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Inequities in inpatient care among children: the role of socioeconomic determinants

Curso de Mestrado em Saúde Pública

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Julho de 2024

NOVA ESCOLA NACIONAL DE SAÚDE PÚBLICA

Inequities in inpatient care among children: the role of socioeconomic determinants

Dissertação apresentada para cumprimento dos requisitos necessários à obtenção do grau de Mestre em Saúde Pública, realizada sob a orientação científica do Professor Doutor João Pereira

Julho de 2024

AGRADECIMENTOS

Agradeço ao Professor Doutor João Pereira todo o apoio, disponibilidade e sensata orientação, incentivando-me a ver os pontos fortes e a fazer sempre melhor. A atitude calma com que me orientou foi fundamental para permitir desenvolver esta disertação no meu tempo, sem deixar (muito) para trás outras tarefas e compromissos.

Aos colegas de Mestrado, agradeço o companheirismo, a partilha, a amizade e os debates apaixonados sobre os mais diversos temas.

Aos meus camaradas das diversas lutas, agradeço terem-se contentado com o contributo que me foi possível dar e terem compreendido as minhas ausências. Tenho a certeza que este trabalho me traz bagagem que me permitirá ser mais forte na luta.

À família e aos amigos, agradeço a espera pelas visitas que não fiz, pelas saídas a que não fui e pelas palavras que não trocámos. Bem sei que o tempo não se recupera, mas temos um tempo novo à nossa frente.

Ao Alexandre. Por me compreenderes, por me ajudares a ultrapassar os meus limites, por me fazeres ser melhor a cada dia, por veres em mim muito mais do que eu própria vejo. Por me apoiares incondicionalmente, mesmo sabendo que significa menos tempo juntos. Por seres meu companheiro.

Por último, às crianças e famílias de Amadora e de Sintra. É um prazer imenso pertencer a esta comunidade.

ABSTRACT

Introduction: Socioeconomic inequities influence children's health and have been associated with longer hospitalisation and clinical severity. This study aims to analyse health inequities, focusing on hospitalisation indicators, and the contribution of demographic and socioeconomic factors in a paediatric population in Amadora and Sintra.

Methodology: A cross-sectional study was conducted, using the local public hospital's records of children hospitalised between 2014 and 2021. Inpatient care, assessed by length of hospital stay (LOS) and admission to intensive care unit (ICU), as well as demographic and socioeconomic factors, were analysed through bivariate and multivariate analysis. Health inequalities were measured using concentration curves and indices for the population ranked by civil parishes' European Deprivation Index.

Results: The study considered 8 016 admissions. Health inequities associated with socioeconomic deprivation were evident, with concentration curves above the diagonal for LOS (concentration index -0.137) and admission to ICU (concentration index -0.147). Neonatal age had the strongest effect on LOS (B = 7.97 days, 95% CI 6.90; 9.04) and admission to ICU (OR = 11.86, 95% CI 7.64; 18.41), followed by Asian ethnicity (B = 5.14 days (95% CI 1.15; 9.13). Black ethnicity, language other than Portuguese, Creole/Fulah or Asian, mother's lower education level and unskilled jobs significantly increased LOS. Odds of admission to ICU were significantly higher for male gender, Asian language and father's occupation in security, personal care and manual work.

Conclusions: Socioeconomic inequities were evident for both inpatient paediatric hospital care indicators, with a strong impact of ethnic factors. Public health policies should be culturally competent and implemented early in life.

Keywords: health inequities; socioeconomic disparities in health; socioeconomic determinants of health; ethnic and racial minorities; children

RESUMO

Introdução: As iniquidades socioeconómicas influenciam a saúde em idade pediátrica e estão associadas a internamentos mais longos e maior gravidade clínica. O objetivo deste estudo foi analisar as iniquidades em saúde, focando em indicadores de internamento, e o contributo de fatores demográficos e socioeconómicos, numa população pediátrica de Amadora e Sintra.

Metodologia: Estudo transversal, recorrendo aos registos do hospital público local, de crianças internadas entre 2014 e 2021. Foram analisadas as necessidades de cuidados hospitalares, medidas através da duração de internamento e internamento em unidade de cuidados intensivos (UCI), bem como fatores demográficos e socioeconómicos, mediante análise bivariada e multivariada. As iniquidades em saúde foram medidas através de curvas e índices de concentração para a população ordenada pelo Índice de Privação Europeu das freguesias.

Resultados: Foram analisados 8 016 internamentos. Foram evidentes iniquidades em saúde associadas a privação socioeconómica, com curvas de concentração acima da diagonal para duração de internamento (índice de concentração -0.137) e internamento em UCI (índice de concentração -0.147). A idade neonatal registou o maior impacto na duração de internamento (B = 7.97 dias, IC 95% 6.90; 9.04) e internamento em UCI (OR = 11.86, IC 95% 7.64; 18.41), seguida de etnia Asiática (B = 5.14 dias, IC 95% 1.15; 9.13). A etnia Negra, outro idioma que não Português, Crioulo/Fula ou Asiático, baixo nível de educação materna e profissão materna não diferenciada demonstraram associação significativa com maior duração de internamento. A possibilidade de internamento em UCI foi significativamente maior para o género masculino, idioma Asiático e profissão paterna nas áreas de segurança, cuidados pessoais e trabalhos manuais.

Conclusões: Foram evidentes iniquidades socioeconómicas para ambos os indicadores de cuidados hospitalares pediátricos, com forte impacto de fatores étnicos. São necessárias políticas de saúde pública que sejam culturalmente competentes e iniciadas precocemente no ciclo de vida.

Palavras-chave: iniquidades em saúde; desigualdades soioeconómicas em saúde; determinantes sociais da saúde; minorias étnicas e raciais; crianças

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LIST OF ABBREVIATIONS AND ACRONYMS

APA	American Psychological Association
CI	Confidence interval
CSDH	Commission on Social Determinants of Health
EDI	European Deprivation Index
EU	European Union
IC	Intervalo de confiança
ICD	International Classification of Diseases
ICU	Intensive care unit
IQR	Interquartile range
LOS	Length of hospital stay
NGO	Non-governmental organisation
OR	Odds ratio
PMM	Predictive mean matching
SD	Standard deviation
SDG	Sustainable Development Goal(s)
SDH	Social determinant(s) of health
UCI	Unidade de cuidados intensivos
USA	United States of America
VIF	Variance inflation factors
WHO	World Health Organization

1. INTRODUCTION

Health status is influenced by socioeconomic factors, which are differently distributed within and across communities and countries. The social determinants of health (SDH) are defined as "the conditions in which people are born, grow, live, work and age" (CSDH, 2008, p. 26).[1] A social gradient generating a health gradient has been described: the lower the socioeconomic status, the worse the health status.[2] In this sense, the concept of health inequity goes beyond that of health inequality, in so far as inequity is interpreted in the field of ethical principles and human rights. Health inequities refer to systematic disparities between groups with different socioeconomic levels, being perceived as socially unfair.[2,3] Not all health inequalities are inequitable; they could be related to biological factors and not systematically related to socioeconomic disparities.[3] However, the two terms are often used interchangeably.[3,4]

Equity in health can be analysed at various levels: health status, financing, access, need or utilisation of healthcare.[4,5] Systematic health inequalities in hospitalisation rates, intensive care need and length of hospital stay (LOS) associated with socioeconomic deprivation have been reported in previous studies.[6–10] Utilisation of health services is closely linked with health status and need, as disadvantaged individuals need to consume more healthcare care resources due to worse health status.[11] The present study focuses on inpatient care variables: LOS and admission to intensive care unit (ICU). These variables are measures of hospital care utilisation and depend on health need according to patient's clinical status and evaluation by physicians. Therefore, systematic differences in these hospital care variables related to sociodemographic factors can be interpreted as inequities in health need.[11]

According to Marmot, health inequities are the result of unequal distribution of income, goods and services, and bad social policies, which generate uneven opportunities and different structural conditions of daily life for some groups.[1] The World Health Organization (WHO) launched the Commission on Social Determinants of Health (CSDH) in 2005 to help countries resolve health inequities.[1] Reducing inequities is aligned with the United Nations' 2030 Agenda for Sustainable Development and its goals[12] and is also one of the main goals of Portugal's National Health Plan 2030, which places SDH at the centre of the conceptual framework.[13]

Socioeconomic inequities emerge early in life, starting *in utero*, and persist into adulthood and across generations.[14] Children are vulnerable to the socioeconomic conditions in which they live and grow, especially the circumstances of their carers (such as income, education, lifestyle and health status). Significant associations between most socioeconomic factors studied and a wide range of health and developmental outcomes in children have been reported in the literature.[15]

The municipalities of Amadora and Sintra, located on the outskirts of Lisbon, are known for having clusters of socioeconomic vulnerability.[16,17] Immigration and the consequent ethnic and cultural diversity are strong features, most commonly from Brazil and Portuguese-speaking African countries,[18] and additionally a growing proportion of new arrivals from Asian countries over recent years.[18,19] This renders Black ethnicity more prevalent than in the remainder of Portugal. Black individuals usually face greater disadvantage compared to other ethnicities.[20,21] Moreover, some clinical conditions are more prevalent among certain ethnicities.[22]

The present study aims to answer the question on whether there are health inequities among children living in Amadora and Sintra, and how socioeconomic factors are associated with health inequities.

There are a few studies about the impact of SDH on the health of immigrant children[23–27] and children of African descent[28] living in Amadora. However, to our knowledge, there are no studies involving the immigrant as well as non-immigrant paediatric population. Moreover, Sintra, the neighbouring and more populous municipality, is seldom subject to study on this matter. It is relevant to investigate the two municipalities, as they share healthcare resources and demographic and socioeconomic features of vulnerability. The purpose of the present work is to expand the existing research in Portugal about paediatric SDH, focusing on the populations of Amadora and Sintra because of their unique sociodemographic characteristics.

The present study is structured in six sections, including this first introductory section. The second section presents a literature review on the study's topics, which addresses the key theories on the impact of socioeconomic factors on children's health, focusing on the pathways of generation of health inequities and how they evolve throughout the life cycle. Specific features of the two municipalities of study are also considered. The main and specific objectives of the study are presented in this section. The third section presents the methodology used, including sample selection and the statistical analysis performed. The results are presented in the fourth section and discussed according to the literature in the fifth section. The discussion includes three subsections: the first on the strengths and limitations found during the development of this work, and the second and third subsections respectively presenting recommendations for future research and for public health policies, based on the study's findings. Finally, the sixth section contains the main conclusions.

2. BACKGROUND

2.1. The influence of social determinants on children's health and development

The most acknowledged model of the SDH is that proposed by Dahlgreen and Whitehead (1991), which is based on a holistic approach that takes into account the multiple dimensions of individuals (genetic, biological, behavioural and lifestyle), the relationships with social networks and the physical, cultural, socioeconomic and political environment (Figure 2.1).[29] At the centre of the model lie the fixed characteristics of the individuals (genetics, biology, ethnicity). The surrounding concentric layers comprise potentially modifiable influencing factors. This model provides the principles to intervene on SDH at their various levels.

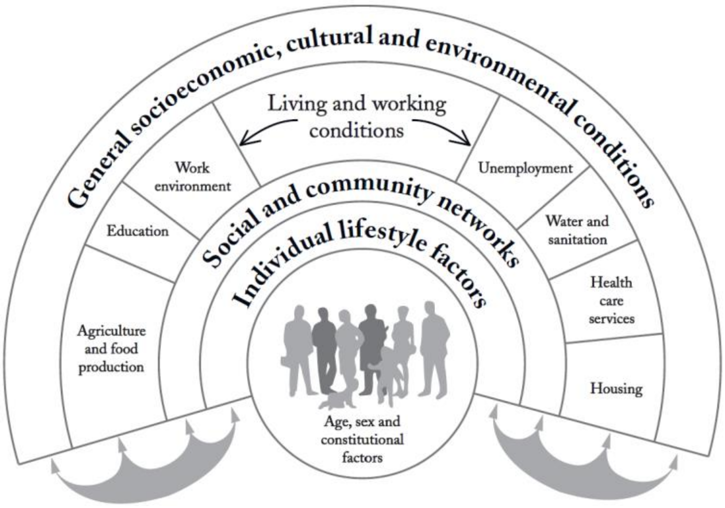


Figure 2.1: The model of social determinants of health by Dahlgren and Whitehead.

Source: Dahlgren G, Whitehead M, World Health Organization. Levelling up (part 2): a discussion paper on European strategies for tackling social inequities in health. Copenhagen: WHO Regional Office for Europe; 2006.[30] With permission.

Children are particularly vulnerable to the socioeconomic circumstances they live in. They depend on their carers and are unable to modify their socioeconomic circumstances, at least during infancy. UNICEF conceptualised a SDH framework for children, as depicted in Figure 2.2,[31] which is based on the abovementioned Dahlgren and Whitehead Social Model of Health[29] and on the Ecological Systems Theory by Urie Bronfenbrenner[32]. The child lies at the centre of the framework; outcomes in his or her life and health are influenced by the world of the child, the world around the child and the world at large.[31] All of the SDH are inter-related, both within and between circles.[29,31] The **world of the child** consists of the closest determinants to individual health: the child's biology, activities such as playing and learning, health behaviours and lifestyle, but also the child's proximal interactions.[14,31] These interactions occur mainly with carers/parents and also with friends/peers and significant subjects at school.[14,31] The **world around the child** consists of economic resources (the socioeconomic status in the household, which is determined by carers' work, income and education); the quality of the neighbourhood; and networks influencing the child's health directly or indirectly (e.g., the community, childcare and school, parents' workplace policies towards flexible schedules and parental leave).[14,31] Finally, **the world at large** refers to macro-level political, social, economic, environmental, educational and healthcare policies.[14,31] These are the structural factors that influence individuals' and communities' socioeconomic circumstances: childcare and schools, health services and broad health policies, labour laws, welfare and social support systems.

