjects that reported having dental pain in the previous six months had lower proportion of visits for prevention/check, but higher proportion of visits for pain or extraction, compared to those with no dental pain. Individuals with decayed teeth and missing teeth had lower proportion of reporting visiting the dentist for prevention/check-up and higher proportion of reporting visiting for pain or extraction, compared with those who had no decayed or missing teeth. In contrast, individuals with filled teeth had higher proportion of reporting visiting the dentist for prevention/check-up and lower proportion of reporting visiting for pain or extraction, compared to those with no filled teeth.

The distribution of the type of service used according to the individual-level characteristics is presented in Table 6-9. The lower the level of education and the lower the income, the higher the proportion of individuals who reported having their last dental visit in a public dental service. Although there was a larger proportion of individuals who visited the private service for all the categories of satisfaction with teeth/mouth, a higher proportion of those who reported being satisfied (65.3%) was observed for those who visited the private service, compared to those who were not satisfied (55.6%). Equivalent results were observed for those who report no dental pain, no need for dental treatment, no decayed, and no missing teeth, compared to their counterparts. In contrast, a higher proportion of individuals who reported visiting the public dental service was observed for those who had no filled teeth (55.4%), compared to those with filled teeth (35.5%).

Table 6-8 - Distribution of the reason for the last dental visit according to individual-level characteristics in the 35-44-year-old sample of SB Brazil, 2010 (n=8,143).

Variables	**Prevention /check-up**		**Pain or extraction**		**Treatment**	
	%	**95% CI**	**%**	**95% CI**	**%**	**95% CI**
Sex						
Male	20.5	17.2 – 24.3	34.2	29.8 – 38.8	45.3	41.2 – 49.5
Female	21.7	19.4 – 24.2	29.1	25.8 – 32.6	49.2	46.2 – 52.2
Level of education (years) ***						
≤ 4	10.9	8.43 – 14.0	49.2	42.9 – 55.6	39.9	33.5 – 46.6
5 – 8	13.3	10.8 – 16.2	38.9	35.2 – 42.6	47.8	44.2 – 51.6
9-11	24.5	20.7 – 28.5	26.0	22.4 – 30.0	49.5	45.4 – 53.7
≥12	35.7	30.4 – 41.4	12.0	9.4 – 15.1	52.3	46.2 – 58.3
Income (R$ - Brazilian Reais) ***						
≤ 500.00	10.8	6.9 – 16.5	48.2	41.5 – 55.0	41.0	35.5 – 47.7
501.00 – 1,500.00	16.0	13.8 – 18.5	35.6	31.8 – 39.6	48.4	44.8 – 52.0
1,501.00 - 2,500.00	31.3	26.4 – 36.7	22.2	18.5 – 26.5	46.5	41.8 – 51.2
≥ 2,501.00	34.6	28.7 – 41.1	11.8	9.2 – 15.1	53.6	46.6 – 60.3
Self-reported satisfaction with teeth/month ***						
Satisfy	30.8	26.9 – 35.1	20.2	16.9 – 24.0	49.0	45.1 – 52.8
Neither	17.1	13.7 – 21.2	31.0	25.9 – 36.6	51.9	45.4 – 58.3
Not satisfy	13.3	10.8 – 16.3	42.2	39.0 – 45.5	44.5	41.2 – 47.7
Self-reported dental pain ***						
No	26.8	24.2 – 29.5	23.5	20.5 – 26.8	49.7	46.2 – 53.2
Yes	7.5	5.3 – 10.5	49.4	43.6 – 55.2	43.1	37.7 – 48.7
Self-reported need for dental treatment ***						
No	39.5	33.8 – 45.5	17.4	13.9 – 21.4	43.1	36.6 – 49.9
Yes	16.2	13.9 – 18.7	34.7	31.5 – 38.0	49.1	45.9 – 52.4
Presence of decayed teeth ***						
No	30.4	26.6 – 34.5	22.2	18.3 – 26.5	47.4	42.9 – 51.9
Yes	13.1	10.9 – 15.7	38.7	35.6 – 41.9	48.2	44.2 – 52.1
Presence of missing teeth ***						
No	36.0	30.0 – 42.3	18.5	13.4 – 25.1	45.5	38.9 – 52.3
Yes	17.7	15.9 – 19.7	33.9	31.1 – 36.7	48.4	45.6 – 51.1
Presence of filled teeth ***						
No	14.2	9.7 – 20.2	52.8	45.5 – 59.9	33.0	26.1 – 40.7
Yes	22.5	20.0 – 25.3	27.0	24.2 – 30.1	50.5	47.5 – 53.4

[1] Overall p-value - Pearson chi-square with correction of Rao and Scott (1981)
p-value *<0.05, **<0.01, ***<0.001

Table 6-9 - Distribution of the type of service used in the last dental visit according to individual-level characteristics in the 35-44-year-old sample of SB Brazil, 2010 (n=8,149).

Variables	**Private Service**		**Public Service**	
	%	**95% CI**	**%**	**95% CI**
Sex				
Male	63.5	57.1 – 69.4	36.5	30.6 – 42.9
Female	60.4	55.8 – 64.8	39.6	35.2 – 44.1
Level of education (years) ***				
≤ 4	42.8	37.3 - 48.5	57.2	51.5 – 62.7
5 – 8	51.2	45.7 – 56.6	48.8	43.4 – 54.2
9-11	67.6	61.8 – 72.9	32.4	27.1 – 38.1
≥12	82.2	76.7 – 86.6	17.8	13.4 – 23.3
Income (R$ - Brazilian Reais) ***				
≤ 500.00	38.8	33.5 – 44.4	61.2	55.6 – 66.5
501.00 – 1,500.00	53.5	48.0 – 58.9	46.5	41.1 – 52.0
1,501.00 – 2,500.00	75.3	69.3 – 80.5	24.7	19.5 – 30.7
≥ 2,501.00	90.2	85.8 – 93.3	9.8	6.6 – 14.1
Self-reported satisfaction with teeth/month **				
Satisfy	65.3	58.9 – 71.1	34.7	28.8 – 41.1
Neither	65.1	58.5 – 71.1	34.9	28.9 – 41.5
Not satisfy	55.6	50.2 – 61.0	44.3	39.0 – 49.8
Self-reported dental pain ***				
No	65.1	59.8 – 70.1	34.9	29.9 – 40.2
Yes	52.6	46.6 – 58.4	47.4	41.6 – 53.4
Self-reported need for dental treatment ***				
No	73.9	68.8 – 78.4	26.1	21.6 – 31.1
Yes	58.1	53.1 – 62.9	41.9	37.1 – 46.9
Presence of decayed teeth ***				
No	69.6	63.9 – 74.8	30.4	25.1 – 36.1
Yes	54.3	49.6 – 59.0	45.7	41.0 – 50.4
Presence of missing teeth ***				
No	73.8	64.5 – 81.4	26.2	18.6 – 35.5
Yes	58.6	54.2 – 62.9	41.4	37.1 – 45.8
Presence of filled teeth ***				
No	44.6	38.8 – 50.5	55.4	49.5 – 61.2
Yes	64.5	59.1 – 69.6	35.5	30.4 – 40.9

[1] Overall p-value - Pearson chi-square with correction of Rao and Scott (1981)
p-value *<0.05, **<0.01, ***<0.001

6.4 Regression analysis

6.4.1 The role of individual-level characteristics in the relationship between colour/race and time since last dental visit

The next sub-sections presented the results of the binary logistic regression for the association between colour/race and the time since last dental visit taking into consideration the role of each individual-level characteristics. The analysis took into consideration those with complete cases for all covariates, colour/race, and time since last dental visit (n=8,106). Visiting the dentist less than one year previously to the survey interview was considered the reference category.

6.4.1.1 The role of each individual-level characteristics in the relationship between colour/race and time since last dental visit

Table 6.10 shows that colour/race was associated with time since last dental visit in the unadjusted model. Individuals self-classified as Pardos and Blacks were 1.34 (95%CI 1.04 – 1.73) and 1.39 (95%CI 1.03 – 1.88) times more likely, respectively, to visit the dentist for a year or more preceding the survey compared to Whites.

The first individual-level characteristic tested was sex, and after this was included in the model with colour/race and time since last dental visit, no reduction on the estimates between Pardos and Blacks compared to Whites was observed. In contrast, when level of education and income were included separately in the model with colour/race and time since last dental visit both had great impact on reducing the magnitude of the difference between colour/race groups, and after the inclusion of each covariate the association between colour/race and time since last dental visit were no longer significant. Among the self-reported oral health characteristics, self-reported dental pain in the last six months was the only covariate to increase the difference between Pardos and Blacks compared to Whites. This meant that when the model included colour/race and the time since last dental visit was adjusted only for dental pain, Pardos and Blacks were now 1.37 (1.07 – 1.75) and 1.41 (1.04 – 1.90) times more likely, respectively, to visit the dentist for a year or more preceding the survey compared to Whites. Additionally, all the models with covariates regarding oral health status clinically evaluated reduced the magnitude of the difference between groups. However, apart from the difference between Black and Whites for the presence of missing teeth (OR 1.37, 95% CI 1.02 – 1.85), all other differences were marginally significant.

Table 6-10 - Association of colour/race and time since last dental visit adjusted by each individual-level characteristic, in a sample of 35-44-year-old adults, Brazil, 2010. (Binary logistic regression models.)

	Pardos		**Blacks**	
	OR (95% CI)	**p-value**	**OR (95% CI)**	**p-value**
Unadjusted model	1.34 (1.04 – 1.73)	0.023	1.39 (1.03 – 1.88)	0.030
Adjusted for				
Sex	1.34 (1.04 – 1.72)	0.024	1.38 (1.02 – 1.87)	0.035
Level of education (years)	1.21 (0.92 – 1.59)	0.163	1.31 (0.98 – 1.75)	0.068
Income (R$ - Reais)	1.17 (0.89 – 1.55)	0.255	1.22 (0.90 – 1.64)	0.197
Satisfaction with teeth/month	1.29 (0.99 – 1.69)	0.056	1.35 (1.00 – 1.81)	0.047
Dental pain	1.37 (1.07 – 1.75)	0.013	1.41 (1.04 – 1.90)	0.026
Need for dental treatment	1.29 (0.99 – 1.67)	0.057	1.38 (1.03 – 1.85)	0.033
Decayed teeth	1.29 (0.99 – 1.68)	0.054	1.33 (0.99 – 1.77)	0.055
Missing teeth	1.29 (0.99 – 1.67)	0.053	1.37 (1.02 – 1.85)	0.035
Filled teeth	1.30 (1.00 – 1.69)	0.048	1.33 (0.97 – 1.69)	0.080

6.4.1.2 The association between colour/race and time since last dental visit while considering the hierarchical adjustment for individual-level characteristics

As previously observed, in the unadjusted model, colour/race was associated with the time since last dental visit. Pardos and Blacks were both more likely to visit the dentist a year or more compared to Whites. Table 6.11 shows how the magnitude of the difference between colour/race groups was affected by the hierarchical adjustment for all individual-level covariates.

The adjustment for sex (Model 2) did not affect colour/race association. Level of education attenuated the difference between Pardos and Blacks compared to Whites and from this model onwards the association between colour/race and time since last dental dentist presented itself as non-statistically significant. Further adjustments for income (Model 4) had also great effect on reducing the differences between Pardos and Blacks in contrast with Whites. Moreover, it is possible to see that this covariate alone (Table 6.10) greatly reduced the difference between groups, but the reduction was greater after the hierarchical adjustment (Table 6.11).

After the inclusion of self-reported and clinically evaluated oral health characteristics (Model 5-7) the estimates continued to be attenuated. The final model confirmed that the association between colour/race and time since last dental visit was fully explained by the adjustments of the investigated covariates.

Table 6-11 - Association of colour/race and time since last dental visit according to unadjusted and adjusted analysis for individual-level factors in 35-44-year-old adults, Brazil, 2010: binary logistic regression models.

Variables		Model 1 [a]	Model 2 [b]	Model 3 [b]	Model 4 [b]	Model 5 [b]	Model 6 [b]	Model 7 [b]
		OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**
Colour/race	Pardo	1.34 (1.04 – 1.73)*	1.34 (1.04 – 1.72)*	1.21 (0.92 – 1.58)	1.13 (0.85 – 1.51)	1.11 (0.83 – 1.50)	1.11 (0.82 – 1.50)	1.09 (0.81 – 1.48)
	Black	1.39 (1.03 – 1.88)*	1.38 (1.02 – 1.87)*	1.30 (0.97 – 1.75)	1.20 (0.88 – 1.62)	1.18 (0.88 – 1.59)	1.19 (0.87 – 1.63)	1.16 (0.84 – 1.60)
Sex	Female	0.79 (0.66 – 0.95)**	0.80 (0.67 – 0.95)*	0.84 (0.70 – 1.00)*	0.82 (0.69 – 0.98)*	0.79 (0.66 – 0.95)*	0.80 (0.67 – 0.96)*	0.81 (0.68 – 0.96)*
Level of education (years)	5 – 8	0.95 (0.70 – 1.30)		0.98 (0.72 – 1.34)	1.00 (0.73 – 1.35)	0.97 (0.72 – 1.31)	0.92 (0.68 – 1.25)	1.00 (0.73 – 1.37)
	9 – 11	0.71 (0.51 – 0.98)*		0.74 (0.53 – 1.03)	0.81 (0.59 – 1.10)	0.81 (0.60 – 1.10)	0.78 (0.58 – 1.05)	0.88 (0.65 – 1.21)
	≥12	0.44 (0.30 – 0.65)***		0.47 (0.32 – 0.70)***	0.65 (0.45 – 0.95)*	0.67 (0.46 – 0.97)*	0.64 (0.44 – 0.93)*	0.75 (0.51 – 1.10)
Income (R$ - Reais)	501.00 – 1,500.00	1.19 (0.87 – 1.63)			1.25 (0.92 – 1.69)	1.28 (0.94 – 1.76)	1.24 (0.91 – 1.70)	1.33 (0.97 – 1.83)
	1,501.00 – 2,500.00	0.68 (0.50 – 0.93)*			0.81 (0.60 – 1.10)	0.86 (0.63 – 1.16)	0.83 (0.61 – 1.14)	0.92 (0.67 – 1.26)
	≥ 2,501.00	0.38 (0.24 – 0.60)***			0.49 (0.30 – 0.79)**	0.53 (0.33 – 0.87)*	0.50 (0.30 – 0.82)**	0.58 (0.35 – 0.95)*
Satisfaction with teeth/month	Neither	1.19 (0.88 – 1.62)				1.11 (0.82 – 1.50)	1.07 (0.79 – 1.45)	1.05 (0.78 – 1.42)
	Not satisfy	1.72 (1.40 – 2.12)***				1.50 (1.22 – 1.86)***	1.50 (1.21 – 1.86)***	1.40 (1.13 – 1.75)**
Dental pain	Yes	0.78 (0.59 – 1.04)					0.56 (0.42 – 0.76)***	0.56 (0.41 – 0.76)***
Need for dental treatment	Yes	1.78 (1.46 – 2.18)***					1.57 (1.28 – 1.92)***	1.57 (1.27 – 1.94)***
Decayed teeth	Yes	1.66 (1.35 – 2.04)***						1.21 (1.00 – 1.47)*
Missing teeth	Yes	1.52 (1.13 – 2.05)**						1.07 (0.74 – 1.54)
Filled teeth	Yes	0.49 (0.35 – 0.70)***						0.58 (0.43 – 0.79)***

[a] Unadjusted; [b] Adjusted / Base outcome: < 1 year / p-value: * <0.05; **<0.01; ***<0.001

Model 1: unadjusted analysis; Model 2: Model 1 + sex; Model 3: Model 2 + education; Model 4: Model 3 + income; Model 5: Model 4 + satisfaction with own teeth/mouth; Model 6: Mode 5 + self-reported need for treatment + self-reported dental pain; Model 7: Model 6 + presence of decay teeth, missing teeth, filled teeth.

6.4.2 The role of individual-level characteristics in the relationship between colour/race and reason to visit the dental services

The association between colour/race and the reason for the last dental visits was assessed through multinomial logistic regression and are presented in the next sub-sections. The analysis included adjustments for the same individual-level characteristics as previously mentioned. Visits to the dentist for prevention/check-up was used as the reference category. The analysis took into consideration those with complete cases for all covariates, colour/race, and reason to visit the dentist (n=8,143).

6.4.2.1 The role of each individual-level characteristics in the relationship between colour/race and reason to visit the dental services

Considering the first part of Table 6.12, which focused on the difference between colour/race groups among those who reported to visit the dentist for pain or extraction, the unadjusted model showed that colour/race was strongly associated with the outcome. Pardos and Blacks respondents were 2.54 (95%CI 1.83 – 3.53) and 2.26 (95%CI 1.39 – 3.68) times more likely, respectively, to visit due to pain or extraction compared to Whites.

The further adjustment for sex did not affect the association between colour/race groups. After adjusting the model containing colour/race and reason to visit the dentist for the level of education, there was a considerable reduction in the difference between Pardos and Blacks compared to Whites, but these minorities were still more likely to visit the dentist for pain or extraction compared to Whites. The same was observed when income was included in the model with colour/race and the outcome. Although all other covariates helped, individually, to reduce the differences between groups, self-report dental pain in the last six months and need for dental treatment did not affect the estimates for Blacks compared to Whites.

The second part of Table 6.12 focused on the differences between Pardos and Blacks compared to Whites among those who reported visiting the dentist due to treatment. The unadjusted model showed that colour/race was associated with the outcome, but only showing statistical differences between Pardos and Whites. Pardos were 1.70 (95%CI 1.19 – 2.42) times more likely to report visiting the dentist due to treatment compared to Whites.

Again, the inclusion of sex had no effect on the estimates, and the inclusion of education and income attenuated the differences between groups. The individual adjustment for all other covariates had small impact on the reduction of the estimates for Pardos and Blacks compared to Whites, when compared to visits for pain or extraction. Moreover, Pardos continued to be more likely to visit the dentist due treatment compared to Whites, even after considering the individual adjustments for individual-level characteristics

Table 6-12 - Association of colour/race and the reason to visit the dentist adjusted by each individual-level characteristic, in a sample of 35-44-year-old adults, Brazil, 2010. (Multinomial logistic regression models)

	Pardos		Blacks	
	OR (95% CI)	**p-value**	**OR (95% CI)**	**p-value**
Pain or extraction				
Unadjusted model	2.54 (1.83 – 3.53)	<0.001	2.26 (1.39 – 3.68)	<0.001
Adjusted for				
Sex	2.53 (1.83 – 3.49)	<0.001	2.25 (1.38 – 3.67)	<0.001
Level of education (years)	1.98 (1.39 – 2.82)	<0.001	1.94 (1.20 – 3.15)	0.007
Income (R$ - Reais)	2.02 (1.43 – 2.86)	<0.001	1.69 (1.04 – 2.74)	0.032
Satisfaction with teeth/month	2.36 (1.65 – 3.38)	<0.001	2.17 (1.35 – 3.48)	<0.001
Dental pain	2.42 (1.76 – 3.33)	<0.001	2.27 (1.36 – 3.81)	0.002
Need for dental treatment	2.31 (1.66 – 3.21)	<0.001	2.26 (1.40 – 3.66)	<0.001
Decayed teeth	2.37 (1.69 – 3.33)	<0.001	2.03 (1.27 – 3.25)	0.003
Missing teeth	2.26 (1.57 – 3.25)	<0.001	2.20 (1.37 – 3.53)	<0.001
Filled teeth	2.42 (1.72 – 3.41)	<0.001	2.11 (1.28 – 3.46)	0.003

Table 6-12 - (Continued). Association of colour/race and the reason to visit the dentist adjusted by each individual-level characteristic, in a sample of 35-44-year-old adults, Brazil, 2010. (Multinomial logistic regression models)

	Pardos		Blacks	
	OR (95% CI)	p-value	OR (95% CI)	p-value
Other Treatments				
Unadjusted model	1.70 (1.19 – 2.42)	0.003	1.22 (0.68 – 2.18)	0.499
Adjusted for				
Sex	1.70 (1.19 – 2.41)	0.003	1.22 (0.68 – 2.17)	0.495
Level of education (years)	1.54 (1.06 – 2.24)	0.024	1.15 (0.64 – 2.06)	0.632
Income (R$ - Reais)	1.51 (1.04 – 2.20)	0.031	1.05 (0.58 – 1.92)	0.853
Satisfaction with teeth/month	1.64 (1.14 – 2.37)	0.008	1.20 (0.69 – 2.09)	0.507
Dental pain	1.66 (1.18 – 2.35)	0.004	1.22 (0.68 – 2.20)	0.500
Need for dental treatment	1.58 (1.11 – 2.25)	0.010	1.22 (0.68 – 2.19)	0.501
Decayed teeth	1.63 (1.13 – 2.35)	0.009	1.14 (0.65 – 1.99)	0.640
Missing teeth	1.57 (1.07 – 2.31)	0.021	1.20 (0.67 – 2.14)	0.538
Filled teeth	1.70 (1.19 – 2.42)	0.003	1.22 (0.68 – 2.18)	0.500

6.4.2.2 The association between colour/race and reason to visit the dental services while considering the hierarchical adjustment for individual-level characteristics

The results for this sub-section was also divided due to the comparisons generated by the multinomial logistic regression. Table 6.13 showed the results of the hierarchical adjustments for individual-level characteristics comparing the report of those who visited the dentist due to pain or extraction, and the following table showed the results for the comparison of those who visited due to other treatments.

As previously mentioned, Pardos and Blacks were more likely to visit the dentist due to pain or extraction compared to Whites (Model 1), and these differences did not change after the adjustment for sex (Model 2). Even though there was great attenuation of the estimates for Pardos and Blacks after further adjustments for education (Model 3) and income (Model 4), the differences between Blacks and Whites were marginally significant after considering the accumulative adjustments. In contrast, the difference between Pardos and Whites were still observed after the hierarchical adjustment, and Pardos were 1.59 (95% CI 1.10 – 2.30) times more likely than Whites to visit the dental service due to pain or extraction in the final model (Model 7).

The second part of Table 6-13 started by showing that there was no statistically significant difference between Blacks and Whites in the use of dental service due to treatment throughout the accumulative adjustments (Model 1 – 7). In contrast, Pardos were more likely to visit due to treatment when considering the further adjustment for sex and level of education (Model 2 and 3). However, the inclusion of income fully explained the statistical difference between Pardos compared to Whites. The final model (Model 7) confirmed that both groups were no difference from Whites to visit the dentist due to treatment.

Table 6-13 - Association of colour/race and the reason for dental service according to unadjusted and adjusted analysis for individual-level factors in 35-44-year-old adults, Brazil, 2010: multinomial logistic regression models.

Pain or Extraction		**Model 1 [a] RRR (95% CI)**	**Model 2 [b] RRR (95% CI)**	**Model 3 [b] RRR (95% CI)**	**Model 4 [b] RRR (95% CI)**	**Model 5 [b] RRR (95% CI)**	**Model 6 [b] RRR (95% CI)**	**Model 7 [b] RRR (95% CI)**
Colour/race	Pardo	2.54 (1.83 – 3.53)***	2.53 (1.83 – 3.49)***	1.98 (1.39 – 2.82)***	1.80 (1.26 – 2.56)***	1.73 (1.19 – 2.53)**	1.68 (1.18 – 2.39)**	1.59 (1.10 – 2.30)*
	Black	2.26 (1.39 – 3.68)***	2.25 (1.38 – 3.67)***	1.94 (1.19 – 3.14)**	1.64 (1.01 – 2.67) *	1.63 (1.00 – 2.67)*	1.66 (1.00 – 2.73)*	1.58 (0.96 – 2.62)
Sex	Female	0.80 (0.59 – 1.09)	0.82 (0.62 – 1.09)	0.95 (0.72 – 1.27)	0.92 (0.69 – 1.22)	0.81 (0.60 – 1.09)	0.78 (0.57 – 1.06)	0.78 (0.57 – 1.06)
Level of education (years)	5 – 8	0.65 (0.45 – 0.93)*		0.68 (0.48 – 0.98)*	0.72 (0.50 – 1.02)	0.64 (0.45 – 0.93)*	0.73 (0.52 – 1.04)	0.83 (0.58 – 1.20)
	9 – 11	0.23 (0.16 – 0.34)***		0.25 (0.17 – 0.37)***	0.31 (0.22 – 0.46)***	0.30 (0.20 – 0.43)***	0.32 (0.23 – 0.46)***	0.40 (0.28 – 0.58)***
	≥12	0.07 (0.05 – 0.11)***		0.08 (0.05 – 0.13)***	0.14 (0.08 – 0.22)***	0.14 (0.09 – 0.23)***	0.17 (0.11 – 0.27)***	0.23 (0.14 – 0.38)***
Income (R$ - Reais)	501.00 – 1,500.00	0.50 (0.29 – 0.85)*			0.62 (0.36 – 1.06)	0.66 (0.40 – 1.11)	0.73 (0.45 – 1.19)	0.83 (0.51 – 1.35)
	1,501.00 – 2,500.00	0.16 (0.08 – 0.29)***			0.31 (0.16 – 0.57)***	0.36 (0.20 – 0.66)***	0.42 0.23 – 0.76)**	0.53 (0.30 – 0.94)*
	≥ 2,501.00	0.07 (0.04 – 0.13)***			0.21 (0.12 – 0.39)***	0.27 (0.15 – 0.49)***	0.33 (0.19 – 0.58)***	0.46 (0.27 – 0.79)**
Satisfaction with teeth/month	Neither	2.76 (1.95 – 3.90)***				2.48 (1.70 – 3.60)***	1.88 (1.27 – 2.80)**	1.78 (1.21 – 2.61)**
	Not satisfy	4.82 (3.38 – 6.88)***				3.82 (2.56 – 5.69)***	2.48 (1.67 – 3.68)***	2.08 (1.37 – 3.18)***
Dental pain	Yes	7.53 (5.01 – 11.31)***					4.67 (3.23 – 6.77)***	4.78 (3.29 – 6.95)***
Need for dental treatment	Yes	4.89 (3.45 – 6.94)***					1.98 (1.34 – 2.91)***	1.93 (1.24 – 2.98)**
Decayed teeth	Yes	4.04 (2.96 – 5.50)***						1.57 (1.10 – 2.25)*
Missing teeth	Yes	3.69 (2.51 – 5.43)***						1.77 (1.21 – 2.59)**
Filled teeth	Yes	0.32 (0.20 – 0.51)***						0.46 (0.27 – 0.79)**

[a] Unadjusted; [b] Adjusted / Base outcome: prevention/check-up / p-value: * <0.05; **<0.01; ***<0.001
Model 1: unadjusted analysis; Model 2: Model 1 + sex; Model 3: Model 2 + education; Model 4: Model 3 + income; Model 5: Model 4 + satisfaction with own teeth/mouth; Model 6: Mode 5 + self-reported need for treatment + self-reported dental pain; Model 7: Model 6 + presence of decay teeth, missing teeth, filled teeth.