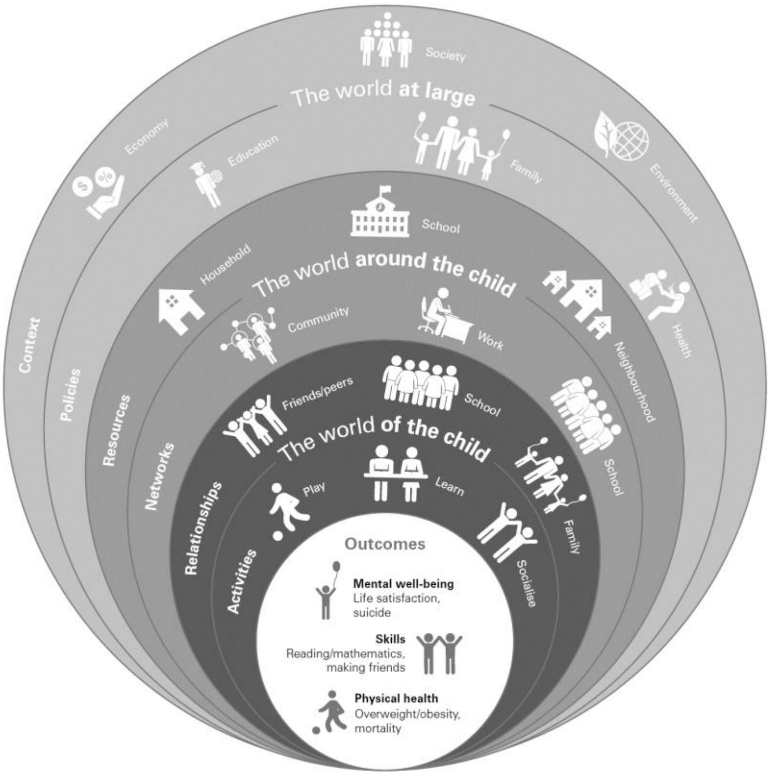


Figure 2.2: Framework of social determinants of health for children.

Reproduced from UNICEF Innocenti. Source: UNICEF Innocenti. Worlds of Influence: Understanding what shapes child well-being in rich countries. Innocenti Report Card 16. Innocenti, Florence: UNICEF Office of Research; 2020.[31] With permission.

General health, perinatal and infant mortality, and developmental outcomes have been shown to be influenced by socioeconomic factors.[15] Tuberculosis, obesity, anxiety disorders, hypertension, poisoning, premature birth, low birth weight, and perinatal hypoxia and trauma are the conditions that have shown greater socioeconomic inequities in the literature.[33] Evidence of this link has also been found for under-five mortality, asthma, dental caries, lower cognitive function, visual impairments, mental health problems and for specific causes of death later in life (coronary heart disease, respiratory disease, stroke and stomach cancer).[15,34,35]

Associations of socioeconomic disadvantage with needed hospital care utilisation have also been found.[15] Children with lower socioeconomic background face higher rates of hospitalisation[7,8] and longer LOS[6,9,36]. Higher risk of hospitalisation for infectious diseases in children 0 to 2 years old associated with low family's income and mother's low education level has been reported.[8] Additionally, increased risk of admission to ICU and thus worse health status has been correlated to childhood poverty.[37]

Deprivation and health differences vary together across regions and neighbourhoods.[38] Several hotspots of socioeconomic inequities have been described, including in Portugal[39], having impact on children's hospitalisation rates and length of stay.[40] The physical and environmental quality of the neighbourhoods – like housing quality, water and sanitation, air pollution and greenness – have a direct influence on health.[2] Furthermore, community resources, such as existing schools, childcare and healthcare centres, other support structures, employment availability and overall socioeconomic position of the community, all play a role.[31] A systematic review by Pillas et al found that most studies use composite measures to define neighbourhood deprivation, which include area-level unemployment, low social class, low income, lack of car tenure and living in a high-population density area. Of these, 80% of associations with poorer childhood health/developmental outcomes were reported as significant.[15]

Household and family's characteristics also have an important impact on child developmental and health outcomes, with 62% of associations being significant.[15] Housing tenure; parents' income, education and employment; and material deprivation are among household-level social factors showing the most significant associations.[15]

SDH reciprocally influence and are influenced by child health. The Health Selection Theory describes the effects of ill health on education and employment.[14] Poor health affects the ability of parents to have stable jobs and to obtain income, which in turn may lead to material deprivation, food insecurity and poor household and neighbourhood conditions.[41,42] This is true in the scenario of parental illness, but also in a family with an ill child having to deal with work absenteeism and healthcare expenses.

A recent example of the reciprocal influence between health and social determinants is the SARS-CoV-2 pandemic. Lower class jobs, household crowding, poor household conditions, low income and low education level led to increased risk of infection.[43,44] On the other hand, the pandemic itself and the lockdowns caused unemployment and reduction in families' income, weight gain due to physical inactivity and unhealthy diet, mental health problems, education inequities and disruption of access to healthcare services, including perinatal and paediatric care, with disadvantaged groups being disproportionately affected.[43,45]

2.1.1. Pathways for health inequities in children

Some authors have proposed theories on the pathways through which social determinants influence children's health.[46–48] Pearce et al summarised those theories into four pathways: material, psychosocial, behavioural and structural.[14]

Material pathway

The material pathway refers to material living conditions. Family income influences housing conditions like warmth and exposure to air pollutants, access to nutritious foods and to healthcare – all of which influence health.[14] There is evidence of a social gradient between lower family income and disability, serious or long-standing illness and premature death.[49] This gradient is also evident for the risk of attention deficit hyperactivity disorder, severe limiting illness and sleep-limiting wheeze.[50]

Psychosocial pathway

Social disadvantage has a stressful impact on the mental health of carers and their children, which in turn affects health behaviours and health status. Long-term exposure to stressful circumstances, such as low income, job insecurity and social isolation, has a cumulative risk for mental health and premature death, a risk that is higher for low social class populations.[49] Biologically, psychosocial factors affect physical health through neuronal and endocrine mechanisms, raising heart rate, blood pressure and alertness, in the same way of the fight or flight response.[51] The psychosocial pathway likely interacts with other pathways and influences socioeconomic circumstances. For instance, parents who continuously deal with anxiety and depression will have less control on housing quality and lower availability for employment.

Behavioural pathway

This pathway refers to lifestyle, such as diet, physical activity, leisure, smoking and alcohol consumption. Parenting skills and parents' health-related behaviours have a direct role on children's health.[14] Children have no control over nutrition, activities and exposure to harmful substances during prenatal and early postnatal years. As they age, health behaviours are still strongly influenced by cohabitants and peers. For example, mealtime family interactions and parents' dietary options are associated with childhood overweight and obesity and thus cardiovascular risk.[52]

The individual focus posed by the behavioural pathway has been contested, as health behaviours are affected by material, psychosocial, and structural pathways.[14] In fact, unhealthy behaviours tend to be more prevalent among socially disadvantaged groups.[53]

Structural pathway

The political, socioeconomic, commercial, cultural and environmental structures in a community or society, as depicted in the outer layers of Figure 2.2, determine the distribution of resources and are considered by some authors to be the primary causes of health inequity.[14,54] Healthcare and childcare services, educational systems, housing policies, taxation, redistribution of income and social welfare are powerful tools that can create or reduce inequity across populations and exert their effect on the other pathways.[14]

2.1.2. Social determinants of health throughout the life course

Early childhood is increasingly recognised as a key period to the individual's physical, mental and social capacities across life span.[34] This period starts as early as pre-conception and determines many adult life characteristics.[34,35] Brain development is highly sensitive to external factors during early infancy. Nutrition (both pre and postnatal), external and cultural stimuli, neighbourhood, carers' education and occupation affect physical and cognitive development and also social and emotional development.[2] Suboptimal biological and developmental conditions during this period may have irreversible consequences in later life, influencing risk of obesity, malnutrition, heart disease and mental health problems.[2]

Disadvantage persists across life and is transmitted to the next generations; this has been linked to the life trajectories of children, through a cumulative process of continuous interaction between exposures.[35] Children's circumstances affect children's health and both shape adult circumstances and adult health by determining the resources available throughout life.[35,55] The effect of childhood on adult health persists even after accounting for adult socioeconomic position.[55]

The influence of socioeconomic factors seems to increase in significance as children age. In the systematic review by Pillas et al, 58% of evaluated associations measured during pre and perinatal life were significant, 54% in early infancy, 64% in toddler age and 68% in preschoolers.[15] This suggests a cumulative effect of these factors throughout childhood.

Stressful socioeconomic disadvantage can influence the gene expression through mechanisms of DNA methylation, thus modelling health since childhood and even prenatally.[56,57] Although still with inconsistent findings in humans, there is a promising field of research in epigenetics.[58]

There are critical transitions in life that can shift individuals and societies into a more or less advantaged trajectory: material and emotional changes during early childhood, entering into school, moving on to the next education level, entering labour market, changing jobs, leaving parents' home, starting a family, and retirement.[49] However, influential factors change with age. The mother or the main carer is particularly important during pregnancy and early infancy, while school and neighbourhood become increasingly influential later in childhood and adolescence.[14,49] Social and public health policies must offer safety nets adapted to these critical milestones.

Childhood poverty is a strong predictor of physical and emotional health, cognitive development and health behaviours in adulthood, such as smoking[59] and unhealthy diet[60]. If present during adolescence, these behaviours tend to persist into adulthood.[35,61] Being born in poverty and continuing poverty into adulthood confers a high risk of poor health in adulthood.[35] This means that policies directed at reducing health inequities must be accompanied by interventions that tackle childhood poverty.

Education is a strong predictor of socioeconomic status and health gradients and exerts its effect across generations. Adolescents with poor school performance are at higher risk of unprotected intercourse, tobacco, drug and alcohol use and shorter life expectancy.[62] Parents' higher education level is associated with healthier diet and better education attainment of children, which in turn is related to higher income, more skilled jobs and living in safer neighbourhoods.[55,62–64] Mother's education level is particularly important, as caring for children is still a predominantly female role worldwide. Mother's education is associated with better birth weight and weight- and height-for-age and to earlier preventive care in children.[65]

Parental education determines parental professional occupation, the household's income and health. The effect of parental occupation is mediated through income, work stress and physical and mental health, with a greater impact among children younger than six years.[66] Some authors postulate a "family process" framework: higher income works either through direct investment on health-promoting goods and through improvement of family's emotional environment in which children grow.[67] The effect is reportedly larger for the father's occupation compared to the mother's.[64]

Socioeconomic disadvantage has also been linked to ethnic health inequity, starting before birth. Children of Black mothers have higher rates of preterm birth, low birth weight and infant mortality.[68,69] These have been linked to poverty, lower maternal education and social stress, which are more prevalent among Black women.[69] However, ethnic disparities persist independently of maternal age, education and adequacy of prenatal care.[68,69] Risk of preterm birth remains high among Black women who were themselves low birth weight children born in impoverished settings and who experienced improvement of economic status, suggesting that *in utero* exposure to poverty, with resulting foetal growth restriction, programs future reproductive physiology.[68]

Ethnic disparities in health go on throughout life. A review by Monroe et al found greater disadvantage for Black adolescents and young adults concerning economic stability, access to and quality of education and healthcare, and quality of the neighbourhood.[70]

Interestingly, Harding et al report contradictory results. According to the Determinants of young Adult Social wellbeing and Health (DASH) study, adolescents in the United Kingdom of Indian, Pakistani, Bangladeshi and Black descent tend to be more exposed to socioeconomic disadvantage than White adolescents; on the other hand, these groups reported better mental health, even after adjustment for socioeconomic circumstances, which the authors related to parental support and discipline, family connectedness and cultural diversity.[71] Despite this advantage, these ethnic groups showed a trend towards worse physical health, with higher systolic blood pressure, lower lung function, higher likelihood of asthma and higher rates of overweight, which the authors attributed to biological inheritance of previous generations.[71]

All these observations suggest that differences in socioeconomic status play a role but do not account for the whole ethnic gap. Exposure to racism and discrimination likely explain part of the cause.[70,71]

Ethnic diversity is closely linked with immigration. Immigrant children and their parents usually have worse health condition and higher rates of treatable diseases.[25,72] Besides the abovementioned factors, several other factors contribute to health inequity among immigrants, including reduced access to healthcare services, language barriers and lack of access to citizenship and welfare, especially among the undocumented.[72] Children of immigrant families are more exposed to poverty, poorer nutrition, housing insecurity and mental health stressors.[72] In addition, immigrant parents and their children have lower education attainment, which further aggravates the socioeconomic and health gaps.[21,72]

2.2. Municipalities of Amadora and Sintra as case studies for health inequities

Amadora and Sintra municipalities went through a territorial organisation in 2013, with fusion of civil parishes into larger units. Amadora has six civil parishes, all predominantly urban (Águas Livres, Alfragide, Encosta do Sol, Falagueira - Venda Nova, Mina de Água and Venteira). Sintra has 11 civil parishes, four of which are predominantly rural (Almargem do Bispo, Pêro Pinheiro e Montelavar; Colares; São João das Lampas e Terrugem; and Sintra) and the remaining seven civil parishes (Agualva e Mira Sintra; Algueirão - Mem Martins; Cacém e São Marcos; Casal de Cambra; Massamá e Monte Abraão; Queluz e Belas; Rio de Mouro) are predominantly urban.

The municipalities of Amadora and Sintra have some clusters of socioeconomic vulnerability compared to Continental Portugal. Table 2.1 summarises the main demographic and socioeconomic characteristics of the population. Located in Lisbon's suburban area, Sintra and Amadora are respectively the second and the tenth most populous municipalities in the country, together comprising 557 060 residents in 2021 (5.6% of Continental Portugal's population). Both municipalities have young populations (26.2% are 0 to 24 years old, compared to 23.2% in Continental Portugal).[73] Birth and infant mortality rates are higher than Continental Portugal's.[74,75]

Immigration is a strong feature of the two municipalities. Sintra is the second and Amadora the fourth municipality of the country with more residents of foreign origin, with 19.2% of the inhabitants in this condition in 2021, compared to 10.6% in Continental Portugal.[18] Reflecting the country's colonial past, the most frequent country of origin is Brazil (23.0%) followed by Angola (19.0%); more than half (54.2%) of immigrants are from Portuguese-speaking African countries (10.4% of the total population of the two municipalities, compared to 3.2% of Continental Portugal's population).[18] This eventually makes Black ethnicity an important feature of the population, along with its biological and pathological background. In recent years there has been an increasing number of immigrants from Asia, making up 4.5% of the foreign population in Amadora and Sintra.[18,19]

Secondary level is the most frequent completed education level in both municpalities.[76] Compared to Continental Portugal, each of the two municipalities have lower rates of no education level completed and a comparable higher education level.[76] Average monthly wage is higher in both municipalities than in Continental Portugal's,[77] especially in Sintra, although the unemployment rate is higher.[78]

Table 2.1: Demographic, socioeconomic and healthcare access characterisation of the population of Amadora and Sintra.

	Amadora	Sintra	Portugal
Resident population	171 454	385 606	9 917 206
0-24 years old	42 409 (24.7%)	103 526 (26.8%)	2 296 356 (23.2%)
Residents of foreign origin	34 561 (20.2%)	72 615 (18.8%)	1 056 647 (10.6%)
Birth rate	10.6‰	10.6‰	8.0‰
Infant mortality rate	3.8‰	2.7‰	2.6‰
Education level[a]			
No level completed	7 143 (4.8%)	12 781 (3.9%)	499 245 (5.8%)
1st or 2nd basic	38 286 (26.0%)	76 079 (23.1%)	2 718 605 (31.6%)
3rd basic	27 611 (18.8%)	68 259 (20.8%)	1 528 976 (17.8%)
Secondary	39 806 (27.1%)	101 246 (30.8%)	2 028 868 (23.6%)
Higher	32 260 (21.9%)	64 960 (19.8%)	1 717 145 (20.0%)
Average monthly wage[b]	1 426 €	1 221 €	1 206 €[c]
Unemployment rate	9.9%	9.1%	8.1%
No access to family doctor[d]	47 686 (27.1%)	112 896 (30.5%)	1 139 340 (10.9%)

Data source: Portuguese Census 2021[18,73–78] and Transparência SNS[79]. Data for 2021 and Continental Portugal, unless specified otherwise.

[a] Population 15 years or older with complete education level.

[b] Includes payments for supplementary work, subsidies and productivity prizes. Data for 2019.

[c] Data for the whole country, including Autonomous Islands.

[d] Among citizens registered in primary healthcare centres.

The healthcare structures in the two municipalities comprise a local public hospital and two groups of primary healthcare centres (one for each of the municipalities). Primary healthcare centres are organised in units located throughout the territory: nine units in Amadora and 29 units in Sintra.[80] The local public hospital is a secondary care unit serving the two municipalities in general, with the exception of the Northern and Western Sintra's civil parishes (São João das Lampas e Terrugem; Almargem do Bispo, Pêro Pinheiro e Montelavar; Colares; Sintra; and Algueirão - Mem Martins), which correspond to 25.4% of the two municipalities' resident population 24 years old or younger. These five civil parishes are served by another public hospital located in a neighbouring municipality (contiguous to Sintra and at approximately 22 km from the public hospital of Amadora and Sintra) for maternal and paediatric services. Nevertheless, citizens can choose which hospital they use. Additionally, there are private health units in Amadora and Sintra, which have increased in number over recent years. By the end of the study period, there were five main private units in Amadora and Sintra, but only one with a paediatric ward (which is a mental health inpatient care unit). There are six hospitals with paediatric inpatient care in Lisbon (three public and three private), located at a distance varying between 7 and 15 km from the public hospital of Amadora and Sintra.

Access to primary healthcare is seriously conditioned in Amadora and Sintra, where 29.4% of citizens registered in primary healthcare centres have not been attributed a family doctor.[79] Hence, people in this region rely substantially on hospital emergency services. Each year during the study period, the number of paediatric emergency episodes varied between 58 485 and 62 263 and decreased only during the pandemic years (29 456 episodes in 2020 and 42 535 in 2021), making the local public hospital's paediatric emergency service the second in Lisbon metropolitan area and the fifth in Continental Portugal with the largest number of emergency episodes.[81–84]

Previous studies concerning Amadora have identified socioeconomic disadvantage among immigrants and people of African origin, with higher unemployment rate, lower education level, predominance of manual jobs, material deprivation and maternal morbidity.[23,28] These studies also identified vulnerability in health status and higher utilisation of healthcare services among immigrants. In a study comparing neonates of immigrant mothers versus neonates of Portuguese mothers living in Amadora and Sintra, Machado et al found higher perinatal mortality rate among the immigrant group; these authors also found higher maternal unemployment, lower maternal education level, predominance of maternal manual occupation, precarious housing, higher socio-material deprivation and higher maternal morbidity among the immigrant group.[23] Muggli et al reported a higher proportion of immigrant children with emotional problems, children requiring monitoring of psychomotor development and a higher prevalence of primary care and emergency service utilisation among these children compared to non-immigrant children in Amadora.[24,25]

In summary, socioeconomic circumstances determine children's health, development and mental wellbeing, starting before conception, and influence health and socioeconomic status in adulthood and across generations. There is a growing body of evidence about health inequities in the paediatric population. However, studies about Portugal are scarce and mostly limited to specific populations.[23–28,39,85,86] Understanding SDH and the pathways through which they influence health is crucial to understanding children's health inequities and thus to designing public health policies that tackle them.

2.3. Study objectives

Based on the literature review presented above, it is hypothesized that there are health inequities among children living in Amadora and Sintra unfavourable to those with socioeconomic disadvantage.

2.3.1. Main objective

The present study aims to analyse health inequities in a paediatric population resident in Amadora and Sintra and hospitalised in the local public hospital between 2014 and 2021.

2.3.2. Specific objectives

1. To characterise the social determinants of health in a paediatric population resident in Amadora and Sintra and hospitalised in the local public hospital between 2014 and 2021.
2. To examine the contribution of each demographic and socioeconomic factor to inequities in needed hospital care in a paediatric population resident in Amadora and Sintra and hospitalised in the local public hospital between 2014 and 2021.
3. To investigate the association between needed hospital care and area-level deprivation, as measured by the European Deprivation Index (EDI), in a paediatric population resident in Amadora and Sintra and hospitalised in the local public hospital between 2014 and 2021.
4. To propose future public health interventions to reduce eventual health inequities among the paediatric population of Amadora and Sintra municipalities.

3. METHODOLOGY

3.1. Study design

This is an observational, analytical, retrospective study examining the admissions to the Department of Paediatrics of the local public hospital from subjects with residence in the municipalities of Amadora and Sintra, in the period between 2014 and 2021. Quantitative methods for data measurement and analysis were used.

3.2. Study sample and selection

The unit of observation was admissions to the Department of Paediatrics – Paediatric ward, Short Admission Unit, Neonatal Intensive Care Unit and Paediatric Intensive Care Unit (ICU) – from 1st January 2014 (the first year with complete electronic clinical records in the hospital) to 31st December 2021 in the local public hospital serving the municipalities of Amadora and Sintra.

Exclusion criteria were: i) residence in a municipality other than Amadora or Sintra; ii) missing information for civil parish; iii) deceased or unknown mother or father; and iv) missing information for all the socioeconomic variables collected through interview at the time of admission.

3.3. Data collection

Data were obtained from three sources: i) administrative records: gender, date of birth, date of admission, date of discharge, municipality of residence, civil parish of residence, ward of admission and discharge destination; ii) electronic form with information reported by carers and collected by nurses through direct interview at the time of admission of patients: ethnicity, main language spoken in the household, mother's and father's education level, employment status and occupation; and iii) diagnosis, established by physicians.

Data on civil parish EDI was obtained from the database available online.[87]

3.4. Variables of interest

Age and LOS were continuous variables. Age group, gender, municipality, civil parish, year of admission, ward of admission, admission to ICU, diagnosis, ethnicity, main language spoken in the household, and mother's and father's education level, employment status and occupation were categorical variables.

3.4.1. Demographic and socioeconomic indicators

The identification of the socioeconomic determinants of interest followed the PROGRESS framework, standing for Place of residence, Race / ethnicity / culture / language, Occupation, Gender/sex, Religion, Education, Socioeconomic status and Social capital.[88]

The following variables were used in the analysis: civil parish of residence; age groups; gender; ethnicity; main language spoken in the household; mother's and father's education level, employment status and occupation.

Age was computed from date of birth and date of admission and was further transformed into the ordinal variable age groups according to international definitions, as follows: under 28 days (neonate), 28 days to 11 months (infant), 1 to 4 years, 5 to 9 years, 10 to 14 years and 15 years or older.[89] Admissions to the Department of Paediatrics of patients older than 18 years who were previously followed in the Department for chronic conditions were included.

For ethnicity, both Black and Asian categories included mixed Black children and mixed Asian children, respectively.

Mother's and father's employment status were categorised as either working or non-working. The latter included unemployed persons, persons who were exclusively studying and incarcerated persons. Persons who were both workers and students were classified as working.

Mother's and father's education level classification was based on the Portuguese Basic Law of the Educational System.[90] According to this law, education degrees are ordered in basic, secondary and higher level. Basic level has three cycles: 1st, with four years duration; 2nd, with two years duration; and 3rd, with 3 years duration.[90] Secondary level lasts for three years. Higher level comprises bachelor's degree, master's degree and doctorate degree. Compulsory school was extended to secondary level or 18 years of age in 2009.[91]

Mother's and father's occupation were classified according to the Portuguese Classification of Occupations, which considers 10 groups: group 0, Armed Forces professionals; group 1, representatives of the legislature and executive bodies, directors and executive managers; group 2, specialists in intellectual and scientific activities; group 3, technicians and intermediate level workers; group 4, administrative staff; group 5, workers in security, personal care and sales persons; group 6, farmers and skilled workers in agriculture, fishing and forest; group 7, skilled workers from industry, construction and craftsmanship; group 8, operators of installations and machines and assembly workers; group 9, unskilled workers.[92]

3.4.2. Hospitalisation variables

The dependent variables LOS and admission to ICU were used as needed hospital care indicators.

LOS, in days, was computed from the dates of admission and discharge.

For the variable ward of admission, the first ward was considered, despite eventual transfer to another ward during the hospitalisation. This variable was transformed into the dichotomous variable admission to ICU.

Diagnosis was coded according to International Classification of Diseases ninth or tenth revision (ICD-9 or ICD-10), which is entered by each physician at the moment of discharge and lately reviewed by a classification team of physicians. This variable was used for descriptive purposes only.

3.4.3. Missing data

Cases with missing data for all the socioeconomic indicators were excluded. The remaining missing data were handled using multiple imputation, on the assumption that the data were missing at random. The method of fully conditional specification was used for imputation, with maximum 10 iterations.[93,94] Logistic regression models were used as the imputation models for the categorical variables. Predictive mean matching (PMM) models identifying the 10 closest cases without missing data were used as the imputation models for the continuous variables (as PMM is less sensitive than linear regression to non-normal distribution of data).[94] All variables to be included in the analysis model were included in the imputation model: age; gender; LOS; admission to ICU; language; mother's and father's education level, employment status and occupation.[94] The number of imputations run was set to at least equal the percentage of cases with missing data;[94] therefore, a total of 40 imputations were performed.

Mother's and father's occupation were imputed on a second run after the imputation of the other variables to account for imputed non-working status. To reduce the number of effects, categories of each of these variables were aggregated following the rationale of "white-collar" workers (groups 1 to 4); armed forces, security, personal care and sales (groups 0 and 5), skilled manual workers (groups 6 to 8); and unskilled workers (group 9).

3.5. Statistical analysis

3.5.1. Univariate and bivariate analysis

A univariate descriptive analysis was performed, expressed as absolute and relative frequencies for the categorical variables, and as mean ± standard deviation (SD) and median (interquartile range – IQR) for the continuous variables age and LOS.

Boxplots and histograms were plotted, and the Kolmogorov-Smirnov test was executed to ascertain for normal distribution of the dependent continuous variable LOS against the independent categorical variables.

After determining that data was not normally distributed, Mann-Whitney U test (for dichotomous variables) and Kruskal-Wallis H test (for polytomous variables) for independent samples were used for comparison of medians. Chi-square test or Fisher's exact test (when 20% or more cells had expected frequencies lower than five and both dependent and independent variables were dichotomous) were performed to study the association between admission to ICU and the categorical variables age groups, gender, ethnicity, language, mother's and father's education level, employment status and occupation, assuming independence between groups.