Table 6-13 – (Continued). Association of colour/race and the reason for dental service according to unadjusted and adjusted analysis for individual-level factors in 35-44-year-old adults, Brazil, 2010: multinomial logistic regression models.

Other treatments		Model 1 [a] RRR (95% CI)	Model 2 [b] RRR (95% CI)	Model 3 [b] RRR (95% CI)	Model 4 [b] RRR (95% CI)	Model 5 [b] RRR (95% CI)	Model 6 [b] RRR (95% CI)	Model 7 [b] RRR (95% CI)
Colour/race	Pardo	1.70 (1.19 – 2.42)**	1.70 (1.19 – 2.41)**	1.54 (1.06 – 2.24)*	1.45 (0.99 – 2.12)	1.43 (0.97 – 2.10)	1.39 (0.95 – 2.04)	1.36 (0.91 – 2.02)
	Black	1.22 (0.68 – 2.18)	1.22 (0.68 – 2.17)	1.15 (0.65 – 2.06)	1.06 (0.59 – 1.90)	1.07 (0.62 – 1.86)	1.08 (0.61 – 1.90)	1.07 (0.61 – 1.87)
Sex	Female	1.03 (0.82 – 1.28)	1.03 (0.84 – 1.28)	1.10 (0.90 – 1.36)	1.10 (0.90 – 1.35)	1.05 (0.86 – 1.28)	1.02 (0.82 – 1.27)	1.02 (0.82 – 1.26)
Level of education (years)	5 – 8	0.98 (0.66 – 1.47)		1.01 (0.68 – 1.51)	1.03 (0.69 – 1.51)	0.97 (0.65 – 1.44)	1.04 (0.70 – 1.54)	1.06 (0.72 – 1.56)
	9 – 11	0.55 (0.38 – 0.80)**		0.56 (0.39 – 0.82)**	0.63 (0.44 – 0.89)**	0.61 (0.43 – 0.85)**	0.65 (0.47 – 0.90)*	0.68 (0.48 – 0.95)*
	≥12	0.40 (0.26 – 0.61)***		0.43 (0.28 – 0.67)***	0.53 (0.35 – 0.80)**	0.53 (0.35 – 0.81)***	0.58 (0.38 – 0.90)*	0.68 (0.46 – 1.01)
Income (R$ - Reais)	501.00 – 1,500.00	0.80 (0.47 – 1.35)			0.88 (0.52 – 1.47)	0.90 (0.56 – 1.47)	0.94 (0.59 – 1.49)	0.99 (0.63 – 1.55)
	1,501.00 – 2,500.00	0.39 (0.23 – 0.67)***			0.52 (0.30 – 0.89)*	0.56 (0.33 – 0.95)*	0.61 (0.36 – 1.02)	0.68 (0.41 – 1.13)
	≥ 2,501.00	0.41 (0.23 – 0.72)***			0.61 (0.35 – 1.07)	0.68 (0.40 – 1.17)	0.75 (0.44 – 1.27)	0.88 (0.53 – 1.48)
Satisfaction with teeth/month	Neither	1.91 (1.31 – 2.77)***				1.79 (1.21 – 2.65)**	1.45 (0.96 – 2.20)	1.37 (0.91 – 2.05)
	Not satisfy	2.10 (1.57 – 2.82)***				1.83 (1.35 – 2.47)***	1.34 (1.01 – 1.78)*	1.19 (0.88 – 1.61)
Dental pain	Yes	3.11 (2.09 – 4.63)***					2.33 (1.57 – 3.46)***	2.27 (1.53 – 3.36)***
Need for dental treatment	Yes	2.78 (1.93 – 4.02)***					1.91 (1.37 – 2.66)***	1.71 (1.25 – 2.34)***
Decayed teeth	Yes	2.35 (1.66 – 3.33)***						1.50 (1.07 – 2.09)*
Missing teeth	Yes	2.15 (1.61 – 2.88)***						1.47 (1.08 – 2.01)*
Filled teeth	Yes	0.96 (0.56 – 1.65)						1.10 (0.65 – 1.86)

[a] Unadjusted; [b] Adjusted / Base outcome: prevention/check-up / p-value: * <0.05; **<0.01; ***<0.001
Model 1: unadjusted analysis; Model 2: Model 1 + sex; Model 3: Model 2 + education; Model 4: Model 3 + income; Model 5: Model 4 + satisfaction with own teeth/mouth; Model 6: Mode 5 + self-reported need for treatment + self-reported dental pain; Model 7: Model 6 + presence of decay teeth, missing teeth, filled teeth.

6.4.3 The role of individual-level characteristics in the relationship between colour/race and the type of service used

The next final two sub-sections presented the results of the binary logistic regression for the association between colour/race and the type of service used in the last dental visit (private vs. public) taking into consideration the role of individual-level characteristics. Visiting the private dental service was considered a reference category. The analysis took into consideration those with complete cases for all covariates, colour/race, and type of dental service (n=8,149).

6.4.3.1 The role of each individual-level characteristics in the relationship between colour/race and type of dental service used

In the unadjusted model, Table 6.14 showed that Pardos and Blacks were 1.65 (95%CI 1.33 – 2.05) and 2.03 (95%CI 1.50 – 2.74) times more likely, respectively, to visit the public dental service compared to Whites. Similar to the previous outcomes, the individual adjustment for sex did not change the estimates, and the adjustment for education and income had a great effect on reducing the magnitude of the differences between Pardos and Blacks compared to Whites on the type of service used. In fact, these socioeconomic characteristics had a bigger effect in reducing the estimates when compared to other covariates tested. Nevertheless, Pardos and Blacks were statistically more likely to visit the public dental service compared to Whites after adjusted for the investigated covariates separately. Additionally, it can be observed that differences between Whites and Blacks were much larger than the respective ones between Whites and Pardos.

Table 6-14 - Association of colour/race and type of service used adjusted by each individual-level characteristic, in a sample of 35-44-year-old adults, Brazil, 2010. (Binary logistic regression models)

	Pardos		Blacks	
	OR (95% CI)	**p-value**	**OR (95% CI)**	**p-value**
Unadjusted model	1.65 (1.33 – 2.05)	<0.001	2.03 (1.50 – 2.74)	<0.001
Adjusted for				
Sex	1.66 (1.34 – 2.05)	<0.001	2.04 (1.50 – 2.78)	<0.001
Level of education (years)	1.37 (1.09 – 1.72)	0.007	1.81 (1.38 – 2.38)	<0.001
Income (R$ - Reais)	1.33 (1.06 – 1.67)	0.014	1.57 (1.19 – 2.07)	0.002
Satisfaction with teeth/month	1.61 (1.30 – 2.01)	<0.001	1.97 (1.46 – 2.67)	<0.001
Dental pain	1.61 (1.29 – 2.01)	<0.001	2.00 (1.45 – 2.76)	<0.001
Need for dental treatment	1.58 (1.28 – 1.95)	<0.001	2.01 (1.48 – 2.74)	<0.001
Decayed teeth	1.58 (1.27 – 1.97)	<0.001	1.92 (1.42 – 2.59)	<0.001
Missing teeth	1.56 (1.24 – 1.95)	<0.001	1.99 (1.44 – 2.76)	<0.001
Filled teeth	1.59 (1.28 – 1.99)	<0.001	1.92 (1.46 – 2.52)	<0.001

6.4.3.2 The association between colour/race and type of dental service used while considering the hierarchical adjustment for individual-level characteristics

Table 6.15 showed that Pardos and Blacks were more likely to visit the public dental service compared to Whites (Model 1), and the further inclusion of sex (Model 2) did not change the estimates. After the additional adjustment for level of education (Model 3) colour/race estimates were attenuated considerably but remained strongly associated with the outcome. This was not observed after the further adjustment for income, whereas the statistical difference between Pardos and Whites was fully explained. Blacks, however, continued to be more likely than Whites to visit the public dental service in the last dental visit.

The inclusion of self-reported and clinically evaluated characteristics continued to reduce the difference between colour/race groups, but only for Blacks the difference was statistically significant throughout all models. In the final model (Model 7), Blacks were 1.49 (95% CI 1.12 – 1.99) times more likely to visit the public dental service compared to Whites.

Table 6-15 - Association of colour/race and type of service used in the since last dental visit according to unadjusted and adjusted analysis for individual-level factors in 35-44-year-old adults, Brazil, 2010: binary logistic regression models.

Variables		Model 1 [a] OR (95% CI)	Model 2 [b] OR (95% CI)	Model 3 [b] OR (95% CI)	Model 4 [b] OR (95% CI)	Model 5 [b] OR (95% CI)	Model 6 [b] OR (95% CI)	Model 7 [b] OR (95% CI)
Colour/race	Pardo	1.65 (1.33 – 2.05)***	1.66 (1.34 – 2.05)***	1.37 (1.10 – 1.71)**	1.23 (0.98 – 1.54)	1.23 (0.97 – 1.55)	1.20 (0.95 – 1.52)	1.18 (0.94– 1.49)
	Black	2.03 (1.50 – 2.74)***	2.04 (1.50 – 2.78)***	1.83 (1.39 – 2.41)***	1.53 (1.16 – 2.01)**	1.52 (1.15 – 2.00)**	1.53 (1.13 – 2.05)**	1.49 (1.12 – 1.99)**
Sex	Female	1.14 (0.91 – 1.42)	1.16 (0.92 – 1.46)	1.33 (1.06 – 1.67)*	1.28 (1.00 – 1.64)*	1.28 (0.99 – 1.64)	1.28 (1.00 – 1.65)*	1.29 (1.01 – 1.66)*
Level of education (years)	5 – 8	0.71 (0.54 – 0.94)*		0.72 (0.55 – 0.94)*	0.76 (0.57 – 1.01)	0.76 (0.57 – 1.00)	0.77 (0.58 – 1.02)	0.82 (0.62 – 1.10)
	9 – 11	0.36 (0.27 – 0.47)***		0.36 (0.27 – 0.48)***	0.45 (0.34 – 0.60)***	0.45 (0.34 – 0.61)***	0.46 (0.35 – 0.61)***	0.51 (0.38 – 0.68)***
	≥12	0.16 (0.11 – 0.23)***		0.17 (0.12 – 0.23)***	0.29 (0.21 – 0.41)***	0.29 (0.21 – 0.41)***	0.31 (0.23 – 0.43)***	0.35 (0.25 – 0.49)***
Income (R$ - Reais)	501.00 – 1,500.00	0.55 (0.40 – 0.77)***			0.66 (0.47 – 0.92)*	0.66 (0.47 – 0.93)*	0.68 (0.48 – 0.96)*	0.71 (0.50 – 1.00)
	1,501.00 – 2,500.00	0.21 (0.14 – 0.31)***			0.31 (0.21 – 0.46)***	0.32 (0.21 – 0.47)***	0.33 (0.22 – 0.50)***	0.36 (0.24 – 0.53)***
	≥ 2,501.00	0.07 (0.04 – 0.11)***			0.13 (0.08 – 0.21)***	0.13 (0.08 – 0.21)***	0.14 (0.08 – 0.22)***	0.15 (0.09 – 0.25)***
Satisfaction with teeth/month	Neither	1.00 (0.70 – 1.45)				0.81 (0.56 – 1.16)	0.72 (0.48 – 1.08)	0.71 (0.47 – 1.06)
	Not satisfy	1.50 (1.19 – 1.89)***				1.05 (0.82 – 1.34)	0.90 (0.67 – 1.21)	0.85 (0.63 – 1.15)
Dental pain	Yes	1.68 (1.28 – 2.21)***					1.21 (0.87 – 1.68)	1.22 (0.87 – 1.72)
Need for dental treatment	Yes	2.04 (1.62 – 2.57)***					1.53 (1.08 – 2.18)*	1.55 (1.12 – 2.14)**
Decayed teeth	Yes	1.93 (1.52 – 2.44)***						1.13 (0.91 – 1.41)
Missing teeth	Yes	1.99 (1.32 – 3.00)***						1.13 (0.75 – 1.71)
Filled teeth	Yes	0.44 (0.32 – 0.61)***						0.65 (0.46 – 0.92)*

[a] Unadjusted; [b] Adjusted / Base outcome: private service / p-value: * <0.05; **<0.01; ***<0.001
Model 1: unadjusted analysis; Model 2: Model 1 + sex; Model 3: Model 2 + education; Model 4: Model 3 + income; Model 5: Model 4 + satisfaction with own teeth/mouth; Model 6: Mode 5 + self-reported need for treatment + self-reported dental pain; Model 7: Model 6 + presence of decay teeth, missing teeth, filled teeth.

6.5 Summary of the findings

The aim of this chapter was to assess associations between colour/race and the three dental service utilisation characteristics in a national sample of 35 to 44-year-old adults in Brazil, and whether individual-level characteristics had a role in explaining these associations. For all outcomes, there was evidence that colour/race was associated, at some level, with dental service utilisation.

The unadjusted models of each outcome are presented in Table 6.16. The results confirmed the hypothesis that individuals self-classified as Pardos and Blacks were more likely than Whites to have last visited a dentist a year or more preceding the interview, to visit more due to pain or extraction, and to visit a public dental service. However, there was no statistical association between Blacks and Whites for visiting the dentist due to treatment.

Table 6-16 - Summary of the unadjusted associations between colour/race and dental service utilisation (Model 1).

	Outcome			
	Time since last dental visit [1]	**Reason for the last dental visit [2]**		**Type of service used [1]**
	≥ 1 year	**Pain / extraction**	**Treatment**	**Public**
Colour/race	**OR (95% CI)**	**RRR (95% CI)**	**RRR (95% CI)**	**OR (95% CI)**
White	1.0	1.0	1.0	1.0
Pardo	1.34 (1.04 – 1.73)*	2.54 (1.83 – 3.53)***	1.70 (1.19 – 2.42)**	1.65 (1.33 – 2.05)***
Black	1.39 (1.03 – 1.88)*	2.26 (1.39 – 3.68)***	1.22 (0.68 – 2.18)	2.03 (1.50 – 2.74)***

*p<0.05; **p<0.01; ***p<0.001 / [1] Binary logitic regression, [2] Multinomial logistic regression
Reference category: time since last dental visit (<1 year), reason for the last dental visit (prevention/check-up), type of service used (private).

Sex showed not to affect the estimates for colour/race in neither of the outcomes. Additionally, education and income were the characteristics that most reduced the differences between Pardos and Blacks compared to Whites for all dental service utilisation characteristics. Other covariates, such as self-reported and clinically evaluated oral health status had a different impact on the estimates for Pardos and Blacks depending on the outcome.

The summary of the fully adjusted model (Model 7) of each outcome is presented in Table 6.17. The hierarchical adjustment for individual-level characteristics contradicted the hypothesis that colour/race was associated with the time since last dental visit. The level of education attenuated considerably the differences between groups and associations became non-significant after the inclusion of this covariate.

Table 6-17 - Summary of the adjusted associations between colour/race and dental service utilisation (Model 7).

	Outcome			
	Time since last dental visit [1]	Reason for the last dental visit [2]		Type of service used [1]
	≥ 1 year	Pain / extraction	Treatment	Public
Colour/race	**OR (95% CI)**	**RRR (95% CI)**	**RRR (95% CI)**	**OR (95% CI)**
White	1.0	1.0	1.0	1.0
Pardo	1.09 (0.81 – 1.48)	1.59 (1.10 – 2.30)*	1.36 (0.91 – 2.02)	1.18 (0.94– 1.49)
Black	1.16 (0.84 – 1.60)	1.58 (0.96 – 2.62)	1.07 (0.61 – 1.87)	1.49 (1.12 – 1.99)**

*p<0.05; **p<0.01; ***p<0.001 / [1] Binary logitic regression, [2] Multinomial logistic regression
Reference category: time since last dental visit (<1 year), reason for the last dental visit (prevention/check-up), type of service used (private).

For the reason to visit the dentist, the hierarchical adjustment confirmed that differences between Pardos and Whites remained after considering the role of individual-level characteristics; however, this was not observed for the differences between Blacks and Whites. Differences in visits due pain or extraction were fully explained for this group by the further adjustment for clinically evaluated oral health characteristics (number of decay teeth, missing teeth, filled teeth). Additionally, the findings contradicted the hypothesis that colour/race would be associated with visits due to treatment. Blacks had no statistical difference with Whites from the unadjusted model, and the difference between Pardos and Whites were fully explained after the further adjustment for income.

Lastly, for the type of service used, the hypothesis that both minority groups were more likely to visit the public dental service compared to Whites was only confirmed between Blacks and Whites. Level of education considerably attenuated the differences, but after the further adjustment for income, the difference between Pardos and Whites was fully explained.

Although for most of the outcomes the inclusion of each individual-level characteristic attenuated the estimates, it is important to highlight that the associations between colour/race and dental service utilisation were considerably reduced when the level of education and income were adjusted in the regression models. Nevertheless, the relationship between colour/race and dental service utilisation was not fully explained by individual-level characteristics for some outcomes. Differences between Pardos and Whites remained unexplained among those who visited for pain or extraction, and differences between Blacks and Whites remained among those who visited the public dental service. The next chapter investigated the extent to which individual-level and contextual-level characteristics contributed to differences between colour/race groups in the use of dental service after capital variation of each outcome was considered.

CHAPTER 7

The role of individual-level and contextual-level characteristics in the relationship between colour/race and dental service utilisation: a multilevel approach

7.1 Chapter overview

This chapter addresses the first and third objective of this thesis. Firstly, the association between colour/race and the three dental service utilisation outcomes were assessed again, but now using a multilevel approach. Secondly, it was investigated the extent to which individual-level and contextual-level characteristics contribute to differences between colour/race groups (Pardos and Blacks compared to Whites) in the same outcomes as previously described.

The chapter was divided into four parts. The first focused on the description of the sample, followed by the distribution of the outcomes according to contextual-level characteristics. The third and fourth parts showed the results of the multilevel analysis for each outcome. The third part focused on looking into the role of each contextual-level characteristics separately in multilevel models containing colour/race variable and the outcome. Finally, the fourth part focused on the results from the hierarchical approach conducted in the multilevel analysis.

7.2 Description of the sample

The individual-level data from the SB Brazil 2010 dataset was linked with contextual-level data by nesting each participant to their State Capital of residence. Considering complete case analysis for outcomes, colour/race, and covariates the final sample sizes were presented in Figure 7.1.

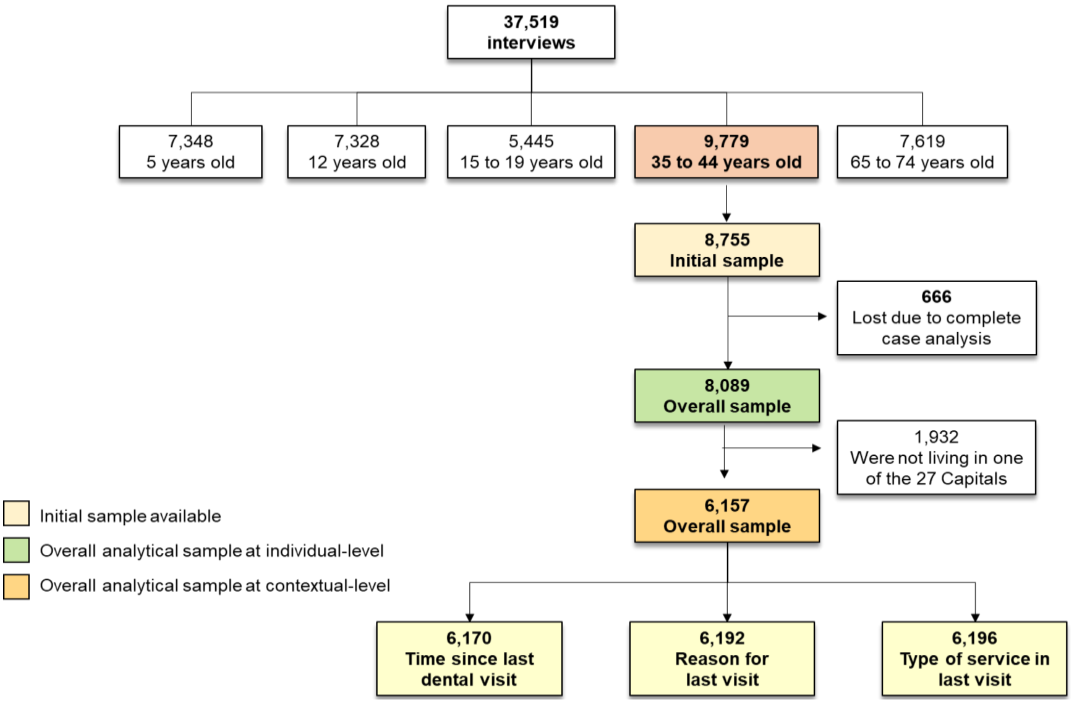

Figure 7-1 - Corresponding sample size from SB Brazil 2010 survey to the final sample used for the multilevel analysis of the present study.

Pearson's correlation coefficients between the contextual characteristics were calculated and presented in Table 7.1. Apart from the correlation between integration of oral health team into Family Health Program (OHT/FHP) and rate of dentist per population, all other correlations were highly statistically significant. The proportion of Pardos/Blacks from the 2010 Census was highly negatively correlated (-0.79) with the Human Development Index of the State Capitals and the rate of dentist per population (-0.72). These findings showed that the higher the proportion of Pardos and Blacks the lower the development of the Capital of residency, and the lower the rate of dentist per population. Another strong but positive correlation was observed between the Human Development Index and the rate of dentist per population (0.79), which shows that better developed State Capitals have more dentist per population.

Table 7-1 - Correlation between contextual-level characteristics.

	% Black and Pardos 2010	HDI 2010	Gini Coefficient 2010	% OHT/FHP 2010	Dentist / 100k population 2008
% Black and Pardos 2010	1.00				
HDI 2010	-0.76*	1.00			
Gini Coefficient 2010	0.37*	-0.27*	1.00		
% OHT/FHP 2010	0.17*	-0.10*	-0.28*	1.00	
Dentist / 100k population 2008	-0.69*	0.79*	-0.27*	0.03 [NS]	1.00

[NS] - Not statistically significant: **/** * p<0.001
HDI – Human Development Index / OHT/FHP - integration of oral health team into Family Health Program

7.3 Bivariate Analyses

7.3.1 Distribution of time since last dental visit according to contextual-level characteristics

Table 7.2 presents the distribution of the time since last dental visit according to contextual-level characteristics of the analytical sample for this outcome (n=6,170).

Overall, apart from OHT/FHP, the table showed strong evidence for the association between the investigated variables. The table shows that the higher the proportion of Pardos/Blacks in State Capitals and the higher the Gini coefficient, the higher the proportion of reporting visiting the dentist a year or more. In contrast, the higher the Human Development Index and the higher rate of dentist per population, the lower the report of last visit to the dentist a year or more ago.

Table 7-2 - Distribution of the time since last dental visit according to contextual-level characteristics of the 35-44-year-old sample of SB Brazil, 2010.

Variables	**< 1 year**		**≥ 1 year**	
	%	**95% CI**	**%**	**95% CI**
% Pardos and Blacks***				
Low	57.2	55.1 – 59.2	42.8	40.8 – 44.8
Moderate	52.2	50.0 – 54.5	47.8	45.5 – 50.0
High	46.6	44.4 – 48.8	53.4	51.2 – 55.6
HDI***				
Low	46.1	44.0 – 48.2	53.9	51.7 – 56.0
Moderate	52.4	50.2 – 54.5	47.6	45.5 – 49.8
High	59.2	56.9 – 61.3	40.8	38.6 – 43.1
Gini coefficient**				
Low	54.5	52.4 – 56.6	45.5	43.4 – 47.6
Moderate	52.2	50.1 – 54.3	47.8	45.7 – 49.8
High	49.6	47.3 – 51.9	50.4	48.1 – 52.6
OHT/FHP				
Low	50.6	48.5 – 52.7	49.4	47.3 – 51.5
Moderate	53.5	51.4 – 55.6	46.5	44.4 – 48.5
High	52.6	50.3 – 54.8	47.4	45.2 – 49.7
Dentist per population***				
Low	49.9	47.8 – 52.0	50.1	47.9 – 52.2
Moderate	48.7	46.5 – 50.1	51.3	49.1 – 53.3
High	59.0	56.7 – 61.2	41.0	38.7 – 43.2

p-value for trend *<0.05, **<0.01, ***<0.001
HDI – Human Development Index / OHT/FHP - integration of oral health team into Family Health Program

7.3.2 Distribution of reason for the last dental visit according to contextual-level characteristics

Table 7.3 presents the distribution of the reason for the last dental visit according to contextual-level characteristics of the analytical sample for this outcome (n=6,192).

For all categories of the contextual-level characteristics, there were a higher proportion of individuals reporting treatment as the reason to visit the dentist compared to prevention/check-up and pain or extraction. The table shows that the higher the proportion of Pardos/Blacks, the lower the proportion of visiting the dentist due to prevention/check-up and the higher the proportion of visiting the dentist due to pain or extraction. The opposite was observed for the Human Development Index and dentist per population.

Table 7-3 - Distribution of the reason for the last dental visit according to individual-level characteristics from the place of living of the 35-44-year-old sample of SB Brazil, 2010.

	Prevention/ check-up		**Pain or extraction**		**Treatment**	
Variables	**%**	**95% CI**	**%**	**95% CI**	**%**	**95% CI**
% Black and Pardos***						
Low	26.6	24.8 – 28.4	27.7	25.8 – 29.5	45.7	43.7 – 47.8
Moderate	22.2	20.4 – 24.1	31.6	29.5 – 33.7	46.2	43.9 – 48.4
High	18.8	17.2 – 20.6	36.4	34.3 – 38.5	44.8	42.6 – 47.0
HDI***						
Low	19.7	18.0 – 21.4	37.5	35.5 – 39.6	42.8	40.7 – 44.8
Moderate	20.0	18.3 – 21.8	29.7	27.8 – 31.7	50.3	48.1 – 52.4
High	29.3	27.3 – 31.4	27.1	25.1 – 29.1	43.6	41.4 – 45.8
Gini coefficient*						
Low	22.5	20.7 – 24.3	30.1	28.2 – 32.1	47.4	45.3 – 49.5
Moderate	24.0	22.2 – 25.8	32.6	30.6 – 34.5	43.4	41.3 – 45.5
High	21.5	19.7 – 23.4	32.6	30.5 – 34.7	45.9	43.6 – 48.2
OHT/FHP						
Low	21.9	20.2 – 23.7	31.3	29.3 – 33.3	46.8	44.6 – 48.9
Moderate	21.9	20.3 – 23.7	32.6	30.7 – 34.5	45.5	43.4 – 47.5
High	24.6	22.7 – 26.6	31.1	29.0 – 33.2	44.3	42.0 – 46.6
Dentist per population***						
Low	19.8	18.2 – 21.5	33.6	31.7 – 35.6	46.6	44.4 – 48.6
Moderate	20.0	18.4 – 21.7	33.9	31.9 – 35.9	46.1	44.0 – 48.2
High	29.4	27.3 – 31.5	26.8	24.9 – 28.9	43.8	41.5 – 46.0

[1] Pearson chi-square *<0.05, **<0.01, ***<0.001
HDI – Human Development Index / OHT/FHP - integration of oral health team into Family Health Program

7.3.3 Distribution of the type of service used in the last dental visit according to contextual-level characteristics

Table 7.4 presents the distribution of the type of service used in the last dental visit according to contextual-level characteristics of the analytical sample for this outcome (n=6,196).

For all the levels of the contextual characteristics investigated, the private dental service was the most reported. However, the table shows that the higher the proportion of Blacks and Pardos the higher the proportion of visits to public dental service. The same was observed for the higher proportion of OHT/FHP. In contrast, the higher the Human Development Index and the dentist per population, the lower the proportion of visits to public dental service.

Table 7-4 - Distribution of the type of service used in the last dental visit according to contextual-level characteristics from the place of living of the 35-44-year-old sample of SB Brazil, 2010.

Variables	Private Service		Public Service	
	%	95% CI	%	95% CI
% Black and Pardos***				
Low	64.7	62.7 – 66.7	35.3	33.3 – 37.2
Moderate	61.8	59.6 – 64.0	38.2	36.0 – 40.3
High	54.5	52.3 – 56.7	45.5	43.3 – 47.6
HDI***				
Low	53.6	51.5 – 55.7	46.4	44.3 – 48.4
Moderate	59.8	57.7 – 61.8	40.2	38.1 – 42.3
High	69.5	67.3 – 71.5	30.5	28.5 – 32.6
Gini coefficient				
Low	59.2	57.1 – 61.3	40.8	38.7 – 42.8
Moderate	61.0	58.9 – 63.0	39.0	37.0 – 41.0
High	61.5	59.3 – 63.7	38.5	36.3 – 40.7
OHT/FHP***				
Low	66.0	64.0 – 68.0	34.0	32.0 – 36.1
Moderate	61.3	59.2 – 63.3	38.7	36.7 – 40.7
High	53.4	51.1 – 55.7	46.6	44.3 – 48.8
Dentist per population***				
Low	59.2	57.1 – 61.2	40.8	38.7 – 42.9
Moderate	55.3	53.2 – 57.4	44.7	42.6 – 46.8
High	68.3	66.1 – 70.4	31.7	29.6 – 33.8

p-value for trend *<0.05, **<0.01, ***<0.001
HDI – Human Development Index / OHT/FHP - integration of oral health team into Family Health Program

7.4 Multilevel analysis

The multilevel analysis explored the relationship between Pardos and Blacks compared to Whites after accounting for the role of individual-level and contextual-level characteristics while considering the variation of each dental service utilisation outcome across the 27 Brazilian State Capitals.

7.4.1 Findings from multilevel analysis: the difference between Pardos and Blacks compared to Whites for the time since last dental visit

The final sample size for the time since last dental visit was 6,170 individuals nested in 27 State Capitals. The average number of individuals per capital was 228.5, with a minimum of 99 and a maximum of 405.

7.4.1.1 The role of each contextual-level characteristics in the relationship between colour/race and time since last dental visit independently from individual-level characteristics.

Table 7.5 shows that Pardos and Blacks were 1.36 (95% 1.21 – 1.52) and 1.39 (95% CI 1.16 – 1.66) times more likely than Whites, respectively, to last visit the dentist a year or more ago. However, after adjusting for all individual-level characteristics, the statistical differences between groups were fully explained. Further adjustment for each contextual-level characteristic did not change the estimates of Pardos and Blacks compared to Whites for the time since last dental visit.

Table 7-5 - Association between colour/race and time since last dental visit adjusted by each contextual-level characteristics, after considering the adjustment for all individual-level characteristics, in a sample of 35-44-year-old adults, Brazil, 2010.

	PARDOS		BLACKS	
	OR (95% CI)	**p-value**	**OR (95% CI)**	**p-value**
Unadjusted model				
(only with colour/race)	1.36 (1.21 – 1.52)	<0.001	1.39 (1.16 – 1.66)	<0.001
Further adjusted for:				
All individual-level characteristics	1.09 (0.96 – 1.23)	0.167	1.07 (0.89 – 1.30)	0.469
Further adjustment for each contextual-level characteristic				
% Black and Pardos	1.08 (0.95 – 1.22)	0.281	1.07 (0.88 – 1.30)	0.501
HDI	1.07 (0.95 – 1.22)	0.261	1.07 (0.88 – 1.30)	0.502
Gini coefficient	1.09 (0.96 – 1.23)	0.167	1.07 (0.89 – 1.31)	0.470
OHT/FHP	1.09 (0.96 – 1.23)	0.168	1.07 (0.89 – 1.30)	0.480
Dentist per population rate	1.08 (0.95 – 1.23)	0.206	1.07 0.88 – 1.30)	0.486

HDI – Human Development Index / OHT/FHP - integration of oral health team into Family Health Program

7.4.1.2 The association between colour/race and time since last dental visit while considering the adjustment for individual-level and contextual-level characteristics

The first model (model 1) presented in Table 7.6 showed that the odds of visiting the dentist a year or more in an 'average' capital was estimated as 0.93 (95% CI 0.82 – 1.05), but this difference was not statistically significant Additionally, although small, the between-capital variance showed statistically significant variation in the proportion of individuals who visited the dentist for a year or more. In this model, 2.6% of the residual variation in the probability to use dental service a year or more was attributable to unobserved characteristics at capital-level, which was calculated through the variance partition coefficient (VPC) (as 0.09/ (0.09+3.29) =0.026).

Model 2 showed that the odds of visiting the dentist for a year or more was 1.36 (95% CI 1.21 – 1.53) and 1.39 (95% CI 1.16 – 1.67) times higher for Pardos and Blacks, respectively, compared to Whites. The estimated variance between-capitals after including colour/race decreased from 0.09 to 0.07, suggesting that the distribution of the use of dental service between colour/race groups is different across capitals. Additionally, the inclusion of colour/race into the model also slightly reduced the percentage of the unexplained variance (from 2.5% to 2.2%).

The following model (Model 3), showed additional adjustments for individual-level characteristics. The adjustment for sex (Model 3a), did not affect the association between colour/race groups. Although Pardos and Blacks continued to be more likely to visit the dentist for a year or more compared to Whites, further adjustment for level of education (Model 3b) considerably attenuated the differences. Nevertheless, it was the further adjustment for income (Model 3c) that fully explained the differences between Blacks and Whites, and additionally reduced the differences between Pardos and Whites.

After additional adjustment for self-report satisfaction with teeth/mouth (Model 3d), the difference between Pardos and Whites became marginally significant, and the addition of self-reported pain and dental need fully explained the difference between those groups. In the final model (Model 3f), after further adjustments for all individual-level characteristics, no significant difference between Pardos (OR 1.09, 95% 0.96 – 1.23) and Blacks (OR 1.07, 95% CI 0.89 – 1.29) compared to Whites were observed on reporting a year or more since their last dental visit.

The inclusion of all the individual-level covariates had a minor effect on the between-capital variance when compared to the inclusion of colour/race (0.07 to 0.06). Still, these characteristics further reduced the percentage of the unexplained variance of the time since last dental visit (from 2.5%, in the null model, to 1.8% in the fully adjusted by individual-level characteristics).

Finally, the adjustments for contextual-level characteristics (Model 4), showed that none of these characteristics considerably change the estimates for Pardos and Blacks compared to Whites, and it continued to be non-statistically significant. These characteristics, however, continued to reduce the between-capital variance and the VPC. In the fully adjusted model (Model 4e), 1.4% of the residual variation in the probability to use dental service a year or more was attributable to unobserved characteristics at capital-level.

Table 7-6 - Association between colour/race and time since last dental visit adjusted by individual and contextual-level characteristics. Results of the multilevel analysis in a sample of 35-44-year-old in Brazil

		MODEL 1	MODEL 2	MODEL 3a	MODEL 3b	MODEL3c
Individual-level characteristics				**OR (95% CI)**		
Colour/race	Pardos		1.36 (1.21 – 1.53)***	1.36 (1.21 – 1.53)***	1.21 (1.07 – 1.36)**	1.16 (1.03 – 1.31)*
	Blacks		1.39 (1.16 – 1.67)***	1.37 (1.14 – 1.64)***	1.21 (1.01 – 1.46)*	1.13 (0.94 – 1.36)
Sex	Female			0.78 (0.70 – 0.87)***	0.78 (0.70 – 0.87)***	0.76 (0.68 – 0.85)***
Level of education (years)	5 – 8				0.92 (0.77 – 1.09)	0.95 (0.80 – 1.13)
	9 – 11				0.61 (0.52 – 0.72)***	0.68 (0.57 – 0.80)***
	≥12				0.39 (0.33 – 0.48)***	0.54 (0.44 – 0.65)***
Income (R$ - Reais)	501.00 – 1,500.00					1.01 (0.86 – 1.20)
	1,501.00 – 2,500.00					0.73 (0.60 – 0.89)**
	≥ 2,501.00					0.51 (0.41 – 0.64)***
Satisfaction with teeth/month	Neither					
	Not satisfy					
Dental pain	Yes					
Need for dental treatment	Yes					
Decayed teeth	Yes					
Missing teeth	Yes					
Filled teeth	Yes					
Constant		0.93 (0.82 – 1.05)	0.77 (0.67 – 0.88)***	0.91 (0.78 – 1.05)	1.49 (1.21 – 1.82)***	1.63 (1.28 – 2.07)***
Between-State Capitals variance (SE)		0.09 (0.03)**	0.07 (0.02)**	0.07 (0.02)**	0.07 (0.02)**	0.06 (0.02)**
% of unexplained variance (VPC)		2.5%	2.2%	2.1%	2.0%	1.8%

p-value *<0.05, **<0.01, ***<0.001 / OR – odds ratio / 95% CI – 95% Confidence Interval
Model 1: Null model; Model 2: Model 1 + colour/race; Model 3a – Model 2 + sex; Model 3b: Model 3a + education; Model 3c: Model 3b + income

Table 7-6 (continued). Association between colour/race and time since last dental visit adjusted by individual and contextual-level characteristics. Results of the multilevel analysis in a sample of 35-44 year-old in Brazil.

		MODEL 3d	**MODEL 3e**	**MODEL 3f**
Individual-level characteristics			**OR (95% CI)**	
Colour/race	Pardos	1.13 (1.00 – 1.27)*	1.10 (0.98 – 1.25)	1.09 (0.96 – 1.23)
	Blacks	1.10 (0.92 – 1.33)	1.10 (0.91 – 1.32)	1.07 (0.89 – 1.29)
Sex	Female	0.74 (0.66 – 0.82)***	0.76 (0.68 – 0.85)***	0.79 (0.70 – 0.88)***
Level of education	5 – 8	0.93 (0.79 – 1.11)	0.91 (0.76 – 1.08)	0.99 (0.83 – 1.18)
(years)	9 – 11	0.68 (0.57 – 0.80)***	0.66 (0.55 – 0.78)***	0.77 (0.65 – 0.93)**
	≥12	0.56 (0.46 – 0.68)***	0.55 (0.45 – 0.67)***	0.66 (0.54 – 0.81)***
Income	501.00 – 1,500.00	1.03 (0.87 – 1.22)	1.01 (0.86 – 1.20)	1.05 (0.88 – 1.24)
(R$ - Reais)	1,501.00 – 2,500.00	0.76 (0.62 – 0.92)**	0.75 (0.61 – 0.91)**	0.80 (0.65 – 0.97)*
	≥ 2,501.00	0.56 (0.45 – 0.70)***	0.55 (0.44 – 0.69)***	0.58 (0.47 – 0.73)***
Satisfaction with teeth/month	Neither	1.38 (1.19 – 1.61)***	1.27 (1.08 – 1.48)**	1.30 (1.11 – 1.52)***
	Not satisfy	1.70 (1.52 – 1.92)***	1.56 (1.38 – 1.78)***	1.54 (1.35 – 1.76)***
Dental pain	Yes		0.64 (0.56 – 0.73)***	0.62 (0.55 – 0.71)***
Need for dental treatment	Yes		1.77 (1.52 – 2.05)***	1.78 (1.53 – 2.08)***
Decayed teeth	Yes			1.18 (1.04 – 1.32)**
Missing teeth	Yes			0.82 (0.69 – 0.97)*
Filled teeth	Yes			0.47 (0.40 – 0.55)***
Constant		1.22 (0.95 – 1.57)	0.93 (0.71 – 1.23)	1.56 (1.13 – 2.15)**
Between-State Capitals variance (SE)		0.07 (0.02)**	0.07 (0.02)**	0.06 (0.02)**
% of unexplained variance (VPC)		2.0%	2.1%	1.8%

p-value *<0.05, **<0.01, ***<0.001 / OR – odds ratio / 95% CI – 95% Confidence Interval

Model 3d: Model 3c + satisfaction with own teeth/mouth; Model 3e: Mode 3d + self-reported need for treatment + self-reported dental pain; Model 3f: Model 3d + presence of decay teeth, missing teeth, filled teeth

Table 7-6 (continued): Association between colour/race and time since last dental visit adjusted by individual and contextual-level characteristics. Results of the multilevel analysis in a sample of 35-44 year-old in Brazil.

		MODEL 4a	**MODEL 4b**	**MODEL 4c**	**MODEL 4d**	**MODEL 4e**
Individual-level characteristics				**OR (95% CI)**		
Colour/race	Pardos	1.08 (0.95 – 1.22)	1.08 (0.95 – 1.22)	1.08 (0.95 – 1.22)	1.07 (0.95 – 1.22)	1.07 (0.95 – 1.22)
	Blacks	1.07 (0.88 – 1.29)	1.07 (0.88 – 1.29)	1.07 (0.88 – 1.29)	1.06 (0.88 – 1.29)	1.06 (0.88 – 1.29)
Sex	Female	0.79 (0.70 – 0.88)***	0.79 (0.70 – 0.88)***	0.79 (0.70 – 0.88)***	0.79 (0.70 – 0.88)***	0.79 (0.70 – 0.88)***
Level of education	5 – 8	0.99 (0.83 – 1.18)	0.99 (0.83 – 1.19)	0.99 (0.83 – 1.19)	0.99 (0.83 – 1.18)	0.99 (0.83 – 1.18)
(years)	9 – 11	0.77 (0.64 – 0.92)**	0.77 (0.64 – 0.92)**	0.77 (0.64 – 0.92)**	0.77 (0.64 – 0.92)**	0.77 (0.64 – 0.92)**
	≥12	0.65 (0.53 – 0.80)***	0.65 (0.53 – 0.80)***	0.65 (0.53 – 0.80)***	0.65 (0.53 – 0.80)***	0.65 (0.53 – 0.80)***
Income	501.00 – 1,500.00	1.05 (0.89 – 1.25)	1.05 (0.89 – 1.25)	1.05 (0.89 – 1.25)	1.05 (0.89 – 1.25)	1.05 (0.89 – 1.25)
(R$ - Reais)	1,501.00 – 2,500.00	0.80 (0.65 – 0.97)*	0.80 (0.65 – 0.98)*	0.80 (0.65 – 0.98)*	0.80 (0.65 – 0.98)*	0.80 (0.65 – 0.98)*
	≥ 2,501.00	0.59 (0.47 – 0.73)***	0.59 (0.47 – 0.74)***	0.59 (0.47 – 0.74)***	0.59 (0.47 – 0.73)***	0.59 (0.47 – 0.73)***
Satisfaction with teeth/month	Neither	1.30 (1.11 – 1.53)***	1.30 (1.11 – 1.52)***	1.30 (1.11 – 1.53)***	1.30 (1.11 – 1.52)***	1.30 (1.11 – 1.52)***
	Not satisfy	1.55 (1.36 – 1.76)***	1.55 (1.36 – 1.76)***	1.54 (1.35 – 1.76)***	1.54 (1.35 – 1.76)***	1.54 (1.35 – 1.76)***
Dental pain	Yes	0.62 (0.55 – 0.71)***	0.62 (0.55 – 0.71)***	0.62 (0.55 – 0.71)***	0.62 (0.55 – 0.71)***	0.62 (0.55 – 0.71)***
Need for dental treatment	Yes	1.78 (1.53 – 2.08)***	1.79 (1.53 – 2.09)***	1.79 (1.53 – 2.09)**	1.79 (1.53 – 2.09)***	1.79 (1.53 – 2.09)***
Decayed teeth	Yes	1.18 (1.04 – 1.32)**	1.17 (1.04 – 1.32)**	1.17 (1.04 – 1.32)**	1.17 (1.04 – 1.32)**	1.17 (1.04 – 1.32)**
Missing teeth	Yes	0.82 (0.69 – 0.97)*	0.81 (0.68 – 0.96)*	0.81 (0.68 – 0.96)*	0.81 (0.68 – 0.96)*	0.81 (0.68 – 0.96)*
Filled teeth	Yes	0.48 (0.41 – 0.56)***	0.48 (0.41 – 0.56)***	0.48 (0.41 – 0.56)***	0.48 (0.41 – 0.56)***	0.48 (0.41 – 0.56)***
Contextual-level characteristics						
% Black and Pardos	Moderate	1.02 (0.78 – 1.33)	0.92 (0.70 – 1.22)	0.91 (0.68 – 1.22)	0.93 (0.69 – 1.26)	0.97 (0.70 – 1.36)
	High	1.16 (0.88 – 1.52)	0.90 (0.61 – 1.31)	0.89 (0.61 – 1.31)	0.86 (0.58 – 1.28)	0.94 (0.59 – 1.50)
HDI	Moderate		0.81 (0.60 – 1.10)	0.80 (0.59 – 1.09)	0.78 (0.57 – 1.07)	0.78 (0.57 – 1.07)
	High		0.70 (0.48 – 1.03)	0.69 (0.47 – 1.02)	0.66 (0.44 – 0.98)*	0.66 (0.42 – 1.04)
Gini coefficient	Moderate			1.00 (0.77 – 1.30)	0.98 (0.75 – 1.28)	0.96 (0.72 – 1.28)
	High			1.05 (0.81 – 1.37)	0.98 (0.73 – 1.33)	0.97 (0.69 – 1.36)
OHT/FHP	Moderate				0.86 (0.64 – 1.16)	0.86 (0.64 – 1.16)
	High				0.91 (0.67 – 1.22)	0.90 (0.67 – 1.21)
Dentist per population rate	Moderate					1.09 (0.80 – 1.47)
	High					1.10 (0.77 – 1.58)
Constant		1.48 (1.04 – 2.11)*	2.00 (1.24 – 3.23)**	1.99 (1.22 – 3.23)**	2.29 (1.30 – 4.02)**	2.11 (1.13 – 3.92)*
Between-State Capitals variance (SE)		0.06 (0.02)**	0.05 (0.02)**	0.05 (0.02)**	0.05 (0.02)*	0.04 (0.02)*
% of unexplained variance (VPC)		1.7%	1.5%	1.5%	1.4%	1.4%

p-value *<0.05, **<0.01, ***<0.001 / OR – odds ratio / 95% CI – 95% Confidence Interval

Model 4a: Model 3c + % Black and Pardos; Model 4b: Model 4a + Human Development Index (HDI); Model 4c: Model 4b + Gini coefficient; Model 4d: Model 4c + Integration of oral health team into Family Health Program (OHT/FHP); Model 4e: Model 4d + dentist per population rate.

7.4.2 Findings from multilevel analysis: the difference between Pardos and Blacks compared to Whites for the reason to visit the dentist

The final sample size for the reason to visit the dentist was 6,192 individuals nested in 27 State Capitals. The average number of individuals per capital was 229.3, with a minimum of 100 and a maximum of 411.

7.4.2.1 The role of each contextual-level characteristics in the relationship between colour/race and reason to visit the dentist independently from individual-level characteristics.

The first part of Table 7.7 showed that Pardos and Blacks were 2.09 (95% CI 1.84 – 2.36) and 2.07 (95% CI 1.71 – 2.49) times more likely than Whites to visit the dentist due to pain or extraction, respectively. After adjusting for all individual-level characteristics, the differences between Blacks and Whites were fully explained; however, Pardos were still 1.26 (95% CI 1.11 – 1.43) times more likely to visit the dentist due to pain or extraction compared to Whites. Although some of the contextual-level characteristics slightly reduce the difference between Pardos and Whites, none fully explain the differences between Pardos and Whites in reporting visiting the dentist due to pain or extraction.

The second part of Table 7.7 also showed that colour/race was strongly associated with visiting the dentist for treatment. In the unadjusted model, Pardos and Blacks were 1.60 (95% CI 1.43 – 1.80) and 1.39 (95% CI 1.16 – 1.66) times more likely, respectively, to visit the dentist due to treatment compared to Whites. After adjusting for all individual-level characteristics, the differences between Blacks and Whites were fully explained; however, Pardos were still 1.21 (95% CI 1.08 – 1.37) times more likely to visit the dentist due to treatment compared to Whites. Again, none of the contextual-level characteristics alone fully explained the differences between colour/race groups in reporting visiting the dentist due to treatment.

Table 7-7 - Association between colour/race and reason to visit the dental service used adjusted by each contextual-level characteristic, after considering the adjustment for all individual-level characteristics, in a sample of 35-44-year-old adults, Brazil, 2010 (Multilevel multinomial logistic models).

	PARDOS		BLACKS	
	RRR (95% CI)	**p-value**	**RRR (95% CI)**	**p-value**
Pain or extraction				
Unadjusted model				
(only with colour/race)	2.09 (1.84 – 2.36)	<0.001	2.07 (1.71 – 2.49)	<0.001
Adjusted for				
all Individual-level characteristics	1.26 (1.11 – 1.43)	<0.001	1.15 (0.94 – 1.40)	0.168
Further adjustment for each contextual-level characteristic				
% Pardos and Blacks	1.24 (1.09 – 1.42)	0.001	1.15 (0.94 – 1.40)	0.172
HDI	1.23 (1.08 – 1.39)	0.002	1.12 (0.92 – 1.37)	0.257
Gini coefficient	1.25 (1.11 – 1.42)	<0.001	1.20 (0.99 – 1.47)	0.061
OHT/FHP	1.27 (1.12 – 1.45)	<0.001	1.15 (0.94 – 1.40)	0.161
Dentist per population rate	1.27 (1.12 – 1.44)	<0.001	1.16 (0.95 – 1.42)	0.129
Treatments				
Unadjusted model				
(only with colour/race)	1.60 (1.43 – 1.80)	<0.001	1.39 (1.16 – 1.66)	0.001
Adjusted for				
all Individual-level characteristics	1.21 (1.08 – 1.37)	0.001	1.04 (0.86 – 1.25)	0.701
Further adjustment for each contextual-level characteristic				
% Black and Pardos	1.21 (1.07 – 1.37)	0.002	1.04 (0.86 – 1.25)	0.678
HDI	1.22 (1.08 – 1.37)	0.001	1.02 (0.84 – 1.23)	0.834
Gini coefficient	1.21 (1.07 – 1.36)	0.002	1.07 (0.88 – 1.29)	0.493
OHT/FHP	1.22 (1.09 – 1.38)	<0.001	1.03 (0.85 – 1.24)	0.778
Dentist per population rate	1.20 (1.07 – 1.36)	0.003	1.04 (0.86 – 1.25)	0.672

RRR – relative risk ratio / 95% CI – 95% Confidence Interval
HDI – Human Development Index / OHT/FHP - integration of oral health team into Family Health Program

7.4.2.2 The association between colour/race and reason to visit the dentist while considering the adjustment for individual-level and contextual-level characteristics

Due to its multinomial nature, the results of the multilevel analysis for the reason to visit the dentist were presented in two tables. Table 7.8 presented the results of the two-level multinomial logistic analysis for the report of visiting the dentist due to pain or extraction, and Table 7.9 for the report of visiting the dentist due to treatment.