3.5.2. Multivariate analysis

The rationale for multivariate analysis was to include in the models the socioeconomic variables which showed statistical significance in bivariate analysis, besides the demographic variables age groups and gender. Cases with non-working mothers or fathers (and thus with no active occupation) were excluded.

Multiple regression was run to analyse the effect of the demographic and socioeconomic variables on LOS. An explanatory model was built. Polytomous independent variables were previously recoded into dummy variables (one for each category of the original variable) with values of 1 and 0, with 0 considered as the reference category according to risk factors described in the literature. The following tests were performed to assess if the model met the required assumptions for multiple regression: Durbin-Watson test for independence of residuals; visual inspection of a plot of studentised residuals against unstandardised predicted values for homoscedasticity; variance inflation factors (VIF) for multicollinearity between independent dummy variables; checking for studentised deleted residuals greater than ±3 SD for outliers; checking for leverage values greater than 0.2; checking for Cook's distance above 1 for influential points; and P-P plot for normality of standardised residuals. Linearity was not tested, as all independent variables were categorical.

A binomial logistic regression was performed to examine the effects of demographic and socioeconomic variables on the odds of being admitted to ICU. An explanatory model was built. Linearity and multicollinearity were not tested, as all variables were categorical. The odds ratio (OR) and 95% confidence intervals (CI) were calculated for each of the variables.

The statistical significance level was set at *p*-value < 0.05. Statistical analysis was conducted using Microsoft 365® Excel® version 2403 and IBM® SPSS® Statistics version 29.0.1.0. Results were reported in American Psychological Association (APA) style.[95]

3.6. Health equity analysis

Health inequity was defined, for the purpose of this study, as systematic association of needed hospital care with socioeconomic deprivation. Investigation of whether such inequity exists, and to what degree, was carried out through ecological small-area analysis using data on residence by civil parish of children admitted to the local public hospital. Given that LOS and admission to ICU depends on health need, it was assumed that any systematic association of hospital care with small-area deprivation is *prima facie* evidence of health inequities.

Deprivation related inequality in LOS and admission to ICU were analysed through concentration curves and indices. In comparison to often used measures of inequality, such as the range and the odds ratio, concentration curves and indices use information on the whole population and are sensitive to how inequality is distributed across socioeconomic groupings.[96,97]

Concentration curves for the two hospital care variables of interest were built by plotting the cumulative proportion of the population aged 0 to 24 years ranked by European Deprivation Index (from most deprived to least deprived) against the cumulative proportion of LOS or of cases admitted to ICU.[11,98] The most recent EDI scores available, as validated for the Portuguese population – according to the national Census 2011 survey, calculated for each civil parish and updated according to the administrative reorganisation of civil parishes occurred in 2013 – were used.[87] A concentration curve lying above the line of proportionality (a diagonal which represents an evenly distributed health variable across the socioeconomic gradient) indicates that the health variable occurs more among the most deprived areas, whereas a concentration curve lying below the diagonal signifies that the health variable is more concentrated among the least deprived areas.[11,98]

The concentration index is calculated as twice the area between the concentration curve and the diagonal and gives a measure of the magnitude of inequity (i.e., deprivation related inequality).[11] It varies from -1 to +1, taking a negative value when the curve lies above the diagonal, which indicates that the health variable is concentrated among the most disadvantaged groups; the contrary being true when the index takes a positive value.[11,96,97,99]

Plotting of concentration curves and calculation of concentration indices were performed using Microsoft 365® Excel® version 2403.

3.6.1. The European Deprivation Index

Several instruments for measuring socioeconomic deprivation have been proposed. The European Deprivation Index has the advantage of having a version for the Portuguese population, reported at municipality and civil parish levels.[87] It is an ecological deprivation index constructed from individual data that uses data from the European Union (EU) - Statistics on Income and Living Conditions Survey, matched with data from the nationwide Portuguese Census.[100] It comprises eight dichotomised variables present in both surveys and shown to correlate with objective and subjective poverty: household without indoor flushing, low education level (six years or less), non-owned household, household with less than six rooms, unemployed looking for a job, women aged 65 years or older, household without bath or shower, and manual occupation.[100]

The Portuguese version of EDI has the following quintile distribution (from least to most deprived): 1 (-8.155 to -1.774); 2 (-1.773 to -0.605); 3 (-0.604 to 0.338); 4 (0.339 to 1.581) and 5 (1.582 to 17.249).[100] EDI score for the municipality of Amadora is 5.609 and for the municipality of Sintra is 2.502, both fifth quintile. With the exception of two civil parishes (Alfragide and Sintra), which are third quintile EDI score, all civil parishes are fifth quintile EDI, corresponding to 91.5% of the population aged 0 to 24 years (Table 3.1).[87] This denotes a high level of deprivation in the two municipalities.

EDI has been used in multiple national and international studies to investigate disparities in health outcomes such as longevity and survival,[101,102], mortatlity,[103] hospital death,[104] cancer,[105–107] infections[108,109] and hip fracture[110].

Table 3.1: Number of residents in 2021 and European Deprivation Index in 2013 by civil parish of the municipalities of Amadora and Sintra.

Municipality	Civil parish	Total residents[73]	Residents 0-24 yo[73]	EDI[87]
Amadora	Alfragide	16 837	4 662	-0.389
	Mina de Água	42 961	11 243	5.224
	Venteira	26 168	5 719	5.849
	Falagueira - Venda Nova	20 788	4 670	7.055
	Águas Livres	37 607	8 979	7.314
	Encosta do Sol	27 093	7 136	8.887
	Total of Amadora	171 454	42 409	
Sintra	Sintra	29 896	7 691	-0.055
	São João das Lampas e Terrugem	17 993	4 487	2.118
	Colares	7 746	1 820	2.437
	Massamá e Monte Abraão	47 804	12 293	2.739
	Almargem do Bispo, Pêro Pinheiro e Montelavar	17 262	4 246	3.196
	Algueirão - Mem Martins	68 649	18 869	3.251
	Rio de Mouro	49 489	13 939	3.451
	Queluz e Belas	52 414	14 053	4.066
	Agualva e Mira Sintra	41 323	10 673	5.098
	Cacém e São Marcos	39 683	11 495	5.225
	Casal de Cambra	13 347	3 960	7.957
	Total of Sintra	385 606	103 526	
Total of Amadora and Sintra		557 060	145 935	

EDI, European Deprivation Index; yo, years old.

3.7. Ethical considerations

The study protocol was approved by the hospital's Ethics Committee, the Unit of Clinical Research and the Data Protection Manager. The study complies with the Portuguese legislation for data protection[111], which is derived from EU legislation, and includes dispositions concerning sensitive data. This legislation permits the collection of information without expressed consent for scientific research purposes in cases of an elevated number of participants, long retrospectivity of data and if information is anonymised.[111]

Access to the hospital's datasets was provided by the hospital's Planning Service following the Ethics Committee approval. Data were anonymised and accessed exclusively by the study's author, under the commitment of deleting the files after the work is concluded.

4. RESULTS

Figure 4.1 illustrates the process of selection of cases. Between 2014 and 2021, there were 8 153 admissions to the hospital's Department of Paediatrics of patients with residence in Amadora and Sintra municipalities. Seventy-five cases had deceased mothers or fathers or unknown fathers and were excluded. There were missing values for all the socioeconomic indicators (ethnicity; main language spoken in the household; mother's and father's education level, employment status and occupation) in 56 cases and for civil parish in six cases, which were also excluded. After this, missing data for socioeconomic variables persisted (Table 4.1). Overall, 3 093 cases (38.6%) had incomplete data, rendering 4 923 complete cases. Missing data were handled through multiple imputation, as described in the Methodology section. The final sample comprised 8 016 hospital admissions, corresponding to 6 088 individuals. During the study period, 1 024 individuals (16.8%) had more than one admission. The maximum number of admissions per individual was 27, with mean 1.32 ± 1.14 admissions and median 1.00 admissions (IQR 1.00; 1.00).

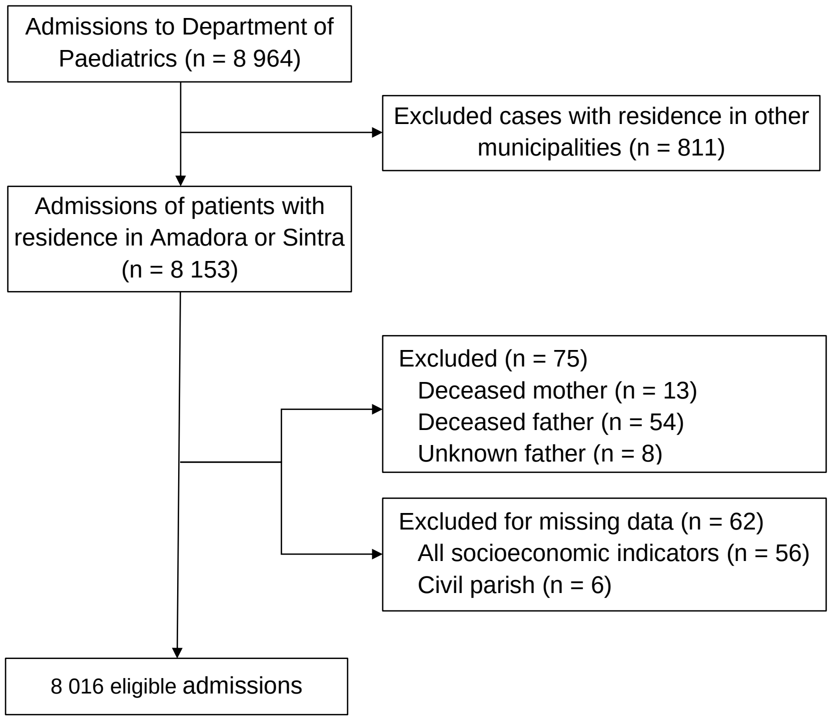


Figure 4.1: Process of case selection.

Table 4.1: Number of valid and missing cases per variable.

n = 8 016	Valid	Missing	Percentage of missing cases
Father's education level	5 880	2 136	26.6%
Mother's education level	6 515	1 501	18.7%
Father's occupation	6 947	1 069	13.3%
Ethnicity	7 060	956	11.9%
Father's employment status	7 347	669	8.3%
Mother's occupation	7 512	504	6.3%
Language	7 651	365	4.6%
Mother's employment status	7 695	321	4.0%

The distribution of admissions throughout the years had some variations, with a clear reduction in the SARS-CoV-2 pandemic years of 2020 and 2021 (Figure 4.2).

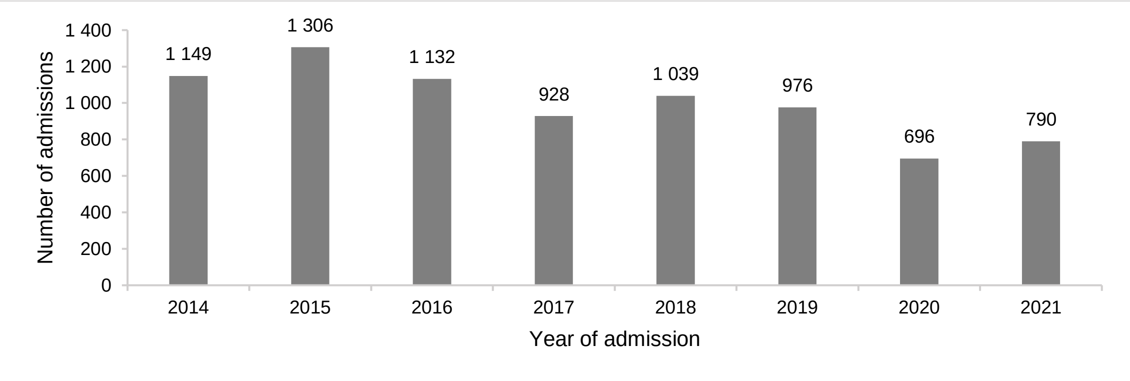


Figure 4.2: Yearly distribution of admissions.

Fifty four percent (4 326) of admissions were of male participants. Age did not follow a normal distribution (Figure 4.3) and ranged from 0.00 to 22.00 years, with mean 5.08 ± 5.74 years and median 2.30 years (IQR 0.40; 8.82). Children were younger than two years in 47.4% of admissions. In only four admissions were the patients 20 years or older (one of them was admitted to ICU).

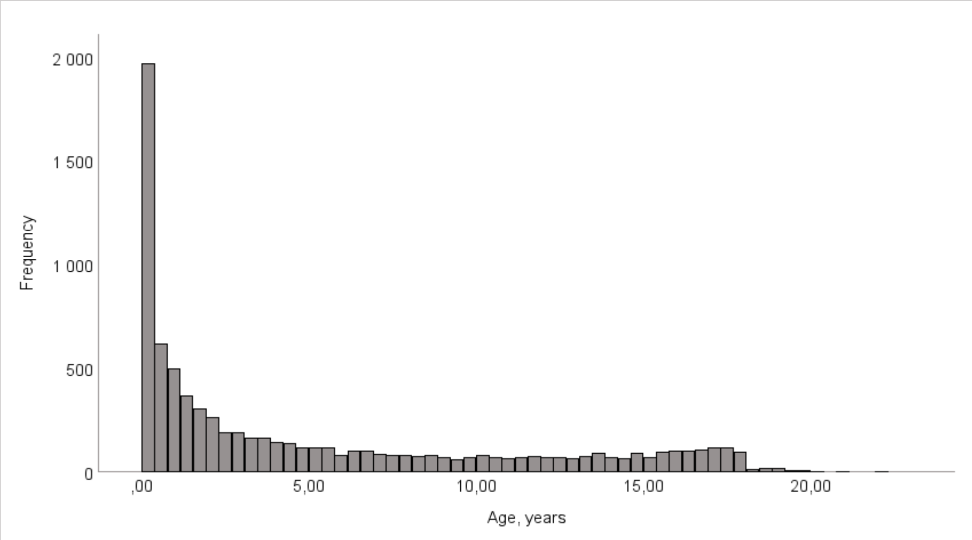


Figure 4.3: Histogram for distribution of age.

Table 4.2 presents data on LOS, ward of admission and discharge destination. LOS ranged from 0.65 to 246.00 days. Admissions to ICU (either paediatric or neonatal) represented 7.8% (628) of all admissions. Only 13 deaths occurred.

Table 4.2: Length of hospital stay, ward of admission and discharge destination.

n = 8 016	n	%	Mean ± SD	Median (IQR)
Length of hospital stay, days			6.47 ± 11.02	4.00 (2.00; 7.00)
Ward of admission				
Paediatrics	6681	83.3%		
Short Admission Unit	707	8.8%		
Paediatric ICU	332	4.1%		
Neonatal ICU	296	3.7%		
Discharge				
Home	7888	98.4%		
Transfer to another hospital	109	1.3%		
Against medical advice	6	0.1%		
Death	13	0.2%		

ICU, intensive care unit; IQR, interquartile range; SD, standard deviation.

Table 4.3 presents the 10 most frequent diagnoses, which represent 72.2% of all admissions. Respiratory diseases and acute gastroenteritis were the most frequent diagnoses, followed by neonatal conditions and sickle cell disease. These four groups of diagnostic conditions accounted for 55.6% of admissions.

Table 4.3: Ten most frequent diagnoses.

	n	%
Respiratory diseases	2 699	33.7
Acute gastroenteritis	711	8.9
Neonatal conditions	546	6.8
Sickle cell disease	502	6.3
Seizure	333	4.2
Urinary tract infection	320	4.0
Cellulitis and/or skin infections	245	3.1
Other digestive system conditions	166	2.1
Other anaemias	126	1.6
Diabetes	123	1.5
Total	5 771	72.2

Figure 4.4 shows the demographic and socioeconomic characteristics of admissions. More than one third of the admissions were of very young children (less than one year old) and neonates represented 10.9% of the sample. Together, White and Black ethnicities comprised 96.9% of the sample. Portuguese was the main language spoken in the household, whilst African languages (Creole and Fulah) comprised 42.5% of the foreign languages reported. Both mothers and fathers had none or only basic education level in more than half of cases (mothers 52.5%, fathers 56.3%), with a slightly higher proportion of mothers (47.5% versus 43.7% of fathers) having secondary or higher level. Non-working status was very high among mothers, being more than double of fathers'.

Residence in the municipality of Sintra accounted for 5 076 (63.3%) of admissions, and 667 admissions (8.3%) were from Sintra's five civil parishes not served by the hospital of the study. The five civil parishes with larger number of admissions correspond to the civil parishes with larger number of inhabitants served by the hospital under study. Figure 4.4 - G presents the distribution of admissions by civil parish of residence, ordered according to deprivation (from least to most deprived – see also Table 3.1). Residence in the most deprived civil parishes (fifth quintile EDI score) accounted for 95.6% (7 663) of admissions.

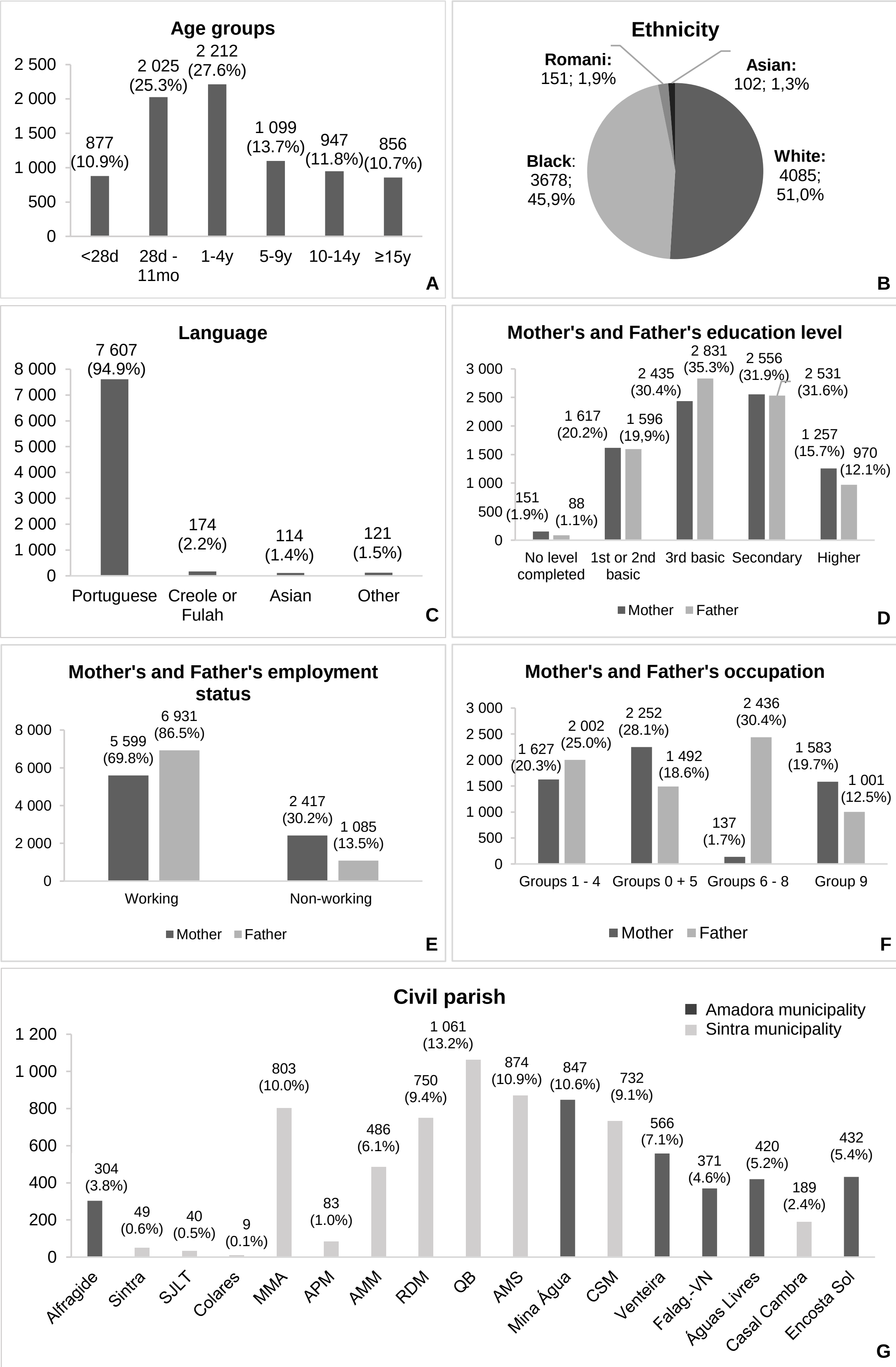


Figure 4.4: Distribution of admissions by demographic and socioeconomic characteristics.

A: Age groups. B: Ethnicity. C: Main language spoken in the household. D: Mother's and father's education level. E: Mother's and father's employment status. F: Mother's and father's occupation. G: Civil parish. AMM, Algueirão - Mem Martins; AMS, Agualva e Mira Sintra; APM, Almargem do Bispo, Pêro Pinheiro e Montelavar; EDI, European Deprivation Index; Falag. - VN, Falagueira - Venda Nova; MMA, Massamá e Monte Abraão; QB, Queluz e Belas; RDM, Rio de Mouro; SJLT, São João das Lampas e Terrugem.

4.1. Length of hospital stay

Table 4.4 shows the bivariate analysis of the hospital care variables according to the demographic and socioeconomic factors. LOS for each category of age groups, gender, ethnicity, language, mother's and father's education level, employment status and occupation did not follow a normal distribution.

Age groups, ethnicity, main language spoken in the household, mother's education level and employment status, and mother's and father's occupation showed a statistically significant association with LOS. Median LOS was significantly longer for admissions of the neonates, Asian language, non-working mothers, and father's with least differentiated jobs (groups 6 to 8 and group 9). There was a statistically significant inverse gradient between LOS and lower mother's education level, as well as mother's least differentiated occupation. Median LOS was significantly shorter for White participants compared to all the other ethnicities and mean LOS was evidently longer for Black and Asian children. There were no differences in LOS for gender, father's education level and father's employment status.

Table 4.4: Descriptive and bivariate analysis of hospital care variables by demographic and socioeconomic indicators.

	Length of hospital stay			Admission to ICU	
	Mean ± SD	Median (IQR)	*p*	n (%[a])	*p*
Age groups (n=8 016)			<.001		<.001
< 28 days	14.15 ± 18.70	8.74 (4.20; 14.88)		315 (35.9%)	
28 days – 11 months	5.79 ± 8.78	4.00 (2.18; 6.25)		78 (3.9%)	
1 – 4 years	4.86 ± 8.79	3.00 (2.00; 5.03)		83 (3.8%)	
5 – 9 years	5.18 ± 7.74	3.16 (2.00; 6.00)		50 (4.5%)	
10 – 14 years	5.95 ± 7.74	4.00 (2.00; 7.00)		53 (5.6%)	
≥ 15 years	6.61 ± 13.56	4.00 (2.00; 7.08)		49 (5.7%)	
Gender (n=8 016)			.388		.002
Male	6.66 ± 11.57	4.00 (2.00; 7.00)		376 (8.7%)	
Female	6.24 ± 10.34	4.00 (2.00; 6.82)		252 (6.8%)	
Ethnicity (n=8 016)			<.001		<.001
White	5.52 ± 8.75	3.40 (2.00; 6.00)		284 (7.0%)	
Black	7.51 ± 12.92	4.00 (2.04; 8.00)		334 (9.1%)	
Romani	5.49 ± 5.24	4.00 (2.47; 7.00)		3 (2.0%)	
Asian	8.76 ± 18.49	4.00 (2.93; 8.00)		7 (6.9%)	
Language (n=8 016)			.007		<.001
Portuguese	6.34 ± 10.40	4.00 (2.00; 7.00)		580 (7.6%)	
Creole or Fulah	8.23 ± 15.97	4.00 (2.56; 9.00)		16 (9.2%)	
Asian	11.22 ± 25.05	5.00 (2.72; 9.65)		28 (24.6%)	
Other	7.79 ± 16.57	4.00 (2.04; 8.00)		4 (3.3%)	
Mother's education level (n=8 016)			<.001		<.001
No level completed	7.10 ± 6.64	5.00 (3.00; 9.00)		6 (4.0%)	
1st or 2nd basic	7.93 ± 16.17	4.00 (2.05; 8.00)		105 (6.5%)	
3rd basic	6.14 ± 9.76	4.00 (2.00; 7.00)		195 (8.0%)	
Secondary	6.12 ± 9.21	3.83 (2.00; 6.84)		183 (7.2%)	
Higher	5.87 ± 8.51	3.89 (2.00; 6.96)		139 (11.1%)	

	Length of hospital stay			Admission to ICU	
	Mean ± SD	Median (IQR)	*p*	n (%[a])	*p*
Father's education level (n=8 016)			.196		.047
No level completed	6.50 ± 6.78	4.02 (3.00; 8.63)		3 (3.4%)	
1st or 2nd basic	5.83 ± 8.92	4.00 (2.00; 7.00)		102 (6.4%)	
3rd basic	6.40 ± 11.32	3.90 (2.00; 7.00)		224 (7.9%)	
Secondary	6.97 ± 12.19	4.00 (2.00; 7.00)		213 (8.4%)	
Higher	6.43 ± 10.26	4.00 (2.00; 7.00)		86 (8.9%)	
Mother's employment status (n=8 016)			<.001		.693
Working	6.21 ± 10.48	3.97 (2.00; 7.00)		443 (7.9%)	
Non-working	7.09 ± 12.16	4.00 (2.06; 7.14)		185 (7.7%)	
Father's employment status (n=8 016)			.060		.052
Working	6.42 ± 10.96	4.00 (2.00; 7.00)		559 (8.1%)	
Non-working	6.81 ± 11.40	4.00 (2.04; 7.17)		69 (6.4%)	
Mother's occupation (n=5 599)			<.001		.036
Groups 1 to 4	5.56 ± 7.86	3.78 (2.00; 6.00)		137 (8.4%)	
Groups 0 and 5	5.74 ± 7.68	3.80 (2.00; 6.83)		151 (6.7%)	
Groups 6 to 8	5.46 ± 5.58	3.84 (2.00; 7.00)		10 (7.3%)	
Group 9	7.60 ± 15.36	4.00 (2.00; 8.00)		145 (9.2%)	
Father's occupation (n=6 931)			.009		.034
Groups 1 to 4	5.68 ± 8.31	3.92 (2.00; 6.13)		137 (6.8%)	
Groups 0 and 5	6.49 ± 10.50	3.87 (2.00; 7.00)		137 (9.2%)	
Groups 6 to 8	7.00 ± 13.46	4.00 (2.00; 7.01)		212 (8.7%)	
Group 9	6.35 ± 11.40	4.00 (2.00; 7.15)		73 (7.3%)	

ICU, intensive care unit; IQR, interquartile range; LOS, length of hospital stay; OR, odds ratio; *p*, *p*-value; SD, standard deviation.