The first model (model 1) presented in Table 7.8 showed that the relative risk of visiting the dentist due to pain or extraction in an ‘average’ capital was estimated as 1.40 (95% CI 1.26 – 1.56) compared to visits for prevention/check-up. Additionally, the between-capital variance in the relative risk of visiting due to pain or extraction compared to preventive/check-up visits (Model 1) was estimated as 0.06 (with a standard error of 0.02), which showed a significant variation between capitals in the proportion of individuals who visited for this reason. Moreover, about 1.7% of the overall variance of visiting for this reason was attributed to characteristics at the State Capitals level.

The next model (Model 2) showed that Pardos and Blacks were 2.09 (95% 1.84 – 2.36) and 2.07 (95% CI 1.71 – 2.49) times more likely to visit the dentist due to pain or extraction compared to Whites, respectively. Again, the additional adjustment for sex (Model 3a) did not change the estimates for colour/race, but the subsequent adjustment for level of education and income considerably attenuated the differences between Pardos and Blacks compared to Whites. Overall, the further controlling for all individual-level covariates continued to reduce the estimates between colour/race groups, and the differences between Blacks and Whites were fully explained after the adjustment for all individual-level characteristics (Model 3f). Pardos, however, were still 1.26 (95% CI 1.11 – 1.43) times more likely to visit the dentist due to pain or extraction compared to Whites. Although the additional adjustment for contextual-level characteristics slightly reduced the estimates for Pardos compared to Whites, in the final model (Model 4e), Pardos remained more likely than Whites to visit the dentist due to pain or extraction (RRR 1.24, 95% 1.09 – 1.42).

The between-capital variance for this reason to visit the dentist significantly reduced after the inclusion of individual-level and contextual-level covariates. In the final model, the total variance of visiting the dentist due to pain or extraction was fully attributed to the characteristics investigated.

Table 7-8 - Association between colour/race and visits due to pain or extraction adjusted by individual and contextual-level characteristics. Results of the multilevel analysis in a sample of 35-44-year-old in Brazil.

Pain or Extraction		**MODEL 1** [1]	**MODEL 2** [1]	**MODEL 3a** [1]	**MODEL 3b** [1]	**MODEL 3c** [1]
Individual-level characteristics				**RRR (95% CI)**		
Colour/race	Pardos		2.09 (1.84 – 2.36)***	2.09 (1.85 – 2.37)***	1.56 (1.37 – 1.77)***	1.48 (1.31 – 1.68)***
	Blacks		2.07 (1.71 – 2.49)***	2.07 (1.72 – 2.50)***	1.64 (1.36 – 1.98)***	1.44 (1.19 – 1.75)***
Sex	Female			1.00 (0.90 – 1.13)	1.05 (0.93 – 1.17)	0.99 (0.88 – 1.11)
Level of education	5 – 8				0.81 (0.69 – 0.96)*	0.93 (0.79 – 1.11)
(years)	9 – 11				0.32 (0.27 – 0.38)***	0.42 (0.35 – 0.50)***
	≥12				0.13 (0.11 – 0.16)***	0.23 (0.19 – 0.29)***
Income	501.00 – 1,500.00					0.81 (0.69 – 0.96)*
(R$ - Reais)	1,501.00 – 2,500.00					0.41 (0.33 – 0.50)***
	≥ 2,501.00					0.29 (0.23 – 0.36)***
Satisfaction with	Neither					
teeth/month	Not satisfy					
Dental pain	Yes					
Need for dental treatment	Yes					
Decayed teeth	Yes					
Missing teeth	Yes					
Filled teeth	Yes					
Constant		1.40 (1.26 – 1.56)***	0.91 (0.81 – 1.04)	0.91 (0.78 – 1.05)	2.73 (2.24 – 3.34)***	3.74 (2.95 – 4.72)***
Between-State Capitals variance (SE)		0.06 (0.02)**	0.05 (0.02)*	0.04 (0.02)*	0.05 (0.02)*	0.04 (0.02)*
% of unexplained variance (VPC)		1.7%	1.4%	1.4%	1.5%	1.4%

p-value *<0.05, **<0.01, ***<0.001 / RRR – relative risk ratio / 95% CI – 95% Confidence Interval
Model 1: Null model; Model 2: Model 1 + colour/race; Model 3a – Model 2 + sex; Model 3b: Model 3a + education; Model 3c: Model 3b + income
[1] Iterations points to converge Model 1 to Model 3c was 20 (default), 38 was needed to converge Model 3d, 34 to Model 3e, and 26 to Model 3f

Table 7-8 - (continued). Association between colour/race and visits due to pain or extraction adjusted by individual and contextual-level characteristics. Results of the multilevel analysis in a sample of 35-44 year-old in Brazil.

Pain or Extraction		**MODEL 3d** [1]	**MODEL 3e** [1]	**MODEL 3f** [1]
Individual-level characteristics			**RRR (95% CI)**	
Colour/race	Pardos	1.37 (1.21 – 1.55)***	1.39 (1.22 – 1.57)***	1.26 (1.11 – 1.43)***
	Blacks	1.31 (1.08 – 1.58)**	1.23 (1.01 – 1.49)*	1.15 (0.94 – 1.40)
Sex	Female	0.88 (0.79 – 0.99)*	0.86 (0.77 – 0.97)*	0.89 (0.79 – 1.01)
Level of education (years)	5 – 8	0.84 (0.71 – 0.99)*	0.98 (0.82 – 1.16)	1.16 (0.97 – 1.39)
	9 – 11	0.41 (0.35 – 0.49)***	0.52 (0.44 – 0.62)***	0.72 (0.60 – 0.87)***
	≥12	0.24 (0.19 – 0.29)***	0.30 (0.24 – 0.37)***	0.50 (0.40 – 0.63)***
Income (R$ - Reais)	501.00 – 1,500.00	0.77 (0.65 – 0.90)**	0.82 (0.69 – 0.97)*	0.86 (0.72 – 1.02)
	1,501.00 – 2,500.00	0.40 (0.33 – 0.49)***	0.47 (0.38 – 0.57)***	0.55 (0.45 – 0.68)***
	≥ 2,501.00	0.36 (0.28 – 0.45)***	0.42 (0.33 – 0.54)***	0.59 (0.47 – 0.76)***
Satisfaction with teeth/month	Neither	2.31 (1.96 – 2.74)***	1.77 (1.49 – 2.09)***	1.81 (1.52 – 2.15)***
	Not satisfy	4.65 (4.09 – 5.29)***	3.25 (2.83 – 3.73)***	2.74 (2.38 – 3.16)***
Dental pain	Yes		3.95 (3.48 – 4.48)***	4.24 (3.72 – 4.84)***
Need for dental treatment	Yes		1.45 (1.23 – 1.72)***	1.13 (0.95 – 1.35)
Decayed teeth	Yes			2.17 (1.90 – 2.47)***
Missing teeth	Yes			2.52 (2.05 – 3.11)***
Filled teeth	Yes			0.32 (0.27 – 0.37)***
Constant		2.00 (1.57 – 2.56)***	0.99 (0.75 – 1.30)	0.61 (0.43 – 0.86)**
Between-State Capitals variance (SE)		0.04 (0.02)*	0.03 (0.01)*	0.01 (0.01)
% of unexplained variance (VPC)		1.3%	1.0%	0.2%

p-value *<0.05, **<0.01, ***<0.001 / RRR – relative risk ratio / 95% CI – 95% Confidence Interval

Model 3d: Model 3c + satisfaction with own teeth/mouth; Model 3e: Mode 3d + self-reported need for treatment + self-reported dental pain; Model 3f: Model 3d + presence of decay teeth, missing teeth, filled teeth

[1] Iterations points to converge Model 1 to Model 3c was 20 (default), 38 was needed to converge Model 3d, 34 to Model 3e, and 26 to Model 3f

Table 7-8 - (continued). Association between colour/race and visits due to pain or extraction adjusted by individual and contextual-level characteristics. Results of the multilevel analysis in a sample of 35-44 year-old in Brazil.

Pain or Extraction		**MODEL 4a**	**MODEL 4b**	**MODEL 4c**	**MODEL 4d**	**MODEL 4e**
Individual-level characteristics				**RRR (95% CI)**		
Colour/race	Pardos	1.25 (1.09 – 1.42)***	1.23 (1.08 – 1.41)**	1.22 (1.07 – 1.39)**	1.22 (1.07 – 1.39)**	1.24 (1.09 – 1.42)***
	Blacks	1.15 (0.94 – 1.40)	1.13 (0.93 – 1.38)	1.17 (0.96 – 1.43)	1.15 (0.94 – 1.41)	1.14 (0.94 – 1.39)
Sex	Female	0.89 (0.79 – 1.00)	0.89 (0.79 – 1.00)	0.89 (0.78 – 1.00)	0.88 (0.78 – 0.99)*	0.88 (0.78 – 0.99)*
Level of education (years)	5 – 8	1.16 (0.96 – 1.39)	1.18 (0.98 – 1.41)	1.17 (0.97 – 1.40)	1.14 (0.95 – 1.36)	1.14 (0.95 – 1.37)
	9 – 11	0.71 (0.59 – 0.86)***	0.73 (0.60 – 0.87)***	0.72 (0.60 – 0.87)***	0.69 (0.58 – 0.83)***	0.69 (0.57 – 0.83)***
	≥12	0.49 (0.40 – 0.62)***	0.49 (0.39 – 0.61)***	0.48 (0.39 – 0.60)***	0.46 (0.37 – 0.58)***	0.45 (0.36 – 0.56)***
Income (R$ - Reais)	501.00 – 1.500.00	0.87 (0.73 – 1.04)	0.89 (0.74 – 1.05)	0.89 (0.75 – 1.06)	0.90 (0.75 – 1.07)	0.89 (0.75 – 1.07)
	1.501.00 – 2.500.00	0.56 (0.45 – 0.69)***	0.56 (0.46 – 0.70)***	0.57 (0.46 – 0.70)***	0.57 (0.46 – 0.70)***	0.57 (0.46 – 0.70)***
	≥ 2.501.00	0.60 (0.47 – 0.76)***	0.63 (0.49 – 0.80)***	0.62 (0.49 – 0.79)***	0.64 (0.50 – 0.81)***	0.64 (0.51 – 0.82)***
Satisfaction with teeth/month	Neither	1.81 (1.52 – 2.15)***	1.82 (1.53 – 2.17)***	1.84 (1.55 – 2.19)***	1.84 (1.54 – 2.18)***	1.84 (1.55 – 2.19)***
	Not satisfy	2.73 (2.37 – 3.15)***	2.77 (2.40 – 3.19)***	2.85 (2.47 – 3.29)***	2.89 (2.51 – 3.33)***	2.93 (2.54 – 3.38)***
Dental pain	Yes	4.29 (3.76 – 4.89)***	4.35 (3.81 – 4.97)***	4.33 (3.79 – 4.94)***	4.45 (3.90 – 5.08)***	4.56 (4.00 – 5.21)***
Need for dental treatment	Yes	1.12 (0.94 – 1.34)	1.13 (0.95 – 1.35)	1.14 (0.95 – 1.36)	1.12 (0.94 – 1.34)	1.11 (0.93 – 1.33)
Decayed teeth	Yes	2.15 (1.88 – 2.45)***	2.14 (1.87 – 2.44)***	2.13 (1.87 – 2.44)***	2.16 (1.89 – 2.46)***	2.21 (1.93 – 2.52)***
Missing teeth	Yes	2.53 (2.05 – 3.12)***	2.53 (2.05 – 3.12)***	2.49 (2.02 – 3.07)***	2.51 (2.04 – 3.10)***	2.49 (2.02 – 3.07)***
Filled teeth	Yes	0.32 (0.27 – 0.37)***	0.31 (0.27 – 0.36)***	0.31 (0.26 – 0.36)***	0.30 (0.26 – 0.35)***	0.30 (0.26 – 0.35)***
Contextual-level characteristics						
% Black and Pardos	Moderate	0.93 (0.78 – 1.10)	0.82 (0.69 – 0.98)*	0.93 (0.77 – 1.11)	1.08 (0.89 – 1.30)	0.98 (0.80 – 1.20)
	High	1.13 (0.95 – 1.34)	1.04 (0.82 – 1.33)	1.12 (0.88 – 1.42)	1.22 (0.96 – 1.55)	1.07 (0.83 – 1.39)
HDI	Moderate		1.20 (0.99 – 1.46)	1.27 (1.05 – 1.54)*	1.35 (1.11 – 1.63)**	1.32 (1.09 – 1.60)**
	High		0.85 (0.67 – 1.08)	0.91 (0.72 – 1.15)	0.92 (0.72 – 1.16)	0.79 (0.61 – 1.03)
Gini coefficient	Moderate			0.87 (0.74 – 1.01)	0.78 (0.66 – 0.92)**	0.82 (0.69 – 0.97)*
	High			0.69 (0.59 – 0.81)***	0.57 (0.47 – 0.70)***	0.62 (0.50 – 0.76)***
OHT/FHP	Moderate				0.84 (0.70 – 1.01)	0.83 (0.70 – 0.99)*
	High				0.67 (0.56 – 0.81)***	0.67 (0.56 – 0.80)***
Dentist per population rate	Moderate					0.84 (0.71 – 0.98)*
	High					1.03 (0.83 – 1.27)
Constant		0.60 (0.42 – 0.85)**	0.62 (0.41 – 0.94)*	0.68 (0.45 – 1.02)	0.85 (0.54 – 1.32)	0.97 (0.61 – 1.52)
Between-State Capitals variance (SE)		0.01 (0.01)	<0.01 (<0.01)	<0.01 (<0.01)	<0.01 (<0.01)	-
% of unexplained variance (VPC)		0.2%	0.1%	<0.09	<0.06	-

p-value *<0.05, **<0.01, ***<0.001 / RRR – relative risk ratio / 95% CI – 95% Confidence Interval / Model 4a: Model 3c + % Black and Pardos; Model 4b: Model 4a + Human Development Index (HDI); Model 4c: Model 4b + Gini coefficient; Model 4d: Model 4c + Integration of oral health team into Family Health Program (OHT/FHP); Model 4e: Model 4d + dentist per population rate

The results presented in the second table (Table 7.9) showed that the between-capital variance of the visits due to treatment (Model 1) was 0.05 (with a standard error of 0.02). Moreover, 1.5% of the overall variation of visiting for treatment was attributed to characteristics operating at the capital level.

After including colour/race into the model (Model 2), Pardos and Blacks were 1.60 (95% CI 1.43 – 1.80) and 1.39 (95% CI 1.16 – 1.66) times more likely, respectively, to visit due to treatment compared to Whites. Again, the adjustment for sex (Model 3a), did not affect the association. This time, the further inclusion of level of education and income fully explained the difference between Black and White; however, Pardos were still more likely to visit the dentist due to treatment compared to Whites. Moreover, the further adjustments for and self-reported satisfaction with teeth/mouth (Model 3d), self-reported dental pain and need for dental treatment (Model 3e), and presence of decayed, missing, and filled teeth (Model 3f) continued to reduce the differences between Pardos and Whites. Nevertheless, after controlling for all individual-level characteristics, Pardos were 1.21 (95% CI 1.08 – 1.37) times more likely than Whites to visit the dentist treatment. The additional adjustment for contextual-level characteristics did not affect the association, and in the final model (Model 4e), Pardos remained more likely than Whites to visit the dentist due to treatment (RRR 1.21, 95% 1.07 – 1.36).

The inclusion of the individual and contextual-level characteristics significantly reduce the between-capital variance for this reason to visit the dentist (0.05 to <0.01). The final model showed that only 0.07% of the remaining variation for this comparison was attributed to characteristics at capital-level.

Table 7-9 - Association between colour/race and visits due to treatment adjusted by individual and contextual-level characteristics. Results of the multilevel analysis in a sample of 35-44-year-old in Brazil.

Treatment		**MODEL 1** [1]	**MODEL 2** [1]	**MODEL 3a** [1]	**MODEL 3b** [1]	**MODEL 3c** [1]
Individual-level characteristics				**OR (95% CI)**		
Colour/race	Pardos		1.60 (1.43 – 1.80)***	1.61 (1.43 – 1.80)***	1.40 (1.25 – 1.58)***	1.35 (1.20 – 1.52)***
	Blacks		1.39 (1.16 – 1.66)***	1.39 (1.16 – 1.67)***	1.28 (1.07 – 1.53)**	1.17 (0.98 – 1.40)
Sex	Female			1.01 (0.90 – 1.12)	1.03 (0.93 – 1.15)	1.00 (0.89 – 1.11)
Level of education (years)	5 – 8				1.15 (0.97 – 1.37)	1.26 (1.07 – 1.50)**
	9 – 11				0.71 (0.60 – 0.84)***	0.83 (0.70 – 0.99)*
	≥12				0.47 (0.40 – 0.57)***	0.67 (0.56 – 0.82)***
Income (R$ - Reais)	501.00 – 1,500.00					1.06 (0.90 – 1.25)
	1,501.00 – 2,500.00					0.67 (0.55 – 0.81)***
	≥ 2,501.00					0.55 (0.45 – 0.68)***
Satisfaction with teeth/month	Neither					
with teeth/month	Not satisfy					
Dental pain	Yes					
Need for dental treatment	Yes					
Decayed teeth	Yes					
Missing teeth	Yes					
Filled teeth	Yes					
Constant		2.02 (1.83 – 2.23)***	1.58 (1.40 – 1.78)***	1.56 (1.36 – 1.80)***	2.32 (1.90 – 2.82)***	2.45 (1.94 – 3.09)***
Between-State Capitals variance (SE)		0.05 (0.02)**	0.05 (0.02)**	0.05 (0.02)**	0.05 (0.02)**	0.04 (0.02)**
% of unexplained variance (VPC)		1.5%	1.5%	1.5%	1.4%	1.3%

p-value *<0.05. **<0.01. ***<0.001 / RRR – relative risk ratio / 95% CI – 95% Confidence Interval

Model 1: Null model; Model 2: Model 1 + colour/race; Model 3a – Model 2 + sex; Model 3b: Model 3a + education; Model 3c: Model 3b + income

[1] Iterations points to converge Model 1 to Model 3c was 20 (default), 38 was needed to converge Model 3d, 34 to Model 3e, and 26 to Model 3f

Table 7-9 (continued): Association between colour/race and visits due to treatment adjusted by individual and contextual-level characteristics. Results of the multilevel analysis in a sample of 35-44-year-old in Brazil.

Treatment		**MODEL 3d**[1]	**MODEL 3e**[1]	**MODEL 3f**[1]
Individual-level characteristics			**RRR (95% CI)**	
Colour/race	Pardos	1.27 (1.13 – 1.43)***	1.25 (1.11 – 1.41)***	1.21 (1.08 – 1.37)***
	Blacks	1.09 (0.91 – 1.31)	1.05 (0.87 – 1.26)	1.04 (0.86 – 1.25)
Sex	Female	0.93 (0.83 – 1.03)	0.97 (0.87 – 1.08)	0.94 (0.84 – 1.05)
Level of education (years)	5 – 8	1.17 (0.98 – 1.38)	1.27 (1.06 – 1.51)**	1.26 (1.05 – 1.50)*
	9 – 11	0.82 (0.69 – 0.97)*	0.95 (0.80 – 1.13)	0.94 (0.79 – 1.13)
	≥12	0.68 (0.56 – 0.82)***	0.79 (0.65 – 0.96)*	0.86 (0.70 – 1.05)
Income (R$ - Reais)	501.00 – 1,500.00	1.01 (0.86 – 1.19)	1.05 (0.89 – 1.24)	1.04 (0.87 – 1.23)
	1,501.00 – 2,500.00	0.66 (0.54 – 0.79)***	0.71 (0.58 – 0.86)***	0.73 (0.60 – 0.89)**
	≥ 2,501.00	0.60 (0.49 – 0.74)***	0.64 (0.52 – 0.80)***	0.74 (0.60 – 0.93)**
Satisfaction with teeth/month	Neither	1.60 (1.39 – 1.86)***	1.33 (1.15 – 1.55)***	1.28 (1.10 – 1.49)**
with teeth/month	Not satisfy	2.39 (2.13 – 2.68)***	1.92 (1.69 – 2.17)***	1.69 (1.48 – 1.92)***
Dental pain	Yes		1.24 (1.09 – 1.41)***	1.23 (1.08 – 1.40)***
Need for dental treatment	Yes		1.80 (1.56 – 2.07)***	1.51 (1.31 – 1.75)***
Decayed teeth	Yes			1.48 (1.31 – 1.66)***
Missing teeth	Yes			1.99 (1.69 – 2.33)***
Filled teeth	Yes			1.44 (1.23 – 1.69)***
Constant		1.88 (1.48 – 2.40)***	1.09 (0.84 – 1.42)	0.43 (0.31 – 0.59)***
Between-State Capitals variance (SE)		0.04 (0.02)**	0.04 (0.01)*	0.03 (0.01)*
% of unexplained variance (VPC)		1.3%	1.2%	1.0%

p-value *<0.05, **<0.01, ***<0.001 / RRR – relative risk ratio / 95% CI – 95% Confidence Interval

Model 3d: Model 3c + satisfaction with own teeth/mouth; Model 3e: Mode 3d + self-reported need for treatment + self-reported dental pain; Model 3f: Model 3d + presence of decay teeth, missing teeth, filled teeth

[1] Iterations points to converge Model 1 to Model 3c was 20 (default), 38 was needed to converge Model 3d, 34 to Model 3e, and 26 to Model 3f

Table 7-9 (continued): Association between colour/race and visits due to treatment adjusted by individual and contextual-level characteristics. Results of the multilevel analysis in a sample of 35-44-year-old in Brazil.

Treatment		**MODEL 4a**	**MODEL 4b**	**MODEL 4c**	**MODEL 4d**	**MODEL 4e**
Individual-level characteristics				**RRR (95% CI)**		
Colour/race	Pardos	1.21 (1.07 – 1.37)**	1.21 (1.07 – 1.37)***	1.20 (1.06 – 1.35)**	1.20 (1.06 – 1.36)**	1.21 (1.07 – 1.36)**
	Blacks	1.04 (0.86 – 1.25)	1.02 (0.84 – 1.23)	1.04 (0.86 – 1.26)	1.02 (0.85 – 1.24)	1.02 (0.85 – 1.23)
Sex	Female	0.94 (0.84 – 1.05)	0.94 (0.84 – 1.05)	0.93 (0.83 – 1.04)	0.93 (0.83 – 1.04)	0.93 (0.83 – 1.04)
Level of education (years)	5 – 8	1.26 (1.05 – 1.51)*	1.27 (1.06 – 1.53)**	1.27 (1.06 – 1.52)**	1.23 (1.03 – 1.48)*	1.24 (1.04 – 1.49)*
	9 – 11	0.94 (0.78 – 1.12)	0.95 (0.80 – 1.14)	0.95 (0.79 – 1.14)	0.91 (0.76 – 1.09)	0.90 (0.75 – 1.08)
	≥12	0.85 (0.70 – 1.05)	0.84 (0.68 – 1.03)	0.83 (0.68 – 1.02)	0.80 (0.65 – 0.98)*	0.79 (0.64 – 0.97)*
Income (R$ - Reais)	501.00 – 1.500.00	1.05 (0.89 – 1.25)	1.08 (0.91 – 1.28)	1.08 (0.91 – 1.29)	1.09 (0.92 – 1.30)	1.09 (0.92 – 1.29)
	1.501.00 – 2.500.00	0.74 (0.60 – 0.90)**	0.75 (0.62 – 0.92)**	0.76 (0.62 – 0.92)**	0.76 (0.62 – 0.93)**	0.76 (0.62 – 0.93)**
	≥ 2.501.00	0.75 (0.61 – 0.94)*	0.79 (0.63 – 0.99)*	0.79 (0.63 – 0.98)*	0.80 (0.64 – 0.99)*	0.80 (0.64 – 1.00)
Satisfaction with teeth/month	Neither	1.28 (1.10 – 1.50)**	1.29 (1.11 – 1.51)***	1.30 (1.11 – 1.51)***	1.28 (1.10 – 1.50)**	1.28 (1.10 – 1.50)***
	Not satisfy	1.68 (1.48 – 1.91)***	1.70 (1.49 – 1.93)***	1.74 (1.53 – 1.98)***	1.76 (1.54 – 2.00)***	1.78 (1.56 – 2.02)***
Dental pain	Yes	1.24 (1.09 – 1.42)***	1.25 (1.10 – 1.42)***	1.25 (1.09 – 1.42)***	1.27 (1.12 – 1.45)***	1.30 (1.14 – 1.48)***
Need for dental treatment	Yes	1.51 (1.30 – 1.74)***	1.51 (1.31 – 1.75)***	1.52 (1.31 – 1.76)***	1.50 (1.30 – 1.74)***	1.49 (1.29 – 1.73)***
Decayed teeth	Yes	1.47 (1.31 – 1.65)***	1.46 (1.30 – 1.65)***	1.46 (1.30 – 1.64)***	1.47 (1.31 – 1.65)***	1.49 (1.33 – 1.68)***
Missing teeth	Yes	1.99 (1.69 – 2.34)***	1.99 (1.69 – 2.34)***	1.97 (1.68 – 2.32)***	1.98 (1.68 – 2.33)***	1.98 (1.68 – 2.33)***
Filled teeth	Yes	1.44 (1.23 – 1.69)***	1.40 (1.19 – 1.64)***	1.37 (1.17 – 1.61)***	1.35 (1.15 – 1.58)***	1.35 (1.15 – 1.59)***
Contextual-level characteristics						
% Black and Pardos	Moderate	0.94 (0.75 – 1.16)	0.86 (0.70 – 1.06)	0.95 (0.77 – 1.18)	1.13 (0.93 – 1.38)	1.02 (0.83 – 1.24)
	High	1.08 (0.86 – 1.35)	1.18 (0.89 – 1.57)	1.25 (0.94 – 1.65)	1.29 (1.00 – 1.66)*	1.09 (0.84 – 1.41)
HDI	Moderate		1.52 (1.21 – 1.91)***	1.60 (1.27 – 2.02)***	1.64 (1.33 – 2.01)***	1.73 (1.43 – 2.09)***
	High		1.06 (0.79 – 1.40)	1.11 (0.84 – 1.47)	1.05 (0.81 – 1.35)	1.10 (0.85 – 1.42)
Gini coefficient	Moderate			0.90 (0.75 – 1.09)	0.79 (0.66 – 0.94)**	0.83 (0.70 – 0.99)*
	High			0.73 (0.61 – 0.89)**	0.56 (0.45 – 0.68)***	0.56 (0.46 – 0.69)***
OHT/FHP	Moderate				0.71 (0.58 – 0.86)***	0.72 (0.60 – 0.85)***
	High				0.60 (0.49 – 0.73)***	0.62 (0.52 – 0.74)***
Dentist per population rate	Moderate					0.82 (0.69 – 0.97)*
	High					0.76 (0.62 – 0.93)**
Constant		0.43 (0.31 – 0.60)***	0.36 (0.24 – 0.54)***	0.38 (0.25 – 0.58)***	0.58 (0.37 – 0.89)*	0.68 (0.44 – 1.04)
Between-State Capitals variance (SE)		0.03 (0.01)*	0.02 (0.01)	0.02 (0.01)	0.01 (<0.01)	<0.01 (<0.01)
% of unexplained variance (VPC)		0.1%	0.5%	0.5%	0.2%	0.07%

p-value *<0.05, **<0.01, ***<0.001 / RRR – relative risk ratio / 95% CI – 95% Confidence Interval / Model 4a: Model 3c + % Black and Pardos; Model 4b: Model 4a + Human Development Index (HDI) ; Model 4c: Model 4b + Gini coefficient; Model 4d: Model 4c + Integration of oral health team into Family Health Program (OHT/FHP); Model 4e: Model 4d + dentist per population rate

7.4.3 Findings from multilevel analysis: the difference between Pardos and Blacks compared to Whites for the type of service used in the last dental visit

The final sample size for this outcome was 6,196 individuals nested in 27 State Capitals. The average number of individuals per capital was 229.5, with a minimum of 100 and a maximum of 410.