[a] Within category of independent variable.

In the multiple regression analysis, a total of seven independent variables were included in the model: age groups, gender, and the socioeconomic indicators which showed statistically significant association in the bivariate analysis (ethnicity, main language spoken in the household, mother's education level, and mother's and father's occupation).

The multiple regression model was statistically significant for association with length of hospital stay, $p < .001$. Five of the seven variables (age groups, ethnicity, main language spoken in the household, mother's education level and mother's occupation) added statistically significance to the model. Regression coefficients are presented in Table 4.5. Age groups had the strongest effect, with neonates having an increased LOS by 7.97 days (compared to adolescents aged 15 years or older), followed by Asian children (longer LOS by 5.14 days compared to White children), language other than Portuguese, Creole/Fulah and Asian (longer LOS by 3.64 days compared to Portuguese language). Mother's first or second basic education level (compared to higher level), mother's occupation group 9 and Black ethnicity had smaller effects, increasing LOS by 1.63, 1.15 days and 1.05 days, compared to higher education level, occupation groups 1 to 4 and

White ethnicity, respectively. Father’s profession did not have a statistically significant contribution to the model.

Table 4.5: Multiple regression of length of hospital stay.

n = 5 019	Length of hospital stay		
	B	95% CI	*p*
Constant	4.02	3.07; 4.97	<.001
Age groups			
< 28 days	7.97	6.90; 9.04	<.001
28 days – 11 months[a]			
1 – 4 years	-1.17	-1.99; -0.35	.005
5 – 9 years	-0.88	-1.86; 0.10	.079
10 – 14 years	-0.28	-1.31; 0.74	.585
≥ 15 years	ref.		
Gender			
Male	0.47	-0.11; 1.04	.113
Female	ref.		
Ethnicity			
White	ref.		
Black	1.05	0.41; 1.69	.001
Romani	-0.62	-4.85; 3.65	.781
Asian	5.14	1.15; 9.13	.012
Language			
Portuguese	ref.		
Creole or Fulah	0.77	-1.48; 3.02	.501
Asian	1.88	-1.22; 4.98	.234
Other	3.64	0.23; 7.05	.036
Mother’s education level			
No level completed	0.80	-2.26; 3.86	.608
1st or 2nd basic	1.63	0.42; 2.84	.008
3rd basic	0.38	-0.63; 1.39	.458
Secondary	0.45	-0.45; 1.38	.327
High	ref.		
Mother’s occupation			
Groups 1 to 4	ref.		
Groups 0 and 5	-0.26	-1.08; 0.56	.537
Groups 6 to 8	-0.30	-2.25; 1.64	.758
Group 9	1.15	0.16; 2.14	.023
Father’s occupation			
Groups 1 to 4	ref.		
Groups 0 and 5	0.33	-0.51; 1.17	.436
Groups 6 to 8	0.56	-0.22; 1.34	.161
Group 9	-0.38	-1.42; 0.67	.483

B, unstandardised regression coefficient; CI, confidence interval; *p*, p-value; ref., reference category.

Model statistic: $F(22, 4996) = 19.57$, $p < .001$, adj. $R^2 = .075$.

There was independence of residuals, as assessed by a Durbin-Watson statistic of 1.82. The assumption of homoscedasticity was met, as assessed by visual inspection of a plot of studentised residuals against unstandardised predicted values. There was no evidence of multicollinearity, as assessed by variance inflation factors (VIF) under 10. There were 63 cases with studentised deleted residuals greater than 3 SD, which were kept in the analysis, and none lower than -3 SD. There were no leverage values greater than 0.2, and no values above 1 for Cook's distance. The assumption of normality was not met, as assessed by a P-P plot of standardised residuals.

[a] Automatically excluded from the model.

4.2. Admission to intensive care unit

In bivariate analysis, the associations between admission to ICU and age groups, gender, ethnicity, language, mother's and father's education and mother's and father's occupation were statistically significant (Table 4.4). Odds of admission to ICU was higher for males than for females (OR = 1.30, 95% CI 1.10; 1.53, p = .002). The proportion of neonates, Black children and patients from families speaking Asian language admitted to ICU was significantly higher compared to the other categories. There was a statistically significant gradient for mother's and father's education level, with proportionally more admissions to ICU as education level increased. Admission to ICU was also relatively more frequent among children of mothers with unskilled jobs (group 9), whilst children of fathers with "white-collar" jobs (groups 1 to 4) were less frequently admitted to ICU. Admission to ICU did not show a statistically significant association with either mother's or father's employment status in the bivariate analysis.

In the logistic regression analysis, a total of eight independent variables were entered in the model: age groups, gender, and the socioeconomic indicators which showed statistically significant association in the bivariate analysis (ethnicity, main language spoken in the household, mother's and father's education level and occupation).

The model was statistically significant, $p < .001$, suggesting that it could establish an association between admission to ICU and the demographic and socioeconomic variables. As shown in Table 4.6, age groups, gender, main language spoken in the household, mother's education level and father's occupation contributed significantly to the model. Neonatal age showed the strongest effect, with children admitted to ICU having 11.86-fold higher odds of being neonates. This was followed by Asian language, father's occupation groups 6 to 8 and groups 0 and 5, and male gender. Odds of being admitted to ICU was 43% lower for children of mothers with first or second basic education level and 41% lower for children of mothers with secondary education level, showing a protective effect of these lower levels when compared to higher education level. Only one case had mother with no education level completed, affecting the statistical significance of this category. Ethnicity, father's education level and mother's occupation did not contribute significantly to the model.

Table 4.6: Logistic regression analysis of admission to intensive care unit.

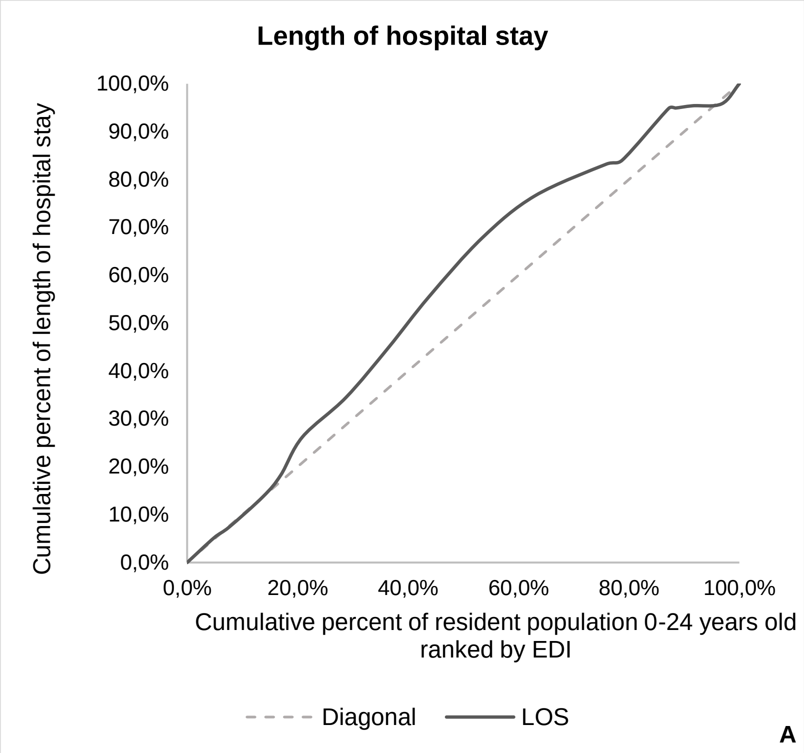
n = 5 019	n (% within category)	OR	95% CI	*p*
Constant		0.044		<.001
Age				
< 28 d	206 (38.0%)	11.86	7.64; 18.41	<.001
28 d – 11 m	45 (4.0%)	0.87	0.53; 1.43	.583
1 – 4 y	46 (3.4%)	0.72	0.44; 1.18	.194
5 y – 9 y	39 (5.4%)	1.15	0.70; 1.92	.581
10 y – 14 y	40 (6.0%)	1.37	0.83; 2.26	.215
≥ 15 y	404 (8.0%)	ref.		<.001
Gender				
Male	250 (9.3%)	1.35	1.07; 1.70	.011
Female	154 (6.6%)	ref.		
Ethnicity				
White	203 (7.0%)	ref.		.345
Black	197 (9.6%)	1.23	0.96; 1.58	.101
Romani	0 (0.0%)	0.00		.998
Asian	4 (12.9%)	2.05	0.49; 8.62	.326
Language				
Portuguese	379 (7.8%)	ref.		.025
Creole or Fulah	9 (10.7%)	1.17	0.54; 2.56	.688
Asian	15 (32.6%)	2.46	1.08; 5.56	.031
Other	1 (2.4%)	0.11	0.01; 1.09	.059
Mother's education level				
No level completed	1 (1.9%)	0.18	0.02; 1.40	.101
1st or 2nd basic	52 (6.7%)	0.57	0.35; 0.91	.019
3rd basic	119 (8.4%)	0.72	0.50; 1.06	.093
Secondary	116 (6.5%)	0.59	0.42; 0.84	.004
Higher	116 (11.8%)	ref.		.023
Father's education level				
No level completed	0 (0.0%)	0.00		.998
1st or 2nd basic	49 (6.0%)	0.76	0.46; 1.27	.292
3rd basic	151 (8.4%)	0.93	0.61; 1.41	.725
Secondary	133 (8.0%)	0.81	0.55; 1.19	.281
Higher	71 (9.9%)	ref.		.657
Mother's occupation				
Groups 1 to 4	133 (8.6%)	ref.		.087
Groups 0 and 5	134 (6.9%)	0.88	0.64; 1.22	.454
Groups 6 to 8	10 (7.9%)	1.30	0.62; 2.73	.486
Group 9	127 (9.1%)	1.30	0.89; 1.90	.173
Father's occupation				
Groups 1 to 4	110 (6.9%)	ref.		.024
Groups 0 and 5	101 (9.2%)	1.55	1.10; 2.18	.013
Groups 6 to 8	144 (8.0%)	1.64	1.16; 2.32	.005
Group 9	49 (8.0%)	1.29	0.83; 2.01	.257

CI, confidence interval, ICU, intensive care unit; OR, odds ratio; *p*, *p*-value; ref., reference category.

Model statistic: $\chi^2(26) = 539.76$, $p < .001$; $p = .077$ for Hosmer and Lemeshow goodness of fit test. The model explained 23.8% (Nagelkerke R^2) of the variance in admission to ICU and correctly classified 92.1% of cases. Sensitivity was 9.4%, specificity was 99.4%, positive predictive value was 57.6% and negative predictive value was 92.6%.

4.3. Health equity analysis: concentration curves and indices

Figure 4.5 depicts the concentration curves of paediatric needed hospital care indicators ranked by EDI. Table 4.7 and Table 4.8 display the distributions of LOS and admissions to ICU by civil parish. For both LOS and admission to ICU, there is clearly concentration among more deprived civil parishes, with the curves lying largely above the diagonal. The concentration indices reflect this configuration, with values of -0.137 for LOS and of -0.147 for admission to ICU.



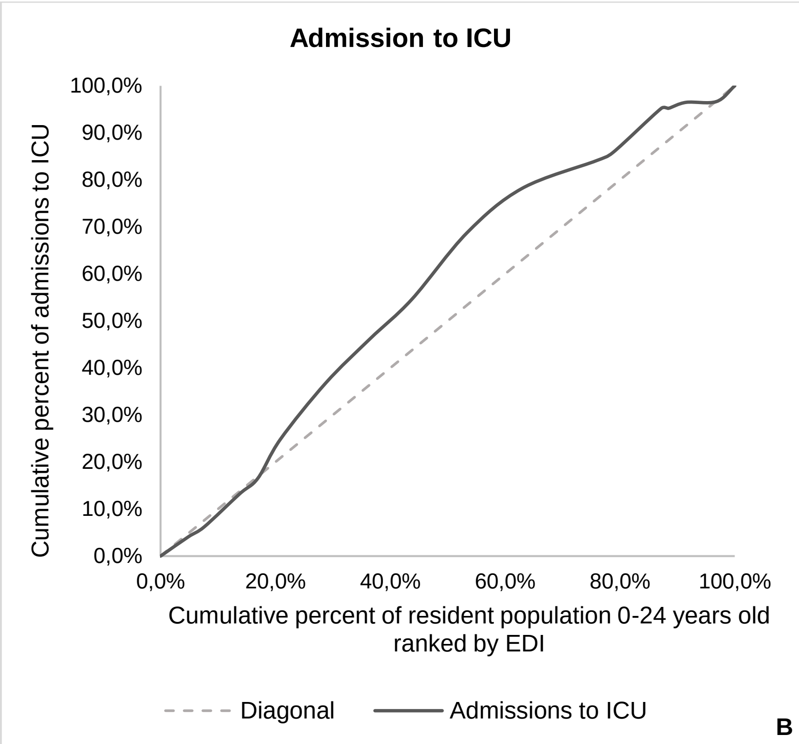


Figure 4.5: Concentration curves of length of hospital stay (A) and admission to intensive care unit (B) for the resident population aged 0 to 24 years ranked by European Deprivation Index.

EDI, European Deprivation Index; ICU, intensive care unit; LOS, length of hospital stay.