7.4.3.1 The role of each contextual-level characteristics in the relationship between colour/race and type of service used independently from individual-level characteristics.

Table 7.10 shows that colour/race was strongly associated with the type of service used in the unadjusted model. Pardos and Blacks were 1.74 (95% 1.54 – 1.97) and 2.41 (95% CI 2.00 – 2.90) times more likely, respectively, than Whites to visit the public dental service compared to Whites.

Table 7-10 - Association between colour/race and type of dental service used adjusted by each contextual-level characteristic, after considering the adjustment for all individual-level characteristics, in a sample of 35-44-year-old adults, Brazil, 2010. (Multilevel binary logistic models)

	PARDOS		**BLACKS**	
	OR (95% CI)	**p-value**	**OR (95% CI)**	**p-value**
Unadjusted model				
(only with colour/race)	1.74 (1.54 – 1.97)	<0.001	2.41 (2.00 – 2.90)	<0.001
Adjusted for				
all Individual-level characteristics	1.25 (1.11 – 1.45)	0.001	1.72 (1.41 – 2.10)	<0.001
Further adjustment for each contextual-level characteristic				
% Black and Pardos	1.26 (1.10 – 1.44)	0.001	1.71 (1.40 – 2.10)	<0.001
HDI	1.25 (1.09 – 1.43)	0.001	1.71 (1.40 – 2.09)	<0.001
Gini coefficient	1.27 (1.11 – 1.45)	<0.001	1.73 (1.41 – 2.11)	<0.001
OHT/FHP	1.26 (1.10 – 1.44)	0.001	1.72 (1.40 – 2.10)	<0.001
Dentist per population rate	1.26 (1.10 – 1.44)	0.001	1.71 (1.40 – 2.10)	<0.001

RRR – relative risk ratio / 95% CI – 95% Confidence Interval
HDI – Human Development Index / OHT/FHP - integration of oral health team into Family Health Program

After accounting for all individual-level characteristics, the inequalities persisted between colour/race groups, but estimates were reduced. Pardos and Blacks were now 1.27 (95% CI 1.11 – 1.45) and 1.72 (95% CI 1.41 – 2.10) times more likely, respectively, to visit the public dental service compared to Whites. After the adjustments for all individual-level characteristics, the contextual-level characteristics, individually, did not affect the relationship between colour/race groups and the type of service used.

7.4.3.2 The association between colour/race and type of service used while considering the adjustment for individual-level and contextual-level characteristics

The results presented in Table 7.11 showed that in the first model (Model 1) the odds of visiting the public dental service in an 'average' capital was estimated as 0.64 (95% CI 0.53 – 0.76) compared to visits in private dental service. Moreover, a residual variation of 6.0% in the odds of using the public dental serviced was attributed to characteristics operating at the capital level.

Model 2 shows that Pardos and Blacks were 1.74 (OR 1.74, 95% CI 1.54 – 1.97) and 2.41 (OR 2.41, 95% CI 2.00 – 2.90) times more likely than Whites to visit the public dental service, respectively. The between-capital variance of the type of service used did not change compared to the previous model, which suggests that the distribution of colour/race groups among those who reported visiting the public dental service was similar across capitals.

The following model (Model 3), showed additional adjustments for individual-level characteristics. The adjustment for sex (Model 3a) did not affect the association between colour/race groups and the outcome. In contrast, the further adjustment for level of education (Model 3b), and income (Model 3c) considerably attenuated the differences between colour/race groups. The further adjustment for self-reported satisfaction with teeth/mouth (Model 3d) did not affect the estimates but controlling for self-reported dental pain and need for dental treatment (Model 3e), and presence of decayed, missing, and filled teeth (Model 3f) continued to reduce the differences between colour/race groups. In the final model, after the adjustments for all individual-level characteristics, Pardos and Blacks were 1.26 (OR 1.26, 95% CI 1.11 – 1.45) and 1.72 (OR 1.72, 95% CI 1.41 – 2.10), respectively, more likely to report to visit a public dental service compared to Whites.

The further adjustment for contextual-level characteristics (Model 4), showed that only the covariates related to the service itself (integration of oral health team into the Family Health Program and dentist per population rate) attenuated the difference between groups. However, the inequalities persisted, and after the adjustment for all individual and contextual-level characteristics, Pardos and Blacks were 1.24 (OR 1.24, 95% CI 1.08 – 1.42) and 1.69 (OR 1.69, 95% CI 1.38 – 2.07) more likely to visit the public dental service compared to Whites.

Furthermore, the inclusion of the individual-level predictors explained away relatively more the variation within-capitals then the variation between-capitals. This can be observed by the increase of the between-capitals variance, and the VPC. In contrast, the contextual-level characteristics significantly reduced between-capital variance for the use of public dental service, and in the final model, only 1.9% of the total variance in the use of public dental service remained attributed to characteristics operating at the capital level.

Table 7-11 - Association between colour/race and type of service used adjusted by individual and contextual-level characteristics. Results of the multilevel analysis in a sample of 35-44-year-old in Brazil.

		MODEL 1	MODEL 2	MODEL 3a	MODEL 3b	MODEL 3c
Individual-level characteristics				**OR (95% CI)**		
Colour/race	Pardos		1.74 (1.54 – 1.97)***	1.74 (1.53 – 1.97)***	1.42 (1.25 – 1.61)***	1.31 (1.15 – 1.50)***
	Blacks		2.41 (2.00 – 2.90)***	2.45 (2.03 – 2.96)***	2.03 (1.67 – 2.47)***	1.78 (1.46 – 2.18)***
Sex	Female			1.31 (1.17 – 1.47)***	1.36 (1.21 – 1.53)***	1.30 (1.15 – 1.47)***
Level of education (years)	5 – 8				0.67 (0.56 – 0.79)***	0.74 (0.62 – 0.88)***
	9 – 11				0.38 (0.32 – 0.46)***	0.49 (0.41 – 0.58)***
	≥12				0.16 (0.13 – 0.19)***	0.30 (0.24 – 0.37)***
Income (R$ - Reais)	501.00 – 1.500.00					0.67 (0.56 – 0.80)***
	1.501.00 – 2.500.00					0.37 (0.30 – 0.45)***
	≥ 2.501.00					0.14 (0.11 – 0.19)***
Satisfaction with	Neither					
teeth/month	Not satisfy					
Dental pain	Yes					
Need for dental treatment	Yes					
Decayed teeth	Yes					
Missing teeth	Yes					
Filled teeth	Yes					
Constant		0.64 (0.53 – 0.76)***	0.43 (0.36 – 0.53)***	0.36 (0.29 - .0.45)***	0.94 (0.72 – 1.23)	1.54 (1.15 – 2.07)**
Between-State Capitals variance (SE)		0.21 (0.06)***	0.21 (0.06)***	0.21 (0.06)***	0.24 (0.07)***	0.23 (0.07)***
% of unexplained variance (VPC)		6.0%	6.0%	6.1%	6.8%	6.6%

p-value *<0.05. **<0.01. ***<0.001 / OR – odds ratio / 95% CI – 95% Confidence Interval
Model 1: Null model; Model 2: Model 1 + colour/race; Model 3a – Model 2 + sex; Model 3b: Model 3a + education; Model 3c: Model 3b + income

Table 7-11 (continued): Association between colour/race and type of service used adjusted by individual and contextual-level characteristics. Results of the multilevel analysis in a sample of 35-44-year-old in Brazil.

		MODEL 3d	MODEL 3e	MODEL 3f
Individual-level characteristics			**OR (95% CI)**	
Colour/race	Pardos	1.30 (1.14 – 1.49)***	1.28 (1.12 – 1.47)***	1.26 (1.11 – 1.45)***
	Blacks	1.78 (1.46 – 2.17)***	1.74 (1.42 – 2.13)***	1.72 (1.41 – 2.10)***
Sex	Female	1.28 (1.14 – 1.45)***	1.27 (1.12 – 1.44)***	1.31 (1.16 – 1.48)***
	5 – 8	0.73 (0.61 – 0.87)***	0.75 (0.62 – 0.89)***	0.78 (0.65 – 0.94)**
Level of education (years)	9 – 11	0.49 (0.41 – 0.58)***	0.50 (0.42 – 0.60)***	0.56 (0.46 – 0.67)***
	≥12	0.30 (0.25 – 0.38)***	0.32 (0.26 – 0.40)***	0.37 (0.30 – 0.46)***
	501.00 – 1.500.00	0.68 (0.57 – 0.80)***	0.68 (0.57 – 0.81)***	0.69 (0.58 – 0.82)***
Income (R$ - Reais)	1.501.00 – 2.500.00	0.37 (0.30 – 0.46)***	0.39 (0.32 – 0.48)***	0.41 (0.33 – 0.50)***
	≥ 2.501.00	0.15 (0.11 – 0.19)***	0.16 (0.12 – 0.20)***	0.16 (0.13 – 0.21)***
Satisfaction with teeth/mouth	Neither	1.22 (1.04 – 1.45)*	1.09 (0.92 – 1.29)	1.09 (0.92 – 1.30)
	Not satisfy	1.24 (1.09 - 1.41)***	1.04 (0.91 – 1.19)	1.00 (0.87 – 1.15)
Dental pain	Yes		1.44 (1.26 – 1.64)***	1.40 (1.23 – 1.61)***
Need for dental treatment	Yes		1.43 (1.21 – 1.69)***	1.37 (1.16 – 1.63)***
Decayed teeth	Yes			1.23 (1.08 – 1.40)***
Missing teeth	Yes			1.04 (0.85 – 1.26)
Filled teeth	Yes			0.69 (0.59 – 0.81)***
Constant		1.35 (1.00 – 1.84)	0.98 (0.70 – 1.36)	1.05 (0.72 – 1.53)
Between-State Capitals variance (SE)		0.23 (0.07)***	0.24 (0.07)***	0.22 (0.07)***
% of unexplained variance (VPC)		6.7%	6.7%	6.3%

p-value *<0.05, **<0.01, ***<0.001 / OR – odds ratio / 95% CI – 95% Confidence Interval

Model 3d: Model 3c + satisfaction with own teeth/mouth; Model 3e: Mode 3d + self-reported need for treatment + self-reported dental pain; Model 3f: Model 3d + presence of decay teeth, missing teeth, filled teeth

Table 7-11 (continued): Association between colour/race and type of service used adjusted by individual and contextual-level characteristics. Results of the multilevel analysis in a sample of 35-44-year-old in Brazil.

		MODEL 4a	MODEL 4b	MODEL 4c	MODEL 4d	MODEL 4e
Individual-level characteristics				**OR (95% CI)**		
Colour/race	Pardos	1.26 (1.10 – 1.44)***	1.26 (1.10 – 1.44)***	1.26 (1.10 – 1.44)***	1.24 (1.09 – 1.42)***	1.24 (1.08 – 1.42)**
	Blacks	1.71 (1.40 – 2.10)***	1.71 (1.40 – 2.09)***	1.72 (1.40 – 2.10)***	1.69 (1.38 – 2.07)***	1.69 (1.38 – 2.07)***
Sex	Female	1.31 (1.16 – 1.48)***	1.31 (1.16 – 1.49)***	1.31 (1.16 – 1.49)***	1.31 (1.16 – 1.49)***	1.31 (1.16 – 1.48)***
Level of education (years)	5 – 8	0.78 (0.65 – 0.94)**	0.78 (0.65 – 0.94)**	0.78 (0.64 – 0.93)**	0.78 (0.65 – 0.94)**	0.78 (0.65 – 0.94)**
	9 – 11	0.55 (0.46 – 0.66)***	0.55 (0.46 – 0.66)***	0.55 (0.46 – 0.66)***	0.55 (0.46 – 0.67)***	0.56 (0.46 – 0.67)***
	≥12	0.37 (0.29 – 0.45)***	0.37 (0.29 – 0.46)***	0.36 (0.29 – 0.45)***	0.36 (0.29 – 0.45)***	0.37 (0.29 – 0.46)***
Income (R$ - Reais)	501.00 – 1.500.00	0.69 (0.58 – 0.82)***	0.69 (0.58 – 0.82)***	0.69 (0.58 – 0.82)***	0.69 (0.58 – 0.82)***	0.69 (0.58 – 0.82)***
	1.501.00 – 2.500.00	0.41 (0.33 – 0.50)***	0.40 (0.33 – 0.50)***	0.40 (0.34 – 0.50)***	0.40 (0.33 – 0.50)***	0.40 (0.33 – 0.50)***
	≥ 2.501.00	0.16 (0.13 – 0.21)***	0.16 (0.13 – 0.21)***	0.16 (0.12 – 0.21)***	0.16 (0.13 – 0.21)***	0.16 (0.13 – 0.21)***
Satisfaction with teeth/month	Neither	1.09 (0.92 – 1.30)	1.09 (0.92 – 1.29)	1.09 (0.92 – 1.30)	1.10 (0.92 – 1.30)	1.10 (0.92 – 1.30)
	Not satisfy	1.00 (0.87 – 1.15)	1.00 (0.87 – 1.15)	1.00 (0.87 – 1.15)	1.01 (0.87 – 1.16)	1.01 (0.88 – 1.16)
Dental pain	Yes	1.41 (1.23 – 1.61)***	1.41 (1.23 – 1.61)***	1.41 (1.23 – 1.61)***	1.41 (1.22 – 1.60)***	1.40 (1.22 – 1.60)***
Need for dental treatment	Yes	1.38 (1.16 – 1.64)***	1.38 (1.16 – 1.64)***	1.38 (1.16 – 1.64)***	1.38 (1.17 – 1.65)***	1.39 (1.17 – 1.64)***
Decayed teeth	Yes	1.23 (1.08 – 1.40)**	1.23 (1.08 – 1.40)**	1.23 (1.08 – 1.40)**	1.23 (1.08 – 1.40)**	1.23 (1.08 – 1.39)**
Missing teeth	Yes	1.04 (0.86 – 1.27)	1.04 (0.85 – 1.26)	1.04 (0.85 – 1.26)	1.04 (0.85 – 1.26)	1.04 (0.86 – 1.27)
Filled teeth	Yes	0.69 (0.60 – 0.81)***	0.69 (0.60 – 0.81)***	0.69 (0.59 – 0.81)***	0.69 (0.59 – 0.81)***	0.69 (0.59 – 0.81)***
Contextual-level characteristics						
% Black and Pardos	Moderate	0.88 (0.56 – 1.38)	0.72 (0.45 – 1.15)	0.76 (0.47 – 1.24)	0.60 (0.42 – 0.85)**	0.63 (0.43 – 0.94)*
	High	1.25 (0.79 – 1.97)	0.79 (0.42 – 1.47)	0.80 (0.43 – 1.51)	0.75 (0.48 – 1.19)	0.83 (0.48 – 1.42)
HDI	Moderate		0.70 (0.43 – 1.16)	0.73 (0.44 – 1.20)	0.72 (0.50 – 1.04)	0.75 (0.53 – 1.08)
	High		0.52 (0.27 – 0.99)*	0.53 (0.28 – 1.01)	0.56 (0.35 – 0.90)*	0.65 (0.39 – 1.09)
Gini coefficient	Moderate			0.97 (0.63 – 1.48)	1.12 (0.82 – 1.54)	1.06 (0.76 – 1.47)
	High			0.82 (0.54 – 1.26)	1.18 (0.83 – 1.69)	1.07 (0.73 – 1.58)
OHT/FHP	Moderate				1.44 (1.01 – 2.03)*	1.45 (1.03 – 2.03)*
	High				2.41 (1.70 – 3.42)***	2.39 (1.69 – 3.37)***
Dentist per population rate	Moderate					1.15 (0.81 – 1.64)
	High					0.94 (0.62 – 1.42)
Constant		1.02 (0.64 – 1.62)	1.75 (0.87 – 3.55)	1.81 (0.89 – 3.65)	1.09 (0.57 – 2.08)	1.00 (0.50 – 2.02)
Between-State Capitals variance (SE)		0.20 (0.06)**	0.17 (0.05)**	0.16 (0.05)**	0.07 (0.02)**	0.06 (0.02)**
% of unexplained variance (VPC)		5.7%	5.0%	4.8%	2.1%	1.9%

p-value *<0.05, **<0.01, ***<0.001 / OR - odds ratio / 95% CI – 95% Confidence Interval / Model 4a: Model 3c + % Black and Pardos; Model 4b: Model 4a + Human Development Index (HDI); Model 4c: Model 4b + Gini coefficient; Model 4d: Model 4c + Integration of oral health team into Family Health Program (OHT/FHP); Model 4e: Model 4d + dentist per population rate

7.5 Summary of the findings

The chapter aimed to assess the associations between colour/race and the three dental service utilisation outcomes in a national sample of 35 to 44-year-old adults in Brazil by taking into consideration a multilevel approach. Additionally, the chapter assessed whether individual and contextual-level characteristics had a role in explaining these associations. For all outcomes, there was evidence that colour/race was associated, at some level, with dental service utilisation, but for some outcomes individual-level characteristics, played a significant role in fully explaining the differences between Pardos and Blacks compared to Whites.

Different from the previous chapter, the results of the multilevel analysis allowed differences between capitals to be considered while investigating the differences between Pardos and Blacks compared to Whites. The summary of the unadjusted is presented in Table 7.12. The results confirmed the hypothesis that individuals self-classified as Pardos and Blacks were more likely than Whites to have their last dental visit for a year or more, to visit more due to pain or extraction, and due to treatment, and to visit a public dental service.

Table 7-12 - Summary of the unadjusted associations between colour/race and dental service utilisation (results from the multilevel analysis).

	Outcome			
	Time since last dental visit [1]	**Reason for the last dental visit [2]**		**Type of service used [1]**
	≥ 1 year	**Pain or extraction**	**Treatment**	**Public**
Colour/race	**OR (95% CI)**	**RRR (95% CI)**	**RRR (95% CI)**	**OR (95% CI)**
White	1.0	1.0	1.0	1.0
Pardo	1.36 (1.21 – 1.53)***	2.11 (1.86 – 2.39)***	1.63 (1.45 – 1.83)***	1.74 (1.54 – 1.97)***
Black	1.39 (1.16 – 1.67)***	2.08 (1.72 – 2.51)***	1.38 (1.15 – 1.66)***	2.43 (2.01 – 2.94)***

*p<0.05; **p<0.01; ***p<0.001 / OR – odds ratio / RRR – relative risk ratio
[1] Binary logistic multilevel analysis, [2] Multinomial logistic multilevel analysis
Reference category: time since last dental visit (<1 year), reason for the last dental visit (prevention/check-up), type of service used (private).

The hierarchical adjustments for individual-level characteristics had a great role in fully explaining the differences between colour/race groups for the time since last dental visit. Moreover, the fully adjusted model containing all individual-level covariates also fully explained the differences between Blacks and Whites for visits due to pain or extraction, and due to treatment. For differences between Pardos and Whites in the reasons to visit the dentist, and for the comparison of both minority groups with Whites for the type of service used, the individual-level characteristics greatly reduced the differences, but did not fully explain it.

With regards to the role of each contextual-level characteristics in the relationship between colour/race and dental service utilisation outcomes, only for some outcomes was there a reduction after the model had been adjusted for all individual-level characteristics. The summary of the fully adjusted model for each outcome (Model 4e) is presented in Table 7.13.

Table 7-13 - Summary of the adjusted associations between colour/race and dental service utilisation (results from the multilevel analysis).

	Outcome			
	Time since last dental visit [1]	**Reason for the last dental visit** [2]		**Type of service used** [1]
	≥ 1 year	**Pain or extraction**	**Treatment**	**Public**
Colour/race	**OR (95% CI)**	**RRR (95% CI)**	**RRR (95% CI)**	**OR (95% CI)**
White	1.0	1.0	1.0	1.0
Pardo	1.07 (0.95 – 1.22)	1.24 (1.09 – 1.42)***	1.21 (1.07 – 1.36)**	1.24 (1.08 – 1.42)**
Black	1.06 (0.88 – 1.29)	1.17 (0.95 – 1.42)	1.05 (0.86 – 1.26)	1.69 (1.38 – 2.07)***

*p<0.05; **p<0.01; ***p<0.001 / OR – odds ratio / RRR – relative risk ratio
[1] Binary logistic multilevel analysis, [2] Multinomial logistic multilevel analysis
Reference category: time since last dental visit (<1 year), reason for the last dental visit (prevention/check-up), type of service used (private).

For the time since last dental visit, the strong significant association showed in the unadjusted analysis was fully explained after the adjustments for the individual-level characteristics. The further adjustments for all contextual-level characteristics showed no changes of the estimates for Pardos and Blacks, as it continued to have non-significant differences to Whites on reporting a year or more since their last dental visit.

Additionally, the association between colour/race and visits due to pain or extraction was fully explained for Blacks in contrast with Whites after the adjustments for the individual-level characteristics. Although the adjustments for contextual-level characteristics slightly reduced the differences between Pardos and Whites, it remained significant in the fully adjusted model. Similar results were observed for the association between colour/race and visits due to treatment. However, for the differences between Blacks and Whites were fully explained earlier in the analysis, right after the further adjustments for income.

Inequalities between colour/race groups were higher for the type of service used. Moreover, the differences between Pardos and Blacks compared to Whites were not fully explained by either the individual nor the contextual-level characteristics. Moreover, there was an important difference in the magnitude of the inequalities between Pardos (OR 1.24) compared to Whites, and Blacks (OR 1.70) compared to Whites even after adjusting for all covariates.

The results showed that while considering the State Capital variation of the outcome, colour/race had a stronger association with the use of dental services. For some outcomes, the investigated individual-level and contextual-level characteristics did not fully explain the inequalities observed, and the next chapter discusses these and the abovementioned findings in light of the literature.

CHAPTER 8

DISCUSSION

8.1 Chapter overview

The primary aim of this thesis was to investigate the differences between Pardos and Blacks compared to Whites in the use of dental service among a Brazilian national sample of 35 to 44-year-old adults. In this last chapter, the findings were discussed in light of the current evidence, and the strengths and limitations of this study, policy implications, and recommendations for future research were also presented.

8.2 Principal findings

The expected hypothesis that colour/race would be associated with dental service utilisation was not supported for all outcomes. After accounting for the covariates, Pardos and Blacks were not less likely to report to visit the dentist in the previous year compared to Whites; however, Pardos were less likely to visit due to preventive/check-up reasons than Whites, and both minority groups were more likely to visit the public dental service compared to the White majority.

For the time since last dental visit, the hypothesis that individual-level characteristics would attenuate the difference between colour/race groups was supported by the findings. In the regression analysis (i.e. only considering individual-level characteristics) of the time since last dental visit, the estimates for Pardos reduced by 18.6% (from OR 1.34 to OR 1.09); and for Blacks decreased by 16.9% (from OR 1.39 to OR 1.16). In the multilevel analysis (i.e. considering adjustments for individual and contextual-level characteristics), the estimates for Pardos reduced by 21.5% (from OR 1.35 to OR 1.06); and for Blacks decreased by 24.1% (from OR 1.41 to OR 1.07). The results corroborate with previous research conducted in Brazil that investigated colour/race as one of the determinants of time since last dental visit and did not observe an association after accounting for individual-level characteristics (Davoglio et al., 2009, Ferreira et al., 2013). However, comparisons should be made with caution as these studies focused on different age groups and, in the case of Ferreira et al. (2013), measured the outcome using a different recall period.

In contrast, recent evidence showed that for Brazilian adolescents (Fonseca et al., 2017b), adults (Herkrath et al., 2018), and elderly people (Souza et al., 2012, Monteiro et al., 2016) colour/race minorities were more likely to visit the dentist less recently compared to Whites, even after accounting for only individual-level (Souza et al., 2012, Monteiro et al., 2016) or further accounting for contextual-level characteristics (Fonseca et al., 2017b, Herkrath et al., 2018). Nevertheless, the categories of colour/race used in these studies were different from the one used in this thesis (they compared colour/race groups by grouping all non-Whites individuals or considered additional categories such as Indigenous and Yellow). Therefore, this thesis is the first to solely focus on Pardos and Blacks differences with Whites for the time since last dental visit in Brazilian adults using a multilevel approach.

For the reason to visit the dentist, the expected hypothesis that individual-level characteristics would attenuate the difference between colour/race groups was also supported by the findings. In the regression analysis of the reason to visit the dentist, the estimates for visits due to pain or extraction for Pardos reduced by 37.4% (from RRR 2.54 to RRR 1.59), and for Blacks decreased by 30.1% (from RRR 2.26 to RRR 1.58); the estimates for visits due to treatment for Pardos reduced by 20.0% (from RRR 1.70 to 1.36), and for Blacks decreased by 12.3% (from RRR 1.22 to RRR 1.07). Differences between Pardos and Whites remained significant in the fully adjusted model for visits due to pain or extraction (RRR 1.59, 95% CI 1.10 – 2.30) for this type of analysis. However, in the multilevel analysis, differences between Pardos and Whites also reduced but remained significant for both reasons (RRR 1.24, 95% CI 1.09 – 1.42 and RRR 1.21, 95% CI 1.07 – 1.36, for pain or extraction and treatment, respectively). In this two-level analysis, the estimates for visits due to pain or extraction for Pardos reduced by 41.2% (from RRR 2.11 to RRR 1.24); and for Blacks decreased by 43.7% (from OR 2.08 to OR 1.17); the estimates for visits due to treatment for Pardos reduced by 25.7% (from RRR 1.63 to RRR 1.21), and for Blacks decreased by 23.9% (from RRR 1.38 to RRR 1.05). For visits due to pain or extraction, differences between Blacks and Whites became marginally significant after the accumulative adjustments for the level of education, income, self-reported oral health characteristics. For visits due to dental treatment, differences between Black and Whites were fully explained by the accumulative adjustment for the level of education and income.

The findings presented in this thesis added new evidence to the study of racial inequalities in the reason to visit the dentist among the adult population. In Brazil, previous studies that have considered colour/race to investigate the purpose of dental visits investigated differences in routine/preventive visits among 5-year-olds (Camargo et al., 2012, Souza et al., 2018), adolescents (Davoglio et al., 2009, Soares et al., 2013), and elderly (Martins et al., 2008b). Among children, similar results were found compared to this thesis, where the covariates affected more the inequalities between Black and Whites compared to Pardos and Whites (Souza et al., 2018). Significant differences were also observed among the elderly population, which showed that Whites were more likely to have routine visits compared to non-White (Martins et al., 2008b). However, again, comparison with the findings presented in this thesis is difficult as these beforementioned studies also had different categorisation used in both outcome and colour/race.

The findings for the type of service used supported the hypothesis that individual-level factors would reduce the differences in visiting the public dental service between Pardos and Blacks compared to Whites. In the regression analysis of the type of service used in the last dental visit, the estimates for Pardos reduced by

28.5% (from OR 1.65 to OR 1.18); and for Blacks decreased by 26.6% (from OR 2.03 to OR 1.49). In this analysis, differences between Blacks and Whites remained significant after the adjustment for all individual-level characteristics (OR 1.49, 95% CI 1.12 – 1.99). In the multilevel analysis, the estimates for Pardos reduced by 28.7% (from OR 1.74 to OR 1.24); and for Blacks decreased by 30.4% (from OR 2.43 to OR 1.69). However, in this latter analysis, differences compared to Whites remained significant for both Pardos (OR 1.24, 95% CI 1.08 – 1.42) and Blacks (OR 1.69, 95% CI 1.38 – 2.07) in the fully adjusted model.

The results observed for this outcome contradicts the findings of a recent paper that showed that individual and contextual-level characteristics fully explained the differences between non-White and White Brazilian among adults aged 35 to 44 years (Pinto Rda et al., 2016). However, there are considerable differences from this thesis. The authors of this beforementioned study combined all non-White colour/race groups (Black, Pardo, Yellow, and Indigenous) into one, analysed data of only one of the 27 States in Brazil, and considered three levels in the multilevel analysis (individual, neighbourhood, and municipalities). Additionally, another study focusing on adults aged 35-44 years based at the same State as the aforementioned study applied regression analysis and observed similar findings compared to the regression chapter of this thesis (Pinto Rda et al., 2014). However, the authors categorised colour/race using different method (Whites, Blacks, and Pardos were combined with Yellow and Indigenous) from the one used in this thesis. In fact, the results of this thesis in comparison to other studies showed the importance of analysing the data for Pardos and Blacks separately, especially for this outcome where the magnitude of inequalities was considerably different between groups after considering the role of individual-level and contextual-level characteristics.

8.3 The role of individual-level characteristics in racial inequalities of dental service utilisation

I. Socioeconomic characteristics

For all outcomes, the role of individual-level characteristics was essential to considerably reduce the difference between Pardos and Blacks compared to Whites, and the socioeconomic characteristics investigated played a major role in this attenuation.

It is not surprising that the effect of socioeconomic measures, such as education and income, have high relevance in reducing inequalities between racial groups. In the general population, there is substantial evidence that level of education predisposes an individual to a greater understanding on the importance of health prevention and greater access to information on its benefits (Lynch and Kaplan, 2000, Marmot and Bell, 2011, Boing et al., 2014). Looking at racial differences, for example, a study conducted in the USA with individuals aged 45 years and older observed that Blacks and less advantaged individuals were less well-informed of dental services and positive dental care attitudes, such as healthy eating habits, compared to Whites (Gilbert et al., 1997). Additionally, the effect of education may be due to its indirect effect on income; wherein, the higher the education level, the higher the possibility of finding a better-paid job, which would increase the ability to pay for a preferred type of dental service. Moreover, education may act as an indicator of an individual's ability to be more aware of the importance of oral health care, and visit a dentist as soon as needed. In other words, the higher the level of education the more likely an individual may be to pursue directly a private dental service which has higher availability rates in the country (Chaves et al., 2017), instead of waiting for an appointment in the public dental service.

For the reason to visit the dentist, socioeconomic characteristics also affected the estimates for minority groups in this present study. For instance, for Blacks, along with the level of education, having sufficient income to pay for a costly dental treatment seemed to be enough to eliminate the differences with Whites. This seems to be important also in the USA, where a study conducted with individuals aged 45 years and older showed that African Americans were less likely to choose root canal therapy after knowing its cost (Tilashalski et al., 2007). Additionally, another study conducted among adults in the USA observed that level of education and income explained a large portion of the racial inequalities in oral health (Sabbah et al., 2009), which can indirectly impact the reason for visits to dental services.

Cost of dental treatment is high worldwide (Dhama et al., 2016). Although in Brazil, dental service is included in the public health system, the dentist in a primary health care centre may only perform simple fillings and extractions. To undergo more complex treatment, such as root canal therapy, crowns, implants, dentures, one needs to be referred to a specialist in secondary care. However, according to population-based studies conducted in the South and Southeast Brazil the waiting period for a consult for complex treatments in the public service can take as long as 11 months (Zaitter et al., 2009, Saliba et al., 2013). Thus, it is understandable when, even with a free public dental service, the last Brazilian oral health survey (2010) showed that visits to the private dental service were reported by over 60% of the general population (Brasil, 2012b).

In Brazil, it is well-established that individuals in the lower socioeconomic position are more likely to use the public dental service (Soares et al., 2015, Oliveira et al., 2016, Barros and Bertoldi, 2002, Baldani et al., 2010), as are minority colour/race groups (Pinto Rda et al., 2014, Oliveira et al., 2016) compared to Whites. This can be exemplified by a study that analysed data from the Brazilian Family Budgets Survey, 2008-2009 (Cascaes et al., 2017), in which a higher mean annual per capita spending with dental service was observed among Whites (R$ 51.41 ~ £11.72) compared to non-Whites (R$ 33.18 ~ £7.56). Historically, White Brazilian population have higher levels of education and income compared to racial minorities. Thus, as observed in the findings of this thesis, it is highly important to overcome socioeconomic inequalities among racial groups in order to reduce differences observed in dental service utilisation.

II. Oral health-related characteristics

In respect to other individual-level characteristics investigated in this study, none of the self-reported and clinical oral health characteristics had an important role in reducing the estimates between colour/race groups for the time since last dental visit. Satisfaction with teeth/mouth was included because according to theoretical models proposed by Andersen and Davidson (1997) and Cooper et al. (2002), satisfaction with one's health is a mediator between race/ethnic differences and use of health service. Although this individual-level characteristic has been empirically associated with dental service utilisation in Brazil (Camargo et al., 2009, Martins et al., 2007), no evidence in the country was found about its role on the relationship between colour/race and dental service use. In the USA, a study conducted with individuals aged 45 years and older observed that satisfaction with dental appearance was negatively associated with the use of dental service, and racial minorities were more likely to be less satisfied with their teeth (Gilbert et al., 2002).

Another characteristic that was believed to be important to reduce differences between racial groups was dental pain. In Brazil, colour/race has been shown to be associated with dental pain (Bastos et al., 2008a) and the impact of dental pain in the daily life of adults (Constante et al., 2012). Some researchers hypothesised that self-reported dental pain is more prevalent in racial minorities because of their lower use of dental services throughout life, and by the time they have a dental visit the disease already reached an advanced stage, thus tooth loss cannot be avoided (Drake et al., 1991, Drake et al., 1995, Edwards et al., 2001).

In accordance, besides considering the role of socioeconomic characteristics, self-reported oral health characteristics were important to fully explain the differences in visits due to pain or extraction between Blacks and Whites. These findings are in line with evidence from Brazil, where colour/race minorities were more likely to have reported dental pain and need for dental treatment compared to Whites (Guiotoku et al., 2012). Moreover, this could mean that emergency visits due to pain and visits resulting in tooth loss might be prevented in the Black population by improving not only socioeconomic conditions but also oral health outcomes. Pardos, instead, were more likely to visit due to pain/extraction and due to treatment compared to Whites even after considering all individual-level characteristics investigated, which supports the importance of investigating the inequalities between Pardos and Blacks compared to Whites separately.

As for the type of service used, self-reported and clinically evaluated oral health measures further reduce the differences between colour/race groups, but Pardos and Blacks continued to be more likely to visit the public dental service compared to Whites. Thus, other characteristics not measured, such as those related to an individual's social/family context, and an individual's relationship with the health care system and the dentist may also influence the type of service used, which was discussed later in this chapter.

8.4 The role of contextual-level characteristics in racial inequalities of dental service utilisation

I. Composition of colour/race groups across Brazilian State Capitals

The first contextual-level characteristic investigated was the proportion of Pardos/Blacks in each Brazilian capital. This characteristic did not affect the estimates for the difference between colour/race groups in neither of the outcomes. Although this characteristic has been tested in relation to the type of dental service use in Brazil (Pinto Rda et al., 2016), this is believed to be the first study that investigated the role of this characteristic for the time since last dental visit and the reason to visit the dentist.

Looking at the time since last dental visit, the findings corroborate with a study conducted in the USA that investigated the role of racial diversity in a community using a multilevel approach amongst adults age 18 to 64 years also did not find this contextual-level characteristic to have an impact on dental service use in the past 12 months (Chi and Carpiano, 2013). Unlike this previously mentioned study, Eisen et al. (2015) investigated the effect of this contextual-level variable by looking into a community that was composed almost equally in regards to their race and socioeconomic status and observed that African Americans were more likely to visit the dentist in the past two years compared to Whites.

This characteristic was investigated as a potential factor to reduce the colour/race inequalities due to its indirect measure of racial segregation, which has been previously observed to be associated with the use of health services (Dinwiddie et al., 2013, Sarrazin et al., 2009, Gaskin et al., 2012, Gaskin et al., 2009, Caldwell et al., 2017). Williams and Collins (2001) extensively discussed that areas with worse health outcomes in the USA, for instance, are the ones with a higher proportion of racial minorities. Additionally, Phelan and Link (2015) also argued that racial segregation restricts access of racial minorities to collective resources, such as better schools, safer places, transportation, and health services.

These abovementioned studies focused on the effect of racial segregation at the neighbourhood level. Thus, the small effect of the proportion of the non-white population in this thesis might be because the characteristic was investigated at capital-level, and neighbourhood or service-level differences would be a better measure. For instance, looking at proportion of minority groups, in a longitudinal study conducted in Florida, USA, at service-level, it was observed that either races (non-Hispanic Whites and African-Americans) were more likely to have their teeth extracted in dental clinics where there were a higher proportion of African Americans as patients (Gilbert et al., 2006).

II. Human Development Index and Gini coefficient

In Brazil, the majority of Pardos and Blacks live where there are lower Human Development Index and higher income inequalities (PNUD, 2013). However, in this thesis, the inclusion of the Human Development Index and the Gini coefficient in the model did not help to attenuate the estimates between colour/race groups for neither of the outcomes. Still, this thesis adds new evidence as the impact of these measurements on racial inequality in dental service utilisation has not been previously tested.

These characteristics were thought to have an impact on the inequalities in dental service utilisation because Human Development Index was shown to be a significant predictor of non-use of dental service for overall population in several countries in Europe (Tchicaya and Lorentz, 2014). Additionally, in another research that compared data from different countries, income inequality was observed to be independently associated with dental service utilisation in the past year, even after controlling for GDP per capita, total health expenditure, and the dentist-to-population ratio among a sample of adults aged 18 years or older (Bhandari et al., 2015).

Nevertheless, these abovementioned studies did not focus on racial or ethnic differences, and results presented in this thesis may help to understand that when it comes to racial inequalities in the use of dental service these contextual-level characteristics looked at the perspective of State Capital differences may not be important. In fact, while looking at neighbourhood differences, recent studies conducted in the city of Sao Paulo (Southeast) observed that primary dental care clinics close to residency of colour/race minorities were more distant to a high-frequency public transportation, compared to clinics close to white majority (Yuen et al., 2018, Yuen et al., 2017). Thus, the development of city-level instead of State Capital-level might have a stronger impact in reducing the inequalities between colour/race groups, especially for the type of service used.

III. Dental service-related characteristics

For this present study, it was hypothesised that the integration of oral health teams into the family health program, as a proxy of access to preventive information (Mattos et al., 2014), would help to reduce further the difference between colour/race groups. However, the results found did not sustain this hypothesis.

The integration of oral health teams into the family health program was investigated because this governmental program was created mainly to increase preventive actions in health and oral health. In Brazil, the non-use of dental service among adults in the general population was associated with the level of integration of the oral health team with the Family Health Program (Martins, 2014). However, this was not tested on colour/race inequalities.

Evidence in Brazil also shows that contextual determinants related to dental service such as lower infrastructure, and lower availability of general and specialist dentist were also associated with the non-use of dental service in the general population (Pinheiro and Torres, 2006). Therefore, the dentist per population rate in the State Capital, which may also imply higher access to dental service, was also tested. However, the results presented showed that this contextual-level characteristic did not have an important impact in reducing the differences between colour/race groups.

The findings corroborate with a study conducted in Brazil with a younger sample (1 to 5-year-olds), which the proportion of dentists was also not found to have an effect in the estimates between White and Black for the use of dental service in the lifetime (Piovesan et al., 2017). It is likely that even though there were State Capitals with a lower proportion of minority colour/race groups (e.g. South) in this study, these locations still had a higher amount of dentist per population, which might have impacted the difference and influence changes for the colour/race estimates.

The small effect may also be because the rate of dentist in State Capitals is not the main issue. Instead, for colour/race inequalities, the proportion of dentists classified as Pardos or Blacks might be a better covariate. This is hypothesized because evidence shows that the likelihood of visiting for preventive reasons may be lower among minorities because the relationship with the dental professional or the service could be different from Whites (Chen et al., 2005). One study in USA found that Black patients believed their appearance negatively affected receptivity in the health care system (Johnson et al., 2004) and other publications indicate that racial minorities have less confidence in their doctors (Musa et al., 2009, Boulware et al., 2003), and show greater satisfaction with the service when cared for by Black providers (LaVeist et al., 2003).

Although the proportion the dentist's colour/race in each State Capital was not investigated in this thesis, the proportion of White students that graduated in dentistry seems to be decreasing over time (83.7% in 2004, and 77.8% in 2007) in Brazil, but it is still very high compared to other colour/race groups (Morita et al., 2010). This was also observed in other countries. A study conducted in the UK observed that only Black ethnic minorities were underrepresented in the dental professional, and 14% of the dentists in 2000 were from an ethnic minority (Newton and Gibbons, 2001). A study conducted in the USA highlighted this issue and observed that Black dentists were not only underrepresented but also disproportionately distributed in the country, and for those who worked as a dentist more than 50% of their patients were Black (Mertz et al., 2017). Thus, increase the accessibility of colour/race minorities in dental degrees should be encouraged, which might consequently improve the relationship between colour/race minorities patients and providers.

8.5 Other pathways that might explain colour/race inequalities in dental service utilisation

The contribution of education and income to colour/race differences in this thesis shows the results are likely to be due to a combination of stronger policies focused on improving socioeconomic status of racial minorities, alongside tougher governmental strategies against structural racism that routinely provides disadvantages to non-White Brazilian population (See Werneck (2016) and Batista and Barros (2017) for a detailed discussion on policies in Brazil to confront racism in health services).

Colour/race minorities are more likely to use the public health system, and to eliminate racial differences scholars should be encouraged to investigate further pathways not explored in this thesis. For instance, it might be the case that even after the level of education and income of Pardos and Blacks reach the level of the White population, these minority groups could continue to use the same system that welcomed their family members in the previous years. This hypothesis may be linked to research conducted by authors who focus on trust in the healthcare system and observed that ethnic and racial minorities have lower trust levels compared to White majority (Musa et al., 2009, Boulware et al., 2003). Additionally, the individual's family pattern of dental service utilisation may also be an important pathway, as shown by a study in the USA where non-White families that visited the dental service for preventive reasons had children with higher probability to visit due to the same reasons (Sohn et al., 2007).

Although individual-level determinants were central to reduce differences between Pardos and Blacks compared to Whites in this thesis, socioeconomically disadvantaged racial groups represent part of the population that has been historically suffering from other determinants such as social justice and discrimination (Sansone, 2003, Lopes, 2005, Chor, 2013). As portrayed by Williams et al. (2016), socioeconomic characteristic is a complex concept and affect racial minorities in mainly four different ways: i) unequal exposure to disadvantaged situations (such as poor living conditions, exploitation, and stress); ii) disproportionately less wealth compared to White majority with the same level of income; iii) discrimination and racism, leading to residential segregation and subsequent prejudice; iv) higher risk of worse psychological and social outcomes, such as mental health issues and violence-related situation. Therefore, although the dataset used in this thesis lacked these and others determinants that are at the core of racial inequalities agenda (Krasnik et al., 2018), it is important to highlight that while differences between Pardos and Blacks compared to Whites were attenuated by the investigated socioeconomic characteristics, these minorities have had an accumulation of disadvantaged experiences throughout their lives and historically that must be considered (Bastos et al., 2018).

The results presented in this thesis showed that when it comes to differences between Pardos and Blacks compared to Whites, the dental service outcome that showed significant differences for both minority groups was the type of service used. The fact that both Pardos and Blacks were more likely to visit the public dental service regardless of individual and contextual-level characteristics shows how much these minorities rely on this type of service and how important is the availability and quality of public dental service in Brazilian State Capitals. As mentioned by some authors that debated the improvements and challenges faced in the first ten years (2000 – 2010) of the largest public oral health care program in the country named “*Brazil Sorridente*” (Pucca et al., 2015, Scherer and Scherer, 2015, Chaves et al., 2017), much more work still needs to be undertaken especially in regards to accessibility, availability of special services, training, and financing.

Additionally, the findings showed that Pardos were more likely to visit the dentist due to pain or extraction and treatment compared to Whites even after considering the role of the investigated individual and contextual-level characteristics. This result may help to bring more insight to the unequal distribution of oral health disease (Peres et al., 2007, Guiotoku et al., 2012) and how this racial group may be unequally assisted by preventive health policies, lacking targeted preventive information, and maybe not having access to a sensitive care and equitable dental service.

Furthermore, the findings from this thesis showed that in terms of time since last dental visit no significant difference between colour/race groups was observed. Information on the pattern of dental service, which was not available in this dataset, could potentially have made an important contribution to the evidence on the racial inequalities for the time of visit. For instance, how often an individual visits the dentist could help reflect on other important characteristics of dental service utilisation, such as those related to access to dental services. Although not the main focus of this thesis, it was performed an analysis to explore the association between colour/race groups and having never visited the dentist. Overall, 11.8% of Blacks, 8.0% of Whites and 7.2% of Pardos reported that they had never visited the dentist. The results for Blacks are the same as observed by Martins (2014) while using the same dataset (SB Brazil 2010).

According to Penchansky and Thomas (1981) the study of access to health service is complex. While referencing the theoretical model used in this thesis (Andersen and Newman, 1973) as part of the conceptual model for access, they describe access as a combination of five dimensions: availability, accessibility, accommodation, affordability, and acceptability. If considering use of dental service as part of the study of access, it can be observed that the availability dimension was tested in this thesis by adding into the model the proportion of dentist per population rate. However, in this sample of adults in Brazil, this characteristic did not have a significant contribution to reduce differences between colour/race groups for the three investigated outcomes. The accessibility dimension was not measured in this thesis, but other studies have highlighted that transportation resources seem to be lower and distance to the clinic may be higher among Blacks compared to Whites (Yuen et al., 2018, Yuen et al., 2017). Another dimension that was not measured in this study was accommodation. The organisation of the dental service facility that individuals sampled from SB Brazil 2010 encountered in their last dental visit would have been interesting to explore. As mentioned by Penchansky and Thomas (1981), this dimension includes appointment systems, opening hours, and waiting times, which have shown to be important determinants of racial inequalities (Okunseri et al., 2013a, Gilbert et al., 2007). This is an important dimension of health service quality and, as mentioned by the authors, "*problems with access (…) are presumed to influence clients and the system (…) (in the) utilization of services, particularly entry use, will be lower, other things being equal; (…)*".

In the case of Brazil, where dental service in a public setting is free of charge, the affordability dimension considered by the abovementioned authors does not fit with the country´s public health system model. However, the acceptability dimension is undoubtedly important in the study of racial inequalities. Penchansky and Thomas (1981) mentioned that the acceptability of the services may be affected by characteristics of the providers, such as ethnicity as well as their willingness to provide care for some type of clients. Accordingly, as described by Maxwell (1992), dimensions of health care quality include equity which helps to understand the role of quality of service in the access to health care.

The health professional's empathy with the client regardless of its colour/race and their ability to treat each individual fairly with no discrimination or prejudice is part of the discussion in many of the studies that address this subject. Studies conducted in Brazil and other countries have shown that there is a close link between racial and ethnic minorities and discrimination in oral health (Bastos et al., 2018) and in dental services (Cabral et al., 2005, Jamieson et al., 2013). There is a body of literature that supports the existence of racial/ethnic inequalities in health care service utilisation and how the relationship, including trust, between patient and healthcare provider, can be affected (Shavers et al., 2012b, Shavers et al., 2012a, Paradies et al., 2014, Klonoff, 2009, Smedley et al., 2002, White and Chanoff, 2011). For instance, a study conducted in Brazil with dentists from both public and private services showed that dentists decided to extract teeth more frequently for Black patients (Blacks and Pardos were combined into one category) than for White patients (Cabral et al., 2005). The authors observed that this racial variation occurred regardless of the dentist`s sociodemographic characteristics, but it changed between the type of practice worked (Cabral et al., 2005). Even with the paucity of studies conducted in the field of dentistry (Cabral et al., 2005, Schroeder et al., 2017, Okunseri et al., 2007), researchers suggest that dental professionals may be a reflection of an unequal society (Madhan et al., 2012, Levett et al., 2009, de Freitas et al., 2006).

Looking at the access and use of health services, those inequities refer to unnecessary and avoidable differences, that is, those considered unfair and undesirable. The concept of equity in health strongly emerged when Margaret Whitehead incorporated the parameter of justice to equal distribution (Whitehead, 1992). While aiming to repair years of unequal opportunities among minorities and fairness into the health system, the National Humanization Policy (NHP) was created by the Brazilian Government (Brasil, 2004a) to contribute to the social development of health professionals and raise awareness for the multi-professional teams to work on different dimensions of health services quality.