However, the pattern of inequality by civil parish is not monotonously concave to the line of proportionality. At the extremes of the distributions, the curves lie virtually on the respective diagonal. For LOS, the four most deprived civil parishes (Encosta do Sol, Casal de Cambra, Águas Livres and Falagueira - Venda Nova) and the two least deprived areas (Alfragide and Sintra) show no systematic association with deprivation. This is clearly not the case for the other civil parishes with intermediate levels of deprivation, where the concentration curve lies above the diagonal. A similar pattern is evident for admissions to ICU, with the concentration curve also showing proportionality between admissions and population at the extremes, but inequity detrimental to the more deprived areas at intermediate levels of EDI.

Table 4.7: Concentration index and distribution of length of hospital stay by civil parish.

Civil parish ranked by EDI (from most to least deprived)	% of residents 0 - 24 years old	Number of days of LOS	LOS rate among residents[a]	% of LOS days[b]	Concentration index
Encosta do Sol	4.9%	2 687	0.38	5.18%	
Casal de Cambra	2.7%	1 149	0.29	2.22%	
Águas Livres	6.2%	3 307	0.37	6.38%	
Falag. - VN	3.2%	2 325	0.50	4.48%	
Venteira	3.9%	4 131	0.72	7.96%	
CSM	7.9%	4 275	0.37	8.24%	
Mina de Água	7.7%	5 407	0.48	10.42%	
AMS	7.3%	5 498	0.52	10.60%	
QB	9.6%	6 370	0.45	12.28%	
RDM	9.6%	4 570	0.33	8.81%	
AMM	12.9%	3 436	0.18	6.63%	
APM	2.9%	436	0.10	0.84%	
MMA	8.4%	5 612	0.46	10.82%	
Colares	1.2%	34	0.02	0.07%	
SJLT	3.1%	246	0.05	0.47%	
Sintra	5.3%	212	0.03	0.41%	
Alfragide	3.2%	2 169	0.47	4.18%	
Total	100.0%	51 872		100.0%	-0.137

AMM, Algueirão - Mem Martins; AMS, Agualva e Mira Sintra; APM, Almargem do Bispo, Pêro Pinheiro e Montelavar; EDI, European Deprivation Index; Falag. - VN, Falagueira - Venda Nova; LOS, length of hospital stay; MMA, Massamá e Monte Abraão; QB, Queluz e Belas; RDM, Rio de Mouro; SJLT, São João das Lampas e Terrugem.

[a] (Number of days of LOS) / (Number of residents 0-24 years old)

[b] (Number of days of LOS) / (Total days of LOS)

Table 4.8: Concentration index and distribution of admissions to intensive care unit by civil parish.

Civil parish ranked by EDI (from most to least deprived)	% residents 0 -24 years old	Number of admissions to ICU	% admissions to ICU among residents[a]	% admissions to ICU[b]	Concentration index
Encosta do Sol	4.9%	26	0.36%	4.14%	
Casal de Cambra	2.7%	13	0.33%	2.07%	
Águas Livres	6.2%	44	0.49%	7.01%	
Falag. - VN	3.2%	21	0.45%	3.34%	
Venteira	3.9%	52	0.91%	8.28%	
CSM	7.9%	75	0.65%	11.94%	
Mina de Água	7.7%	59	0.52%	9.39%	
AMS	7.3%	53	0.50%	8.44%	
QB	9.6%	89	0.63%	14.17%	
RDM	9.6%	59	0.42%	9.39%	
AMM	12.9%	37	0.20%	5.89%	
APM	2.9%	11	0.26%	1.75%	
MMA	8.4%	59	0.48%	9.39%	
Colares	1.2%	0	0.00%	0.00%	
SJLT	3.1%	8	0.18%	1.27%	
Sintra	5.3%	1	0.01%	0.16%	
Alfragide	3.2%	21	0.45%	3.34%	
Total	100.0%	628		100.0%	-0.147

AMM, Algueirão - Mem Martins; AMS, Agualva e Mira Sintra; APM, Almargem do Bispo, Pêro Pinheiro e Montelavar; EDI, European Deprivation Index; Falag. - VN, Falagueira - Venda Nova; ICU, intensive care unit; MMA, Massamá e Monte Abraão; QB, Queluz e Belas; RDM, Rio de Mouro; SJLT, São João das Lampas e Terrugem.

[a] (Number of admissions to ICU) / (Number of residents 0-24 years old)

[b] (Number of admissions to ICU) / (Total admissions to ICU)

5. DISCUSSION

The present study examined the association between socioeconomic factors and needed hospital care (length of hospital stay and admission to ICU) among a sample of 8 016 hospitalised paediatric patients resident in Amadora and Sintra, during an eight-year period from 2014 to 2021. This is a particularly vulnerable population, characterised by clusters of low socioeconomic status, ethnic diversity and limitations in access to healthcare. The study clearly confirmed the hypothesis of existence of health inequities detrimental to the most deprived groups among hospitalised children in Amadora and Sintra. This is consistent with previous studies describing increased risk of hospitalisation among children with poorer socioeconomic status, as described in the literature.[7,15]

This study demonstrated a clear association between needed hospital care and deprivation across civil parishes. This was shown by the concentration curves and the relatively large negative values of the concentration indices. This method detected inequity among the civil parishes with intermediate deprivation, comprising the largest proportion of the population. This association would have probably been missed if other instruments were used, e.g. odds ratio.[112]

Previous studies have also reported a geographical deprivation gradient in children's health, both at national and international levels.[15,23,36,39,40] Interestingly, the work by Machado et al, which refers to the municipality of Amadora on this matter, found an association between incidence of neonatal infectious diseases, infant mortality (below one year of age) and residence in areas of socio-material deprivation.[23]

Of all the demographic and socioeconomic factors analysed, age, language spoken in the household and mother's education level were statistically significantly associated with both LOS and admission to ICU. Additionally, Asian and Black ethnicities; language other than Portuguese, Creole/Fulah or Asian; and mother's occupation group 9 were statistically significantly associated with longer LOS. Odds of admission to ICU was higher for male gender; Asian language; and father's occupation in manual jobs and in security, personal care and sales jobs. Also, in bivariate analysis, children of non-working mothers had significantly longer LOS and children of non-working fathers had higher frequency of admission to ICU (although not statistically significant) compared to children of working parents. The association of lower socioeconomic status with worse health status and greater healthcare utilisation in children, as found in the present work, has been described extensively throughout the literature.[6–8,15,36,113,114] Ribeiro et al found maternal education, paternal occupation and income as the most significant socioeconomic indicators of health inequities in children.[85]

Neonatal age had the strongest effect on both hospital care indicators, increasing LOS by 7.97 days and raising the odds of admission to ICU by 11.86-fold. In fact, neonatal conditions (such as prematurity/low birth weight, congenital malformations, neonatal infections) came as the third most frequent diagnosis. These are usually prolonged admissions and potentially severe, which could explain the effect of neonatal age on both LOS and admission to ICU.[10,115] The effect of neonatal age could also be related to the higher odds of admission to ICU found for male gender. In fact, Carrilero et al reported higher prevalence of congenital anomalies among males.[33]

Ethnicity showed a strong association with needed hospital care, especially factors related to Asian groups or language. Ethnicity was significantly associated with LOS and admission to ICU in bivariate analysis, with White children having shorter LOS (3.40 days versus 4.00 days for the other ethnicities, $p < .001$) and Black children having greater proportion of admission to ICU (9.1% versus 2.0 to 7.0% for the other ethnicities, $p < .001$). These results are supported by numerous studies reporting longer LOS for Black children.[116–119]

It is important to highlight that ethnicity remained as a statistically significant predictor of LOS even when the other demographic and socioeconomic factors were added in the multivariate analysis. Asian ethnicity was the second strongest factor contributing to longer LOS, raising it by 5.14 days. Black ethnicity also showed statistically significant association, increasing LOS by 1.05 days. Other studies have also reported longer LOS for children of either Asian or Black ethnicities.[116]

Sickle cell disease, which is endemic among subjects of African origin or descent and with often long in-hospital stays,[120] might play a role in the association found between longer LOS and Black ethnicity. In fact, sickle cell disease was one of the most frequent diagnoses in this sample.

However, the effect of Black ethnicity on LOS was not as strong as that of Asian ethnicity. One possible explanation is the trend in immigration. Although historically the two municipalities have had a pronounced immigration from African countries, especially Portuguese-speaking nations, immigration from Asian countries has been rising over recent years.[19,121] These recently arrived individuals are now those struggling for integration, for means of living and for access to healthcare. Another worrisome aspect that cannot be excluded is implicit discrimination by the healthcare team and patient/family mistrust of healthcare staff, conscient or not. This has been reported in several papers, focusing mostly on Black children and adults but also on other ethnic groups.[122–126]

An association between ethnicity and admission to ICU was not found in multivariate analysis. This differs from other studies.[118] One possible explanation is the fact that the proportion of admissions to ICU in the sample was small (7.8%) and was made up almost entirely (98.4%) of children of White and Black ethnicities, with a residual expression of the remainder ethnicities.

Several mechanisms have been proposed for ethnic inequities in health. Immigrants and ethnic groups other than White people are at higher risk of economic deprivation and social exclusion, facing racism and discrimination, lower income, worse housing conditions and less access to education and healthcare.[68,70,72] Interestingly, Wallander et al report reduction in ethnic health disadvantage after adjustment for family's structure, socioeconomic status, education level and language spoken in the household.[21] However, other studies reveal persistence of the gap despite socioeconomic status,[69,127] advocating for an effect of ethnic discrimination. Moreover, lack of access to primary and preventive healthcare often leads to greater out-of-pocket expenditure for these families and greater severity of illness at the time of seeking for medical attention, thus widening the socioeconomic and health gap.[128] This could be the case among the study sample, considering that 29.4% of the population in Amadora and Sintra have no access to a family doctor[79], and that immigrants tend to be more affected by this limited access[72].

The same mechanisms could play a role in language barrier. Not speaking the dominant language of a country has been linked to lower access to healthcare, worse physical and developmental health, more hospitalisations and ICU admissions and longer LOS among children.[36,129–131] Language barrier has been pointed out as an independent risk factor, with health disparities persisting even after adjustment for ethnicity and socioeconomic status.[129] In fact, in the present study, the odds of admission to ICU was 2.46-fold higher for Asian language despite ethnicity, pointing to greater hospital care need and increased clinical severity among this group. Although in bivariate analysis LOS was significantly longer among children of Asian-speaking families (mean 11.22 days versus 6.34 to 8.23 days for the other three language categories; median 5.00 days versus 4.00 days for the other three language categories, $p < .001$), in multivariate analysis only language other than Portuguese, Creole or Fulah and Asian languages showed significant association, increasing LOS by 3.64 days. Having Creole of Fulah as preferred language did not have a statistically significant influence on LOS nor on admission to ICU in multivariate analysis, probably because most of these families come from Portuguese-speaking African countries and speak Portuguese as an alternative language.

The results of the effect of mother's education on hospitalisation of children were inconsistent. There is a broad agreement throughout the literature that parents' lower education level is related to worse health in children.[15,132,133] Mother's education has been widely demonstrated to have one of the strongest effects among a variety of socioeconomic factors,[8,69,85,86,134] being approximately double that of the father's in some studies.[135,136] This was the case of the present study, which found a significant inverse gradient between LOS and lower mother's education level in bivariate analysis, and a statistically significant association between low maternal education (first or second basic levels) and longer LOS by 1.63 days in multivariate analysis. The persistence of maternal education as a strong determinant of child health points to a gender-specific role of women in childcare and children's health equity. This provides opportunities for public health interventions, as discussed below.

However, results concerning mother's education and admission to ICU were strikingly different from the education and health gradient described throughout the literature. Having an education level below higher level was shown to be a protective factor. Possible missing information bias as an explanation for this finding cannot be excluded; in fact, 18.7% of the sample had missing data on this variable. Collecting socioeconomic information at the time of hospitalisation for a severe clinical state might be considered by carers and health staff as inopportune. Nevertheless, other explanations must be considered. There is a growing body of evidence linking children's adverse health outcomes with mothers' nonstandard work schedules, including working at night, weekend, evenings or different times.[137,138] Although Wang found a gradient of increased risk of children's behaviour problems for lower maternal education level, this author also found a significant positive relationship between mothers' working different times and children's behaviour problems for those children with the most educated mothers.[139] Indeed, Portugal is the fifth country among the EU with longer working hours.[140] Regular working times and schedules are poorly adhered to by employers and workers among more qualified jobs in Portugal, with frequent unscheduled extra working hours (often unpaid) extending through evening and night. This might affect parenting and have adverse consequences on child health. Further research on this matter is needed to clarify the consequences of parents' work schedules dysregulation on children's health.