Considering the 'welcoming' of the health service´s users and the promotion of co-responsibility for health care as a foundation of the NHP, it is essential to apply these also to the Primary Health Care. As in the UK, Primary Care in Brazil is the user's first contact into the public health service (Brasil, 2012a) and, besides working towards the determinants of dental service utilisation mentioned throughout this thesis, it is important to maintain a stronger link between the different parties (Government, health professionals, and population). Government investment to improve access while joining forces with dental professionals to improve quality, making dental service effectively humanised (i.e. kinder, gentler, with empathy), are particularly important for colour/race minorities as the results of this thesis showed that they are more likely to visit the public dental service and use it for non-preventive reasons compared to Whites.

8.6 Strengths and limitations

8.6.1 Strengths of the study

8.6.1.1 National representative sample

Brazil is the 5th largest country worldwide and, in 2010, was also the 5th in terms of population size. Thus, surveys with representative samples of the country are complex and expensive. Among the 28 selected studies that investigated to some extent colour/race inequalities in dental service utilisation, 8 used data with a representative sample of the Brazilian population. However, only 3 studies focused on the adult population (Herkrath et al., 2018, Guiotoku et al., 2012, Peres et al., 2012b), and among those only one conducted appropriate analysis that enable some discussion of colour/race inequalities and it focused only on time since last dental visit (Herkrath et al., 2018). Therefore, this study was the first to conduct analysis using a representative sample of the country for all three dental service utilisation outcomes with focus on colour/race inequalities among adults.

8.6.1.2 Colour/race inequalities

This study was the first study to solely focus on differences between Pardos and Blacks compared to Whites in Brazilian adults showing inequalities in three different measures of dental service utilisation. It presented the differences for Pardos and Blacks compared to Whites separately as recommended (Bailey, 2008, Loveman et al., 2012, Travassos and Williams, 2004), and not combining the groups as non-White. Moreover, this allowed observing that each group presented different pattern of dental service utilisation inequality compared to Whites as the individual and contextual-level characteristics were considered in the analysis of each outcome.

8.6.1.3 Range of dental service utilisation outcomes

As it was observed in Chapters 3 and 4, the pathways that linked differences between colour/race/ethnic groups in dental service utilisation are complex and many different approaches have been used. This thesis explored three characteristics of dental service utilisation which allowed a more comprehensive assessment of the issue and highlighted a wider picture of the different and potential patterns for these outcomes.

8.6.1.4 Variety of individual-level and contextual-level covariates

Another strength of this thesis was the various individual and contextual covariates used in the adjustment process. By looking at the theoretical model used in this study (Andersen and Davidson, 1997), this thesis was able to cover most of the categories considered important for racial differences in dental service utilisation. Additionally, the constructs were assessed with relevant and validated measures, and one of the benefits of using the 2010 SB Brazil survey data, was to have the individual-level variables collected in a representative sample and to have clinical oral health measures.

8.6.1.5 Analytical approach

Multilevel analysis has been used in public health research for decades (Diez-Roux, 2000). However, looking at the current evidence in Brazil, there are only a few, and relatively recent, studies that used a multilevel approach to dental service utilisation and considered colour/race as an independent variable (Pinto Rda et al., 2016, Herkrath et al., 2018, Fonseca et al., 2017b). These studies did not focus on how different determinants changed the estimates for colour/race, and this thesis was the first to present and discuss results in Brazil using multilevel analysis focusing on inequalities between Pardos and Blacks compared to Whites.

In this thesis, multilevel analysis was used to estimate how distinct levels of an individual´s life (individual´s own characteristics and characteristics from the State Capital they were living in at the time of the interview) can affect their report on dental service utilisation. The variation of each of the three investigated outcomes at each State Capital in Brazil was used as a second-level to the sample-level characteristics. The use of this technique, in contrast with the regression analysis, helped to understand better the impact of the State Capital variation on the individual-level determinants. In these results, individual level characteristics had a larger effect in reducing the differences between colour/race groups compared to the contextual-level characteristics.

When considering the time since last dental visit as the outcome, the multilevel model that adjusted for all individual-level characteristics showed a larger attenuation in the estimate for Blacks only, but not for Pardos, compared to the respective regression analysis. This could mean that State Capital variation for this outcome may have a more significant effect on individual-level determinants for Blacks compared Whites, than for Pardos compared to Whites. This is something that could not have been observed in the regression analysis, hence highlighting the added value of using multilevel modelling when appropriate. Additionally, while comparing the adjusting for all individual-level covariates, multilevel analysis presented smaller odds ratio compared to the regression analysis, but this was not observed among the type of service used. The substantial differences in the availability of services previously discussed between State Capitals may have increased the differences between Pardos and Blacks compared to Whites, even after accounting for individual and contextual-level characteristics. This finding could not be observed in the regression analysis as it does not consider the variation of the outcome between State Capitals in the analysis. Additionally, after controlling for all covariates the multilevel analysis showed that Pardos and Blacks were both more likely to report to visit the public dental service compared to Whites, and differences between Pardos and Whites for both reasons to visit the dentist were significantly different compared to results from the regression analysis. Furthermore, throughout all the models for all outcomes, the confidence intervals for Pardos and Blacks compared to Whites were narrower and statistical differences between groups were stronger for multilevel analysis compared to regression analysis.

8.6.2 Limitations of the study

8.6.2.1 Study design

The aim of this thesis was to assess associations between colour/race and dental service utilisation outcome and to understand how these could be affected by individual and contextual-level characteristics while using data from a cross-sectional design survey. Thus, it is not possible to infer any causal relations between the main exposure and outcomes.

Additionally, it is essential to address two issues due to the use of multilevel analysis in this thesis. First, the upper level consisted of analysing data from the 27 capitals in Brazil, and although is a viable number of groups in a second-level to estimate unbiased regression coefficients, it can lead to underestimated standard errors and variance components (Moineddin et al., 2007, Maas and Hox, 2004, Maas and Hox, 2005). Second, sampling weights were applied in Chapter 6 (bivariate and regression analyses) to account for the complexity of the survey design, but this was not the case for Chapter 7 (multilevel analysis) where unweighted data were used in the respective analyses. The data from SB Brazil 2010 included all 27 State Capitals in Brazil, which was where each individual was living at the time of the interview. Thus, this process did not require a probabilistic weight for them to be selected at this level.

8.6.2.2 Information bias

In this study, the individual-level characteristics were almost all self-reported. This could imply social desirability bias, especially in regard to the time since last dental visit and the reason to visit the dentist, where the more frequently the dental service is used and more for preventive reasons the better the individual will be viewed favourably by others (Sjostrom and Holst, 2002, Phillips and Clancy, 1972).

This type of bias could also apply to the primary explanatory variable: colour/race. As mentioned in the background (Chapter 2), the self-classification method is the most widely used and the one that estimates the exposure to risk behaviours attributed to cultural factors. However, characteristics such as the colour/race of the interviewer and the socioeconomic position of the interviewee could imply different self-ascribe colour/race (Bastos et al., 2008b, Bastos et al., 2009b, Laguardia, 2014, Longo and Campos, 2006), which was not measured in this study.

Additionally, recall bias should also be addressed in this study. Participants were asked “When was your last dental visit?”, “What was the reason for the last dental visit?”, “Where was your last dental visit?”. These questions were all dependent on the individual’s ability to recall past events, which could have been more than 2 to 3 years past the interview date.

8.6.2.3 Exploring a single age group

In this thesis, only individuals aged 35 to 44 years were included in the analysis. As previously mentioned (section 5.2.1.5), this age group comprised individuals who are entitled to make their own decisions in terms of visiting the dentist and, especially in Brazil, they are an age group that retain many of their natural teeth compared to individuals aged 65 and older (Brasil, 2004). Nevertheless, there are other adult age groups (e.g. 20-35, 45-60) that were not included in the analysis because data were not available. For future studies, it would be interesting to understand the racial inequalities in dental service utilisation in various stages of adult life, especially considering the role of individual-level characteristics in this process.

8.6.2.4 Missing data

Complete case analysis was used to estimate colour/race differences in all three outcomes. Although complete case analysis is commonly used, it reduces the statistical efficacy of the estimates by decreasing sample size and increasing the probability of selection bias (Barzi and Woodward, 2004, Sterne et al., 2009). This has particular importance in more advanced analysis, such as the ones conducted in this thesis, because even low rates of missingness may result in high rates of casewise missingness (Mackinnon, 2010).

In this study, there were no significant differences between the groups regarding missingness for neither of the outcomes, and missing values for covariates and the overall sample was lower than 10%. Although some authors suggest that complete case analysis is suitable within 5% missing in one covariate or outcome (Harrell, 2001), others support that this number can be up to 10% (Barzi and Woodward, 2004, Marshall et al., 2010). Therefore, no imputation method was employed.

8.7 Recommendations for future research

In the discussion, it was highlighted (section 8.5) some characteristics not investigated in this thesis that might bring light to better understand differences between colour/race groups. Moreover, it appears that for future research, especially for the type of service use, simultaneous modelling considering variation of the outcomes in other levels such as neighbourhood and health service should also be explored. For instance, it may be that at the neighbourhood-level characteristics such as quality of public transportation, distance from the individual's household/work to the service, and neighbourhood segregation (Phelan and Link, 2015, Williams and Collins, 2001, Yuen et al., 2018, Yuen et al., 2017) could help to better explain differences between Pardos and Blacks compared to Whites. Characteristics at service-level, such as those related to opening hours, number of colour/race minority dentists, self-describe quality of service, availability of service when needed, may also contribute to these inequalities.

Additionally, characteristics at professional-level and service-level from an individual's point of view should also be encouraged to be investigated (Smedley et al., 2002, Chen et al., 2005, Johnson et al., 2004). These would be characteristics regarding experiences of racism and discrimination perpetuated by the dentist (Cabral et al., 2005, Okunseri et al., 2007) and/or the service itself. Thus, more in-depth interviews with colour/race minorities should be considered.

Furthermore, another issue not explored in this thesis is the use of other types of health service used. The results showed significant difference between Pardos and Blacks compared to Whites in terms of public dental service utilisation, but other services such as emergency medical services, visits to a general medical practitioners for oral health reasons, and even self or informal dental care should also be explored. These were not available in the SB Brazil 2010 survey but may help to better understand the approach to the health system by minorities.

Therefore, the use of these and the beforementioned characteristics could bring light on how to reduce colour/race inequalities in the use of dental service, especially for the reason to visit the dentist and the type of service used.

8.8 Recommendations for policymakers

The Unified Health System in Brazil ("SUS") main goal is to provide universal and equalitarian actions and services, prioritising equity in health services, with no prejudice and privileges to any group. However, this study draws attention to the significant importance of public dental service for minority middle-aged Brazilian adults, showing that inequalities between colour/race groups are significant especially for this outcome. From the perspective of dental service utilisation, the difficulty in accessing the service for any reason could result in pain, tooth loss, and cycles of emergency attendance, which goes against preventive actions introduced with the Family Health Program in 1995. Policy interventions not only at the individual-level but at the State Capital level are important to reduce inequalities.

The findings of this thesis are in line with a Brazilian policy launched in 2007 entitled "National Comprehensive Health Policy for the Black population", acknowledging the health needs of the minority racial groups, and encouraging research and policy actions to promote health equity for individuals classified as Pardos and Blacks (Brasil, 2007). Although a reduction in dental service inequalities have been observed among different groups in Brazil (Peres et al., 2012a), differences between colour/race groups in the use of dental service had been recently emphasised (Fonseca et al., 2017b, Herkrath et al., 2018, Souza et al., 2012), which highlight, alongside the results from this thesis, that much more work needs to be undertaken to reduce racial inequalities in the country.

Based on the findings presented in this thesis and the work published by other researchers mentioned throughout this document, several aspects must be considered to improve equity in dental service utilisation for colour/race minorities in Brazil, such as: *i)* continue to improve access to education for colour/race minorities (Santos, 2013), which together with income showed to be essential determinant to reduce differences between groups; *ii)* continue to provide better job opportunities (Leite and Souza, 2010) and overall living conditions among minorities; *iii*) continue to delivery sensitive care by training dental professionals about the myriad of determinants of racial inequalities (Brasil, 2010a).

8.9 Conclusion

This thesis investigated the differences between Pardos and Blacks compared to Whites in the use of dental service in a national sample of 35 to 44-year-old adults in Brazil taking into consideration the role of individual-level and contextual-level characteristics. The findings demonstrated the importance, especially, of individual-level characteristics in reducing differences between colour/race groups in the three investigated outcomes. In summary, colour/race was not independently associated with the time since last dental visit after fully adjusted for individual and contextual-level characteristics. For the reason to visit the dentist, Pardos were 1.24 and 1.21 times more likely than Whites to visit the dentist for pain/extraction and treatment, respectively. Furthermore, Pardos and Blacks were 1.24 and 1.69 times, respectively, more likely to visit the public dental service compared to Whites.

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APPENDICES

Table A- 1 **-** Databases included in literature review, official language, last update, search strategies used, and totals of articles found.

Database	**Official language**	**Last update**	**Search strategy**	**Number of papers found**	**Number of papers selected**
PubMed	English	08/11/2018	("Dental Health Services/statistics and numerical data"[Mesh] OR "dental service use"[TIAB] OR "oral health service"[TIAB] OR "dental care"[TIAB] OR "oral care"[TIAB]) AND ("Brazilian"[ALL] OR "Brazil"[Mesh])	425	67
Scielo	English, Spanish, Portuguese	08/11/2018	*(utilizacao de servico odontologico) OR (servico odontológico) OR (serviço de saúde bucal) + Brasil*	163	21
LILACS	Portuguese	08/11/2018	*tw:(serviços de saúde bucal AND (instance:"regional") AND (db:("LILACS") AND mj:("Serviços de Saúde Bucal" OR "Assistência Odontológica" OR "Atenção Primária à Saúde"))) AND (instance:"regional") AND (pais_assunto:("brasil"))*	250 (237 after excluding duplicates)	48

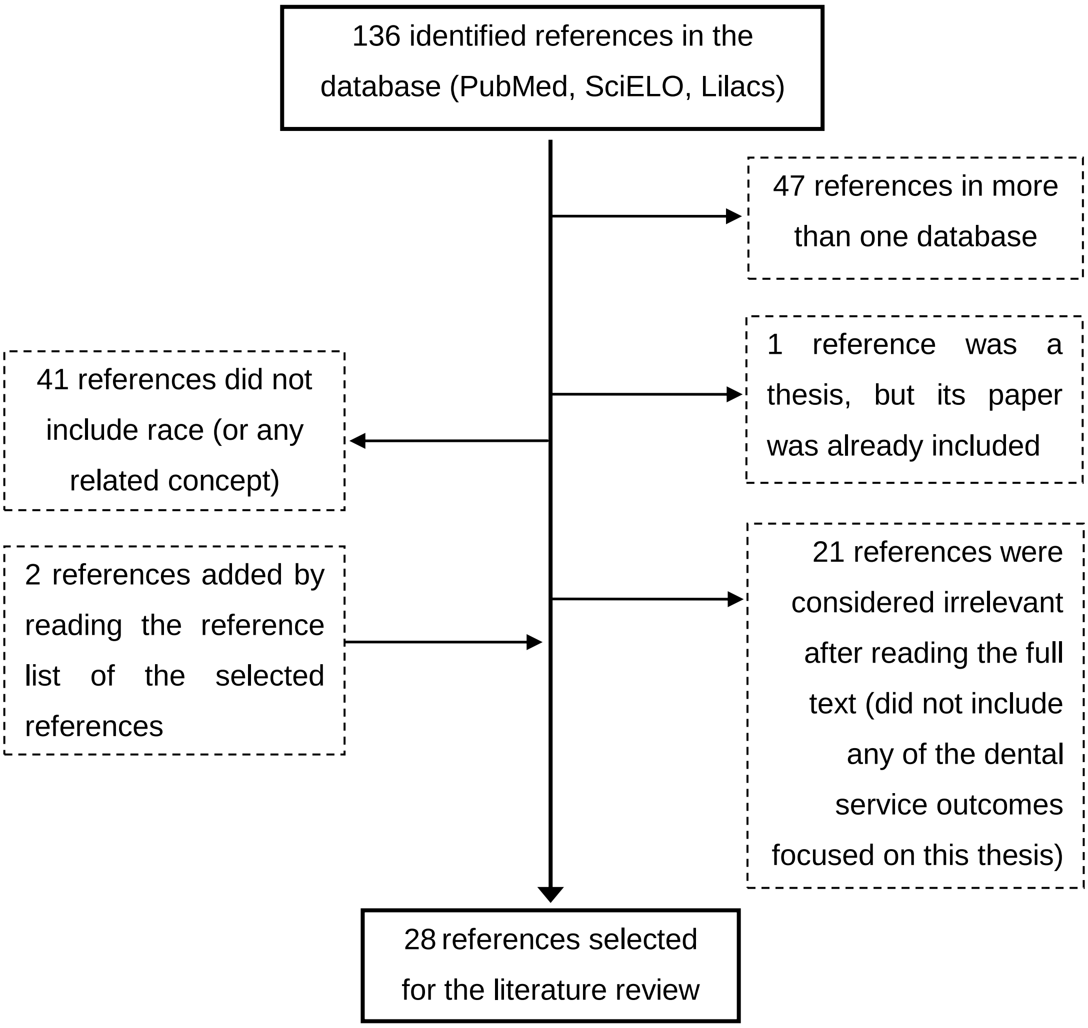

Figure A- 1 - Flowchart of the strategic search about race and use of dental service in the Brazilian literature.

Table A- 2 - Distribution of colour/race and individual-level characteristics in the 35-44-year-old sample of SB Brazil, 2010, that never visited the dentist.

Characteristics	**%**	**95% CI**
Colour/Race		
White	43.2	36.8 - 49.9
Pardo	41.2	34.6 - 48.1
Black	15.6	11.9 - 20.1
Sex		
Male	41.8	38.0 - 45.8
Female	58.2	54.2 - 62.0
Level of education (years)		
≤ 4	23.9	18.3 - 30.5
5 – 8	31.0	26.3 - 36.1
9 - 11	26.4	22.4 - 31.0
≥12	18.7	13.6 - 25.1
Income (R$ - Brazilian *Reais*)		
≤ 500.00	27.7	22.5 - 33.5
501.00 – 1,500.00	51.3	46.1 - 56.5
1,501.00 – 2,500.00	14.6	10.9 - 19.3
≥ 2,501.00	6.4	4.4 - 9.3
Self-reported satisfaction with teeth/month		
Satisfy	41.2	36.1 - 46.5
Neither	19.1	15.3 - 23.8
Not satisfy	39.7	33.5 - 46.2
Self-reported dental pain		
No	82.7	79.0 - 85.9
Yes	17.3	14.1 - 21.0
Self-reported need for dental treatment		
No	35.9	28.2 - 44.5
Yes	64.1	55.5 - 71.8
Presence of decay teeth		
No	33.7	29.3 - 38.4
Yes	66.3	61.6 - 70.7
Presence of missing teeth		
No	17.7	13.5 - 22.9
Yes	82.3	77.2 - 86.5
Presence of filled teeth		
No	46.6	40.4 - 52.8
Yes	53.4	47.2 - 59.6
Regions		
North	34.7	24.4 - 46.5
Northeast	30.4	21.4 - 41.1
Southeast	13.8	8.8 - 20.8
South	8.7	5.1 - 14.5
Centre-West	12.4	6.9 - 21.4
Total	**100.0**	

Table A-3 - Association of colour/race and time since last dental visit. Results from the interaction and stratified analysis with level of education and income in a sample of 35-44-year-old adults, Brazil, 2010 (Binary logistic regression models).

		Pardos		Blacks	
		OR	**95% CI**	**OR**	**95% CI**
Level of education (years)	**Interaction analysis**				
	≤ 4	1.14	0.71 - 1.84	1.06	0.46 - 2.44
	5 – 8	0.96	0.57 - 1.63	1.22	0.49 - 3.06
	9 - 11	0.88	0.45 - 1.72	1.25	0.48 - 3.22
	≥12	1.67	0.80 - 3.48	1.71	0.55 - 5.33
	Stratified analysis				
	≤ 4	1.14	0.71 - 1.84	1.06	0.46 - 2.44
	5 – 8	1.10	0.78 - 1.54	1.30	0.73 - 2.28
	9 - 11	1.01	0.62 - 1.64	1.32	0.81 - 2.16
	≥12	1.90	1.06 - 3.42	1.80	0.83 - 3.94
Income (R$ - Brazilian *Reais*)	**Interaction analysis**				
	≤ 500.00	1.02	0.60 - 1.74	1.27	0.64 - 2.55
	501.00 – 1,500.00	1.10	0.59 - 2.04	1.09	0.48 - 2.50
	1,501.00 - 2,500.00	1.14	0.53 - 2.48	0.40	0.16 - 0.97
	≥ 2,501.00	1.35	0.66 - 2.79	1.26	0.33 - 4.78
	Stratified analysis				
	≤ 500.00	1.02	0.60 - 1.74	1.27	0.64 - 2.55
	501.00 – 1,500.00	1.12	0.86 - 1.47	1.39	0.82 - 2.39
	1,501.00 – 2,500.00	1.17	0.74 - 1.86	0.51	0.28 - 0.92
	≥ 2,501.00	1.39	0.85 - 2.24	1.62	0.50 - 5.24

Table A-4 - Association of colour/race reason to visit the dentist. Results from the interaction and stratified analysis with level of education and income in a sample of 35-44-year-old adults, Brazil, 2010 (Multinomial logistic regression models).

		Pardos		Blacks	
Prevention/check-up		**OR**	**95% CI**	**OR**	**95% CI**
Level of education (years)	**Interaction analysis**				
	≤ 4	1.48	0.59 - 3.69	1.56	0.42 - 5.79
	5 – 8	0.96	0.31 - 2.94	0.85	0.19 - 3.79
	9 - 11	0.91	0.32 - 2.85	0.90	0.21 - 3.77
	≥12	2.93	0.77 - 11.10	1.19	0.28 - 5.03
	Stratified analysis				
	≤ 4	1.48	0.59 - 3.69	1.56	0.42 - 5.79
	5 – 8	1.43	0.89 - 2.37	1.33	0.58 - 3.09
	9 - 11	1.35	0.86 - 2.10	1.40	0.70 - 2.78
	≥12	4.35	1.62 - 11.67	1.86	0.85 - 4.07
Income (R$ - Brazilian *Reais*)	**Interaction analysis**				
	≤ 500.00	3.59	0.99 - 12.90	2.10	0.54 - 8.13
	501.00 – 1,500.00	0.59	0.16 - 2.19	0.57	0.08 - 3.75
	1,501.00 - 2,500.00	0.24	0.05 - 1.09	0.49	0.10 - 2.40
	≥ 2,501.00	0.56	0.13 - 2.38	0.82	0.09 - 7.53
	Stratified analysis				
	≤ 500.00	3.59	0.99 - 12.9	2.10	0.54 - 8.13
	501.00 – 1,500.00	2.13	0.57 - 2.53	1.20	0.57 - 2.53
	1,501.00 – 2,500.00	0.88	0.49 - 1.57	1.03	0.43 - 2.48
	≥ 2,501.00	2.02	1.03 - 3.96	1.73	0.25 - 11.68
Treatment					
Level of education (years)	**Interaction analysis**				
	≤ 4	1.10	0.43 - 2.81	1.86	0.58 - 6.62
	5 – 8	1.16	0.38 - 3.52	0.31	0.07 - 1.31
	9 - 11	1.12	0.39 - 3.18	0.90	0.21 - 3.85
	≥12	2.85	0.89 - 9.17	0.66	0.14 - 3.00
	Stratified analysis				
	≤ 4	1.10	0.43 - 2.81	1.86	0.58 - 6.62
	5 – 8	1.27	0.76 - 2.13	0.58	0.24 - 1.39
	9 - 11	1.23	0.76 - 1.99	1.68	0.82 - 3.47
	≥12	3.14	1.54 - 6.04	1.22	0.55 - 2.71
Income (R$ - Brazilian *Reais*)	**Interaction analysis**				
	≤ 500.00	3.43	0.97 - 12.06	1.23	0.28 - 5.35
	501.00 – 1,500.00	0.49	0.12 - 1.98	0.94	0.15 - 5.99
	1,501.00 - 2,500.00	0.25	0.07 - 0.89	0.67	0.14 - 3.19
	≥ 2,501.00	0.46	0.12 - 1.87	1.48	0.22 - 9.84
	Stratified analysis				
	≤ 500.00	3.43	0.97 - 12.06	1.23	0.28 - 5.35
	501.00 – 1,500.00	1.68	1.11 - 2.55	1.16	0.61 - 2.22
	1,501.00 – 2,500.00	0.87	0.51 - 1.46	0.83	0.40 - 1.76
	≥ 2,501.00	1.59	0.90 - 2.81	1.83	0.56 - 5.99

Table A-5 - Association of colour/race and type of service used. Results from the interaction and stratified analysis with level of education and income in a sample of 35-44-year-old adults, Brazil, 2010 (Binary logistic regression models).

		Pardos		Blacks	
		OR	**95% CI**	**OR**	**95% CI**
Level of education (years)	**Interaction analysis**				
	≤ 4	1.54	0.94 - 2.52	1.34	0.60 - 3.00
	5 – 8	0.96	0.51 - 1.81	1.38	0.54 - 3.57
	9 - 11	1.06	0.57 - 2.00	1.28	0.45 - 3.62
	≥12	1.03	0.54 - 1.95	1.65	0.58 - 4.65
	Stratified analysis				
	≤ 4	1.54	0.94 - 2.52	1.34	0.60 - 3.00
	5 – 8	1.48	0.99 - 2.21	1.86	1.08 - 3.22
	9 - 11	1.64	1.11 - 2.43	1.72	0.92 - 3.21
	≥12	1.59	1.04 - 2.43	2.22	1.09 - 4.53
Income (R$ - Brazilian *Reais*)	**Interaction analysis**				
	≤ 500.00	1.29	0.68 - 2.45	1.58	0.69 - 3.65
	501.00 – 1,500.00	1.09	0.57 - 2.11	0.80	0.31 - 2.05
	1,501.00 - 2,500.00	1.64	0.63 - 4.30	1.32	0.44 - 3.92
	≥ 2,501.00	0.83	0.29 - 2.31	0.50	0.12 - 2.00
	Stratified analysis				
	≤ 500.00	1.29	0.68 - 2.45	1.58	0.69 - 3.65
	501.00 – 1,500.00	1.41	1.06 - 1.88	1.26	0.79 - 2.01
	1,501.00 – 2,500.00	2.12	1.14 - 3.95	2.09	0.97 - 4.53
	≥ 2,501.00	1.07	0.47 - 2.45	0.79	0.24 - 2.57

Table A- 6 - Distribution of colour/race and individual-level characteristics in the 35-44-year-old sample of SB Brazil, 2010. Analytical sample for the time since last dental visit as outcome (n=8,106).

Characteristics	**N**	**%**	**95% CI**
Colour/Race			
White	3,518	50.2	46.5 – 54.0
Pardo	3,763	39.2	35.5 – 43.0
Black	825	10.6	8.9 – 12.6
Sex			
Male	2,725	36.0	32.8 – 39.3
Female	5,381	64.0	60.7 – 67.2
Level of education (years)			
≤ 4	1,285	19.3	16.5 – 22.5
5 – 8	2,245	27.7	24.9 – 30.8
9 - 11	2,600	30.4	27.8 – 33.2
≥12	1,976	22.6	18.6 – 27.1
Income (R$ - Brazilian *Reais*)			
≤ 500.00	1,103	11.4	9.3 – 13.8
501.00 – 1,500.00	4,041	53.6	49.2 – 57.8
1,501.00 – 2,500.00	1,616	21.4	18.8 – 24.2
≥ 2,501.00	1,346	13.7	10.9 – 17.1
Self-reported satisfaction with teeth/month			
Satisfy	3,226	40.8	37.8 – 43.8
Neither	1,481	20.8	18.7 – 23.2
Not satisfy	3,399	38.4	35.3 – 41.6
Self-reported dental pain			
No	6,058	71.4	67.7 – 74.8
Yes	2,048	28.6	25.2 – 32.3
Self-reported need for dental treatment			
No	1,656	21.8	19.5 – 24.3
Yes	6,450	78.2	75.7 – 80.5
Presence of decay teeth			
No	3,298	47.0	43.8 – 50.2
Yes	4,808	53.0	49.8 – 56.2
Presence of missing teeth			
No	1,142	19.3	16.9 – 22.0
Yes	6,964	80.7	78.0 – 83.2
Presence of filled teeth			
No	1,514	14.9	12.8 – 17.3
Yes	6,592	85.1	82.7 – 87.2
Total	**8,106**	**100.0**	

Table A- 7 - Distribution of colour/race and individual-level characteristics in the 35-44-year-old sample of SB Brazil, 2010. Analytical sample for the reason to visit the dentist as outcome (n=8,143).

Characteristics	**N**	**%**	**95% CI**
Colour/Race			
White	3,529	50.2	46.5 – 54.0
Pardo	3,786	39.2	35.5 – 43.0
Black	828	10.6	8.9 – 12.6
Sex			
Male	2,734	36.0	32.8 – 39.3
Female	5,409	64.0	60.7 – 67.2
Level of education (years)			
≤ 4	1,290	19.3	16.5 – 22.5
5 – 8	2,268	27.8	25.0 – 30.9
9 - 11	2,605	30.3	27.7 – 33.1
≥12	1,980	22.5	18.6 – 27.0
Income (R$ - Brazilian *Reais*)			
≤ 500.00	1,110	11.4	9.3 – 13.8
501.00 – 1,500.00	4,065	53.6	49.2 – 57.8
1,501.00 – 2,500.00	1,621	21.4	18.8 – 24.2
≥ 2,501.00	1,347	13.7	10.9 – 17.1
Self-reported satisfaction with teeth/month			
Satisfy	3,239	40.8	37.8 – 43.8
Neither	1,484	20.8	18.6 – 23.1
Not satisfy	3,420	38.5	35.3 – 41.7
Self-reported dental pain			
No	6,080	71.4	67.8 – 74.8
Yes	2,063	28.6	25.2 – 32.2
Self-reported need for dental treatment			
No	1,664	21.8	19.5 – 24.3
Yes	6,479	78.2	75.7 – 80.5
Presence of decay teeth			
No	3,307	47.0	43.8 – 50.2
Yes	4,836	53.1	49.8 – 56.2
Presence of missing teeth			
No	1,146	19.3	16.9 – 22.0
Yes	6,997	80.7	78 – 83.1
Presence of filled teeth			
No	1,537	15.0	12.9 – 17.4
Yes	6,606	85.0	82.6 – 87.1
Total	**8,143**	**100.0**	

Table A- 8 - Distribution of colour/race and individual-level characteristics in the 35-44-year-old sample of SB Brazil, 2010. Analytical sample for the type of service used in the last dental visit as outcome (n=8,149).

Characteristics	**N**	**%**	**95% CI**
Colour/Race			
White	3,532	50.2	46.5 - 54
Pardo	3,788	39.2	35.5 - 43
Black	829	10.6	8.9 - 12.6
Sex			
Male	2,739	36.0	32.8 - 39.3
Female	5,410	64.0	60.7 - 67.2
Level of education (years)			
≤ 4	1,292	19.3	16.5 - 22.5
5 – 8	2,272	27.8	25 - 30.9
9 - 11	2,606	30.3	27.7 - 33.1
≥12	1,979	22.5	18.6 - 27
Income (R$ - Brazilian *Reais*)			
≤ 500.00	1,113	11.4	9.4 - 13.8
501.00 – 1,500.00	4,067	53.5	49.2 - 57.8
1,501.00 – 2,500.00	1,623	21.4	18.8 - 24.2
≥ 2,501.00	1,346	13.7	10.9 - 17.1
Self-reported satisfaction with teeth/month			
Satisfy	3,240	40.8	37.8 - 43.8
Neither	1,487	20.8	18.7 - 23.2
Not satisfy	3,422	38.4	35.3 - 41.7
Self-reported dental pain			
No	6,085	71.4	67.8 - 74.8
Yes	2,064	28.6	25.2 - 32.2
Self-reported need for dental treatment			
No	1,662	21.8	19.5 - 24.3
Yes	6,487	78.2	75.7 - 80.5
Presence of decay teeth			
No	3,307	46.9	43.8 - 50.2
Yes	4,842	53.1	49.8 - 56.3
Presence of missing teeth			
No	1,146	19.3	16.9 - 22
Yes	7,003	80.7	78 - 83.1
Presence of filled teeth			
No	1,540	15.1	12.9 - 17.4
Yes	6,609	85.0	82.6 - 87.1
Total	**8,149**	**100.0**	

Table A- 9 - Distribution of missingness, and its odds ratio according to the time since last dental visit sample size for colour/race and individual-level characteristics in 35-44-year-old sample of SB Brazil, 2010.

Variables	**n missing**	**Missingness (%)**	**OR**	**95% CI**	**p-value**
Colour/Race					
White	273	7.2	1		
Pardo	305	7.5	0.61	0.39 - 0.94	0.026
Black	71	7.9	0.94	0.53 - 1.67	0.834
Total	649	7.4			
Sex					
Male	251	8.4	1		
Female	398	6.9	0.88	0.59 - 1.30	0.517
Total	649	7.4			
Level of education (years)					
≤ 4	129	9.1	1		
5 – 8	188	7.7	1.21	0.72 - 2.02	0.475
9 - 11	155	5.6	0.52	0.34 - 0.80	0.003
≥12	136	6.4	0.72	0.43 - 1.21	0.222
Total	608	7.0			
Income (R$ - Brazilian *Reais*)					
≤ 500.00	58	5.0	1		
501.00 – 1,500.00	243	5.7	1.05	0.58 - 1.91	0.866
1,501.00 – 2,500.00	79	4.7	0.87	0.41 - 1.86	0.719
≥ 2,501.00	74	5.2	1.05	0.47 - 2.35	0.897
Total	454	5.3			
Self-reported satisfaction with teeth/month					
Satisfy	283	8.1	1		
Neither	114	7.1	0.86	0.53 - 1.41	0.563
Not satisfy	216	6.0	0.68	0.42 - 1.12	0.134
Total	613	7.0			
Self-reported dental pain					
No	490	7.5	1		
Yes	126	5.8	1.08	0.70 - 1.69	0.719
Total	616	7.1			
Self-reported need for dental treatment					
No	129	7.2	1		
Yes	358	5.3	0.63	0.34 - 1.15	0.129
Total	487	5.7			
Presence of decay teeth					
No	196	5.6	1		
Yes	289	5.7	1.30	0.84 - 2.00	0.239
Total	485	5.6			
Presence of missing teeth					
No	60	5.0	1		
Yes	425	5.8	1.17	0.72 - 1.90	0.528
Total	485	5.6			
Presence of filled teeth					
No	157	9.4	1		
Yes	328	4.7	0.64	0.42 - 0.98	0.039
Total	485	5.6			
Total missing overall	**579**	**6.7**			

OR – odds ratio

Table A- 10 - Distribution of missingness, and its odds ratio according to the reason to visit the dentist sample size for colour/race and individual-level characteristics in 35-44-year-old sample of SB Brazil, 2010.

Variables	**n missing**	**Missingness (%)**	**OR**	**95% CI**	**p-value**
Colour/Race					
White	262	6.9%	1		
Pardo	282	6.9%	0.59	0.38 - 0.94	0.026
Black	68	7.6%	0.9	0.49 - 1.65	0.732
Total	612	7.0%			
Sex					
Male	242	8.1%	1		
Female	370	6.4%	0.88	0.59 - 1.32	0.540
Total	612	7.0%			
Level of education (years)					
≤ 4	124	8.8%	1		
5 – 8	165	6.8%	1.18	0.68 - 2.03	0.553
9 - 11	150	5.4%	0.55	0.35 - 0.85	0.007
≥12	132	6.3%	0.74	0.43 - 1.26	0.266
Total	571	6.6%			
Income (R$ - Brazilian *Reais*)					
≤ 500.00	51	4.4%	1		
501.00 – 1,500.00	219	5.1%	1.08	0.57 - 2.04	0.814
1,501.00 – 2,500.00	74	4.4%	0.89	0.40 - 1.98	0.774
≥ 2,501.00	73	5.1%	1.06	0.45 - 2.47	0.888
Total	417	4.9%			
Self-reported satisfaction with teeth/month					
Satisfy	270	7.7%	1		
Neither	111	7.0%	0.88	0.53 - 1.45	0.609
Not satisfy	195	5.4%	0.64	0.38 - 1.08	0.098
Total	576	6.6%			
Self-reported dental pain					
No	468	7.1%	1		
Yes	111	5.1%	1.1	0.70 - 1.73	0.681
Total	579	6.6%			
Self-reported need for dental treatment					
No	121	6.8%	1		
Yes	329	4.8%	0.61	0.32 - 1.16	0.133
Total	450	5.2%			
Presence of decay teeth					
No	187	5.4%	1		
Yes	261	5.1%	1.27	0.80 - 1.99	0.301
Total	448	5.2%			
Presence of missing teeth					
No	56	4.7%	1		
Yes	392	5.3%	1.21	0.73 - 2.01	0.464
Total	448	5.2%			
Presence of filled teeth					
No	134	8.0%	1		
Yes	314	4.5%	0.73	0.46 - 1.13	0.161
Total	448	5.2%			
Total missing overall	**582**	**6.7**			

OR – odds ratio

Table A- 11 - Distribution of missingness, and its odds ratio according to the type of dental service used sample size for colour/race and individual-level characteristics in 35-44-year-old sample of SB Brazil, 2010.

Variables	**n missing**	**Missingness (%)**	**OR**	**95% CI**	**p-value**
Colour/Race					
White	259	6.8	1		
Pardo	280	6.9	0.59	0.38 - 0.94	0.025
Black	67	7.5	0.89	0.48 - 1.65	0.715
Total	606	6.9			
Sex					
Male	237	8.0	1		
Female	369	6.4	0.88	0.58 - 1.32	0.535
Total	606	6.9			
Level of education (years)					
≤ 4	122	8.6	1		
5 – 8	161	6.6	1.19	0.69 - 2.05	0.534
9 - 11	149	5.4	0.55	0.36 - 0.85	0.008
≥12	133	6.3	0.75	0.44 - 1.28	0.292
Total	565	6.5			
Income (R$ - Brazilian *Reais*)					
≤ 500.00	48	4.1	1		
501.00 – 1,500.00	217	5.1	1.13	0.59 - 2.17	0.710
1,501.00 – 2,500.00	72	4.2	0.91	0.40 - 2.08	0.832
≥ 2,501.00	74	5.2	1.13	0.48 - 2.66	0.770
Total	411	4.8			
Self-reported satisfaction with teeth/month					
Satisfy	269	7.7	1		
Neither	108	6.8	0.85	0.51 - 1.42	0.539
Not satisfy	193	5.3	0.64	0.38 - 1.08	0.097
Total	570	6.5			
Self-reported dental pain					
No	463	7.1	1		
Yes	110	5.1	1.1	0.70 - 1.74	0.675
Total	573	6.6			
Self-reported need for dental treatment					
No	123	6.9	1		
Yes	321	4.7	0.6	0.31 - 1.14	0.118
Total	444	5.2			
Presence of decay teeth					
No	187	5.4	1		
Yes	255	5.0	1.26	0.80 - 1.98	0.322
Total	442	5.1			
Presence of missing teeth					
No	56	4.7	1		
Yes	386	5.2	1.2	0.72 - 2.00	0.487
Total	442	5.1			
Presence of filled teeth					
No	131	7.8	1		
Yes	311	4.5	0.74	0.47 - 1.16	0.188
Total	442	5.1			
Total missing overall	**582**	**6.7**			

OR – odds ratio

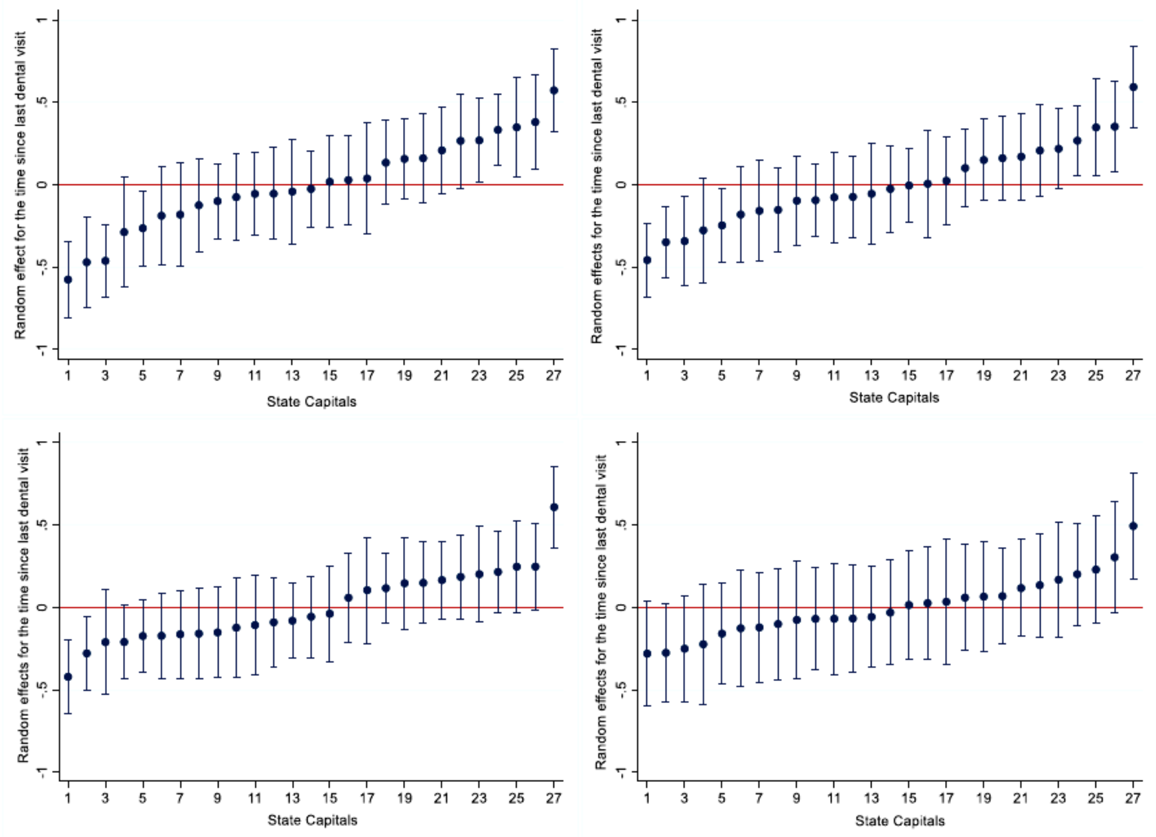

Figure A-2 - Caterpillar plots of the State Capitals effect for the time since last dental visit among 35-44-year-olds sampled from SB Brazil, 2010.

Four plots are presented: the null model (top left), model adjusted for colour/race (top right), the further adjustment for individual-level characteristics (bottom left), and the final model with all covariates including contextual-level characteristics (bottom right).

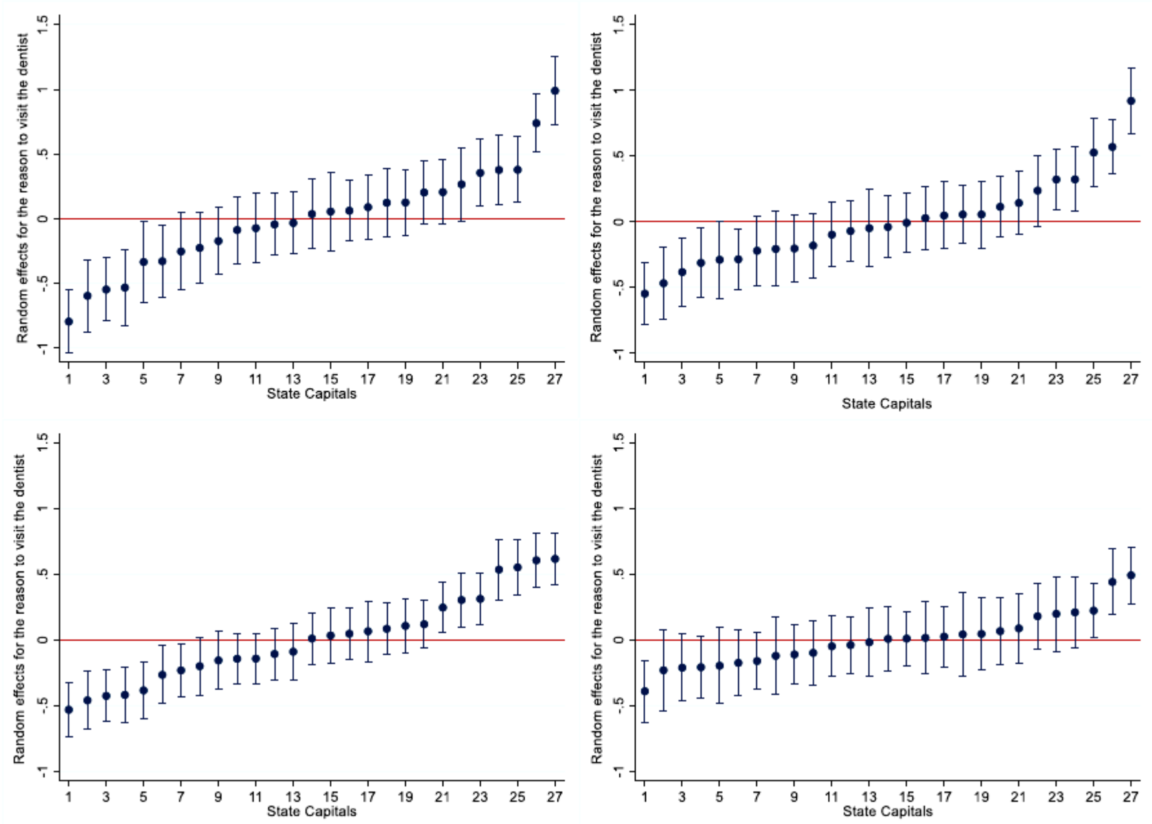

Figure A-3 - Caterpillar plots of the State Capitals effect for the reason to visit the dentist among 35-44-year-olds sampled from SB Brazil, 2010.

Four plots are presented: the null model (top left), model adjusted for colour/race (top right), the further adjustment for individual-level characteristics (bottom left), and the final model with all covariates including contextual-level characteristics (bottom right).

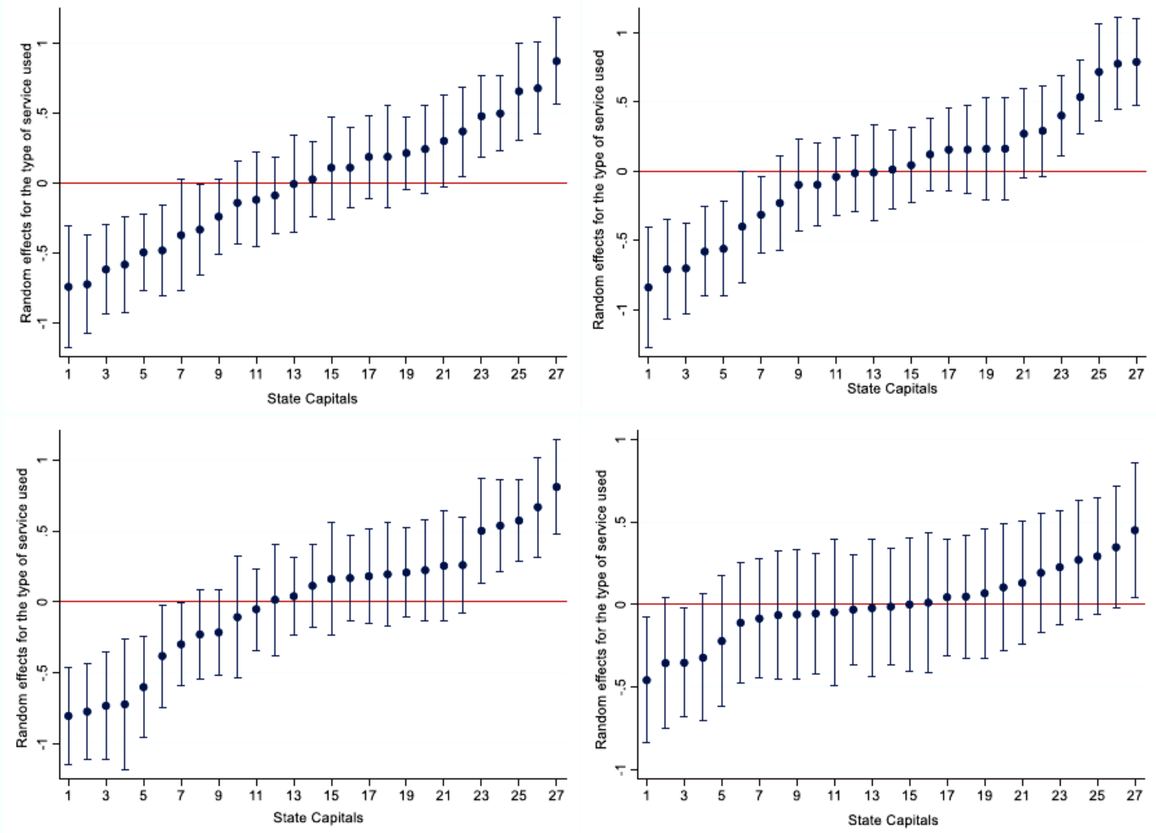

Figure A-4 - Caterpillar plots of the State Capitals effect for the type of service used among 35-44-year-olds sampled from SB Brazil, 2010.

Four plots are presented: the null model (top left), model adjusted for colour/race (top right), the further adjustment for individual-level characteristics (bottom left), and the final model with all covariates including contextual-level characteristics (bottom right).

PRESENTER IN MEETINGS / CONFERENCES

2018 Constante HM, Tsakos G, Watt R. Racial inequalities in types of dental service: multilevel approach among Brazilians. In: 96th General Session & Exhibition of the International Association for Dental Research (IADR). **London/UK**

2018 Constante HM, Tsakos G, Watt R. Racial inequalities in dental service utilisation amongst middle-aged Brazilian adults: a multilevel approach. In: 1st World Congress on Migration, Ethnicity, Race and Health. **Edinburgh/UK**

2017 Constante HM, Tsakos G, Watt R. Racial inequalities in dental service utilisation amongst middle-aged Brazilian adults. In: Society for Social Medicine annual scientific meeting. **Manchester/UK**

CONFERENCE PUBLICATION

Constante, H.M.; Tsakos, G.; Watt, R. G. Racial inequalities in dental service utilisation amongst middle-aged Brazilian adults: a multilevel approach. In 1st World Congress on Migration, Ethnicity, Race and Health, Edinburgh/UK**. European Journal of Public Health**; Abstract supplement; 2018; 28(Suppl1):3.10-P11

Constante, H. M.; Tsakos, G.; Watt, R. G. Racial inequalities in dental service utilisation amongst middle-aged Brazilian adults. In: Society for Social Medicine annual scientific meeting 2017, Manchester. **Journal of Epidemiology & Community Health** - SSM annual scientific meeting 2017; 71(Suppl 1): A64-A5, P29.