Children of non-working mothers had statistically significant longer median LOS comparing to children from working mothers in bivariate analysis. On the other hand, father's employment status did not show an association with either hospital care variables. In fact, several other studies and reviews did not find parental employment to influence child's health and development as much as other socioeconomic factors, like education, occupation and income.[15,85] Furthermore, an additional factor to consider besides parental unemployment and consequent financial hardship is the influence of children's health problems on parents' availability for participation in labour market.[141,142]

In the present work, there was an evident relationship between parental manual and unskilled occupations and children's greater need for hospital care, as reported in the literature.[64,66,143,144] Both mother's and father's occupation had some effect on children's health inequities. Indeed, mother's occupation demonstrated a statistically significant gradient of longer median LOS with more unskilled professional group in bivariate analysis, with group 9 (unskilled workers) significantly increasing LOS by 1.15 days in multiple regression analysis. Although a higher proportion of children of mothers with occupation group 9 were admitted to ICU compared to other professional groups in bivariate analysis, this lost significance in multivariate analysis. Odds of admission to ICU was higher by 1.55 and 1.64-fold, respectively, for children of fathers with intermediate skilled profession groups 0 and 5 (security, sales and personal care) and 6 to 8 (agriculture, manual jobs and industry). Previous studies have been inconsistent about how much maternal versus paternal occupation matter to children's health. Some studies found a stronger effect of father's occupation on child health and wellbeing,[64] and other studies found it for mother's occupation.[143,145]

The contribution of parental occupation, either mother's or father's, for children's health inequities could be exerted through two pathways, closely linked to parental education. One is the pathway of availability for parenting and childcare and the impact of work on parents' physical and mental wellbeing.[66,143] The other pathway is that of higher parental education and income providing better health literacy and healthcare.[64,145,146] "White-collar" and more skilled jobs are usually associated not only with higher wages and education level, but also with more prestigious social status. Income has a direct effect on children's health, as parents can provide better health investment, such as high quality nutrition, better housing and healthcare.[66,145] On the contrary, "blue-collar", manual and unskilled jobs are associated with lower wages and lower education level and with risk of harmful exposures and physical strain. This generates a cycle of carers with worse health status, less physical and mental availability for work and for childcare and consequent lower family socioeconomic and health status. This cycle of disadvantage tends to persist from childhood into adulthood: not only the offspring of unskilled or underpaid parents have worse health status in adulthood, they also perpetuate lower education attainment and lower quality jobs.[55,64]

It is important to notice that the two regression models had low power in estimating the effect size of the independent variables on the hospital care variables, especially in the case of LOS. The multiple regression model explained only 7.5% of the variance of LOS.

The logistic regression model explained 23.8% of admissions to ICU. This means that there are likely other factors contributing to the inequalities found. Further studies are warranted, with a broader approach and more comprehensive data collection. Furthermore, admissions to ICU, although numerous in absolute figures, were only a small proportion of the sample (7.8%), which reduces the statistical power of the analyses and could leave undetected some associations between socioeconomic indicators and this variable.

5.1. Strengths and limitations of the present study

The present work has some strengths and limitations that should be outlined.

To date, this is one of the first studies broadly investigating paediatric hospital care utilisation according to socioeconomic factors in both municipalities of Amadora and Sintra. Previous studies only addressed immigrant children,[23–27] children of African descent[28] and mostly in Amadora municipality only.[24,25,27] After the work by Machado et al establishing the association between children's health and areas of deprivation in Amadora,[23] this is also the first study to correlate paediatric needed hospital care with socioeconomic deprivation by civil parish both in Amadora and Sintra. Although immigration was not directly addressed by the present study, the socioeconomic variables analysed, like ethnicity and main language spoken in the household, contributed to understand this population's background. Due to Portugal's colonial past, these immigrant populations might have biological and cultural characteristics, as well as health utilisation behaviours, that differ from the populations included in other studies in Europe.

The present work uses a large sample size and covers a long period of time (eight years). These two strengths allow a powerful portrayal of the trends in hospital care utilisation and socioeconomic status of the population. The use of nationwide official classification systems for education level and occupation makes the results relevant to Portugal's background. Also, the use of EDI as a measure of socioeconomic deprivation, a validated instrument adapted to Portugal's reality and correlating with objective and subjective poverty, adds to the reliability and comparableness of results.

Finally, the collection of socioeconomic data by an interviewer instead of autonomously by the carer might have facilitated the collection of information, especially from subjects with language barriers, for whom understanding questions written in a foreign language could make comprehension difficult.

It is also important to consider this study's limitations, so that its results can be properly interpreted, and certain aspects improved in future research.

First, this is a retrospective study, using a pre-existing database lacking relevant information like family's income, immigration status and access to primary healthcare. Moreover, this database had a considerable proportion of missing information, which could pose a risk of information bias. Additionally, one cannot completely rule out that the data were missing not at random. This could be the case if some carers with low education level or low socially perceived occupation would opt not to answer to the respective questions or if language barrier would discourage health staff from interviewing or carers from answering questions.

Another limitation is the fact that the sample was affected by the most impacted pandemic years of 2020 and 2021. Utilisation of healthcare services was drastically reduced during these years. This certainly had an impact on the size and the characteristics of the sample.

This study limited its scope to hospitalisation in the main local public hospital serving the two municipalities, which might have caused a selection bias, especially considering that the Northern and Western parts of Sintra municipality are served by another hospital and that there are many other public and private healthcare facilities in this region at a close distance. However, this effect seems to have had limited impact, because the five civil parishes served by another public hospital represented only 8.3% of the study's sample, whereas they make up 25.4% of the two municipalities' resident population 24 years old or younger. Nonetheless, investigating access and utilisation of primary healthcare would give a broader picture of the pattern of utilisation of health services among this paediatric population.

The present work did not distinguish between admissions for medical conditions and admissions for social causes. Although admissions exclusively for social causes represent a small proportion of paediatric hospitalisations (0.3 to 1.2%, as reported in previous studies in Portugal), these can be prolonged.[147,148] Thus, potential outliers due to admissions for social causes could have an impact on results.

Finally, other limitations are related to the ecological data used. The reorganisation of civil parishes in 2013, with the consequent recalculation of EDI scores at civil parish level, might have introduced some bias. In fact, the process of recalculation is not described by the authors.[100,149] Furthermore, given the fact that the study period is situated between two consecutive Portuguese Censuses (2011 and 2021), and that data for the resident population was derived from Census 2021 instead of the estimations for each year in between, could have affected the representativeness of the sample.

5.2. Recommendations for future research

Based on what has been discussed thus far, this study presents recommendations for future work on children's health inequities.

A prospective cohort study is best suited for detecting the mechanisms through which socioeconomic factors influence health and how they act across the life cycle. Moreover, such a study design could overcome problems with a database not built for the purpose of the study and substantially reduce the amount of missing data.

Future studies should include other important socioeconomic indicators, namely family income and housing conditions. In addition, other composite socioeconomic deprivation indices besides EDI could be considered for analysis.

Considering that socioeconomic factors influence health in diverse ways, other health services utilisation indicators and health outcomes should be investigated.[15,34,35,85] This includes emergency department utilisation, mental and developmental outcomes, mortality, chronic conditions and highly prevalent diseases which pose a great burden to children and their families and to the health system. On that matter, information on carers' health literacy and primary healthcare access and utilisation is fundamental for understanding the impact of preventive care on health status. In addition, to fully understand the impact of health inequalities on children and families, other indicators, like school and job absenteeism, income reduction, perceived health status and quality of life, are required.

To investigate the association between geographical deprivation and health, the characteristics of the neighbourhood or area of residence, such as greenness, air quality, mean income and mean housing costs, should be addressed. In addition, access to relevant services, like healthcare, childcare and schools, public transportation and social support services, are socioeconomic indicators contributing to quality of life and not addressed by income. Widening the geographical scope and conducting multicentric studies would give a more comprehensive perspective of the problem and would allow comparison between diverse regions, either in Lisbon metropolitan area or at national or international level.

All the abovementioned data cannot be properly assessed solely through quantitative methods. Therefore, a combination of qualitative and quantitative methods would be a more fruitful approach. As discussed above, a qualitative approach would also facilitate the collection of data in cases where language barriers exist.

Establishing partnerships with social support services and non-governmental organisations (NGOs) would widen the recruitment of participants and the access to disadvantaged groups. On the other hand, it would raise concerns about sensitive data, with necessary adoption of mechanisms to properly handle it.

5.3. Implications for public health policies

As discussed before, understanding how socioeconomic factors and health are mutually influenced is crucial to identifying entry points for public health interventions and social programmes, thus achieving better results in health. Based on this study's findings, aspects to be considered when designing and implementing public health policies are proposed.

Policies aimed at reducing the health gap must focus on the period before conception and on the various dimensions seen to influence socioeconomic circumstances and health across the life cycle, starting on parents' background.[35] In this sense, policies that include both social and public health interventions in a multisectoral and coordinated fashion[67] must be the new paradigm to address the reciprocally amplifying effect of the health and socioeconomic risk factors. Recommendations advocate for proportionate universalism: a combination of universal services and programmes targeted at the most disadvantaged groups according to the level of disadvantage.[14,150] A Health in All Policies strategy considers two levels: social policies and classic public health policies.[14] This calls for action at multiple levels: government, community, child health organisations and health workers.[151]

Policies which influence the social gradient relate to educational system, employment and reduction of poverty.[14,67] Guaranteeing universal access to services that promote healthy early child development is the central aspect, both at individual and community levels. This should include promotion of physical and mental health, healthy behaviours, parenting and carer support, childcare, primary healthcare, nutrition, education, psychological and social support.[34,35]

Social policies should include childhood poverty reduction efforts. Income support interventions have demonstrated a positive effect on birth weight outcomes and children's mental health,[67] as well as attendance to health and dental services, fewer hospital attendances, higher enrolment rates in preschool and welfare services utilisation.[152] These include interventions like financial counselling, unconditional and conditional cash transfer and earned income tax credit.[67,152]

As demonstrated, education is one of the most powerful SDH. Ensuring universal early childcare and education, especially for the most disadvantaged, is of great value in promoting equity.[153] Moreover, education opportunities for parents with low education level, especially mothers, as well as supporting engagement in labour market,[154] are additional protective strategies acting through either improved health literacy and income raising.

The setting where beneficiaries are enrolled is an important aspect to be considered. Primary healthcare centres are a privileged setting for their proximity and health promotion environment,[154] as well as home visits, local welfare services and NGOs.[152] Facilitated communication links with frontline health workers allows the raising of awareness of the programmes, screening for modifiable SDH at the moment of clinical care and referring beneficiaries.[152,155] Hospitalisation is also an opportunity to screen for adverse SDH and engage children and carers into structured social and health support programmes that include follow-up after discharge and referral to community services.[156] Schools, where children spend a large part of their day and many social vulnerabilities can be detected, are also privileged sites for screening modifiable SDH. In fact, public health programmes directed at schools in Portugal, namely targeted at nutrition, immunisations, visual and auditive screenings and children with special needs or chronic conditions, are a strength of the Portuguese National Health Service.

Policies aimed at reducing risk exposure refer to classic public health policies.[14,67] These include health surveillance and prevention programmes, especially targeted at the preconception period, gestation and childhood. Such programmes already exist in Portugal and must be maintained, perfectioned and monitored and their universalism ensured.

In a region with a strong immigration and cultural and ethnic diversity, specific programmes designed to facilitate integration of these groups are crucial. These should include Portuguese language learning, information on citizenship, social support services and supporting engagement in labour market. Enrolment in targeted health programmes is an important public health intervention in this case. A culturally competent healthcare model has several components, including bilingual/bicultural health professionals or cultural mediators.[157] Kroening and Dawson-Hahn propose a comprehensive overview of the health needs of immigrant children, including a set of practical recommendations to address them.[22] Again, partnership with local agencies and NGOs has proven beneficial.[25]

Deprived civil parishes, as identified in this study, must be specifically targeted. For that purpose, working in partnership with municipal and civil parish administrative councils, primary healthcare centres, local social support agencies and NGOs offers opportunity for enquiring local needs and acting accordingly. Ensuring access to healthcare, childcare, education, welfare, employment, transportation and decent housing is the basic package to be met.

Moreover, health institutions must adapt to a health equity centred model of care. Among other aspects, this involves, incorporating in payment models an adjusted-risk scoring system that weighs SDH, based on the realistic assumption that socially disadvantaged people will need complex and costly healthcare interventions.[158]

Finally, evaluation of the interventions is essential to monitor their impact in reducing health inequities and to match new challenges, such as immigration from new origins.[35]

6. CONCLUSIONS

This study clearly demonstrated inequities in needed paediatric hospital care and clinical severity associated with socioeconomic deprivation among children hospitalised between 2014 and 2021 and resident in Amadora and Sintra municipalities. Length of hospital stay and admission to ICU were concentrated among the most deprived civil parishes. Black and Asian ethnicities, Asian language and parents' unskilled or manual occupations were significantly associated with needed hospital care, with a strong impact of ethnic factors.

The present study highlights the relevance of analysing SDH among children in Amadora and Sintra, two municipalities with a young population characterised by socioeconomic vulnerability, immigration and cultural an ethnic diversity. To date, this is the first study to broadly address paediatric health inequities and the various factors of socioeconomic disadvantage, instead of limiting to the immigrant population in this region. Moreover, it adds to the scarce Portuguese studies on children's SDH.

This study's findings support the role of socioeconomic factors on children's health status. Therefore, this work contributes to a better understanding of how social determinants influence children's health and how the socioeconomic gradient determines the gradient of health inequity.

Childhood is a period of increased susceptibility to socioeconomic deprivation. This period starts as early as pre-conception and is a complex process of biological, cognitive, mental and social development, which strongly influences the socioeconomic status, health and mental wellbeing in adulthood. Therefore, public health policies must not miss this unique window of opportunity for interrupting a chain of cumulative adverse life events and reducing inequity from childhood to adulthood through interventions directed at modelling patterns of disadvantage arising early in life. This requires addressing health as well as poverty and education of children and their families and promoting healthy neighbourhoods and communities. This is aligned with the United Nations' 2030 Agenda, namely Sustainable Development Goals (SDG) 3 and 10, but also SDG 1, 2, 4, 8, 11 and 17, in a true Health in All Policies strategy.

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