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Person, place and time contexts of growth and development of second- generation migrant children in Portugal

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Person, place and time contexts of growth and development of second-generation migrant children in Portugal



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Abbreviations and Acronyms

ANOVA: Analysis of variance

APC: Annual percent change

BMI: Body mass index

CI: Confidence interval

CRAS: Communication-related acculturative stress

CTSPC: Conflict Tactics Scale Parent-Child

FGM: First-generation migrants

GDP: Gross domestic product

GXXI: Generation XXI birth cohort

HAV: Hepatitis A virus

HBsAg: Hepatitis B surface antigen

HBV: Hepatitis B virus

HCV: Hepatitis C virus

HIV: Human immunodeficiency virus

INE: Instituto Nacional de Estatística

L2: Second language

LBW: Low birthweight

LGA: Large for gestational age

OR: Odds ratio

SGA: Small for gestational age

SGM: Second-generation migrants

WHO: World Health Organization

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Abstract

The goals of child development research are to describe the different stages of development; explain what causes developmental change; to predict or forecast later stages of development based on past or present characteristics; and to intervene using this knowledge to enhance the quality of children's lives. The health effects of international migration on first generation migrants have been well documented. It is also important to understand whether, when and how migration improves or diminishes the growth and development of the migrant children.

Literature review showed that there has never been any comprehensive and longitudinal study of growth and development of second-generation migrant children in Portugal. This thesis evaluated the hypothesis that there is no difference in growth and development of migrant and native Portuguese children. Different dimensions of growth and development were determined during prenatal, postnatal, early and middle childhood stages of their lives.

The specific objectives of this thesis were: 1. To compare risk factors and prevalence of adverse pregnancy outcomes in native Portuguese and migrants; 2. To compare 20 years trend of risk factors for adverse pregnancy outcomes in Portuguese and non-Portuguese mothers using the national birth registry data of Portugal; 3. To determine the impact of the 2007-2008 global financial crisis on low birthweight (LBW) in Portugal; 4. To assess the effect of maternal country of birth on breastfeeding practices; 5. To track blood pressure of children between 4 and 7 years. Secondly, to determine the prevalence of hypertension and its predictors at 4 and 7 years; 6. To compare parental disciplinary practices of Portuguese and migrants from the maternal and child perspectives. Data from two sources, the Generation XXI birth cohort and national birth registry of Portugal were used for the analyses.

Objectives 1, 4, 5 and 6 were addressed using Generation XXI birth cohort data by employing appropriate analyses. Generation XXI is a prospective and closed birth cohort of mother-child pair assembled at birth (2005-2006) in Porto, North of Portugal. A total of 8495 mothers (91.4% of those invited) and 8647 children were enrolled at baseline. We performed analysis on data obtained at baseline, 4 and 7 years evaluation. Logistic regression models were fitted to assess the association between migrant status and

adverse pregnancy outcomes (Objective 1). Logistic regression was used to assess the effect of maternal country of birth on breastfeeding initiation. Kaplan-Meier estimate was used to compare breastfeeding duration by maternal country of birth and length of residence by migrant mothers in Portugal (Objective 4). The association between predictor (exposure) variables and children's blood pressure (Hypertensive vs. Normotensive) at 4 and 7 years were estimated with logistic regression analyses expressed as crude and adjusted odds ratio (OR) and 95 % confidence intervals (95% CI) (Objective 5). Parental disciplinary strategies were assessed for 5277 children and their mothers using a Portuguese version of Conflict Tactics Scales Parent-Child questionnaire during the seven years follow-up evaluation of Generation XXI birth cohort of Porto, Portugal. Past year prevalence and chronicity scores of parental disciplinary practice were compared between Portuguese and non-Portuguese. (Objective 6)

We also studied 2,105,497 live births from the Portuguese national birth registry (1995-2014) obtained from Statistical Institute of Portugal for objectives 2 and 3. Time-trend analysis using Joinpoint regression method was performed to identify trends (Joinpoints) and compare time changes in prevalence rate of socio-demographic and obstetric factors for the latest trend expressed as annual percent changes (APC) (Objective 2). Joinpoint regression analysis was also done to identify the years in which changes in low birthweight trends occurred and annual percent changes (APC) estimated. LBW risk by time period expressed as prevalence ratios were computed using the Poisson regression. Contextual changes in socio-demographic and economic factors were provided by their trends (Objective 3).

Prevalence of risk factors for adverse pregnancy outcomes varied between native Portuguese and migrants: teenage mothers (5.6 and 2.0%), primiparae (57.1 and 63.9%), smoking during pregnancy (23.0 and 19.1%), twins (3.2 and 8.0%), and caesarean section (35.2 and 45.7%). Among singleton births, prevalence of low birthweight, preterm birth and small for gestational age were 7.3 and 3.9%, 7.5 and 6.2%, and 15.1 and 7.6%, respectively for native Portuguese and migrants. The native Portuguese had an adjusted significantly higher risk of low birthweight (OR 2.67, 95% CI 1.30, 5.48) and small for gestational age (OR 2.01, 95% CI 1.26, 3.21), but a similar risk for preterm birth (OR 1.38, 95% CI 0.81, 2, 34).

Proportion of live births by non-Portuguese mothers increased between 1995-99 (2.9%), 2000-04 (6.3%), 2005-09 (9.5%) and 2010-14 (9.8%). Proportion of mothers aged ≥ 35 years among Portuguese mothers varied from 11.1% (1995-1999), 14.4% (2000-04), 18.6% (2005-09) to 25.5% (2010-14) compared to non-Portuguese with 15.7% (1995-99), 14.6% (2000-04), 16.1% (2005-09) and 19.0% (2010-14). The rate of

change in maternal age ≥ 35 years had 3 Joinpoints in both Portuguese (APC=6.5% 6.2,6.9; 2005-14) and non-Portuguese (3.3% 2.5,4.0; 2002-14). The increase in caesarean section rate was more for non-Portuguese (24.0 to 36.1%) than the Portuguese (30.6 to 31.6%) between 1995 and 2014.

The joinpoint analysis identified 3 distinct periods (2 jointpoints) with different APC in LBW, corresponding to 1995-1999 (APC=4.4; 95% CI 3.2 to 5.6), 2000-2006 (APC=0.1; 95% CI -0.50 to 0.7) and 2007-2014 (APC=1.6; 95% CI 1.2 to 2.0). For non-Portuguese, it was, respectively, 1995-1999 (APC=1.4; 95% CI -3.9 to 7.0%), 2000-2007 (APC=-4.2; 95% CI -6.4 to -2.0) and 2008-2014 (APC=3.1; 95% CI 0.8 to 5.5). Compared with 1995-1999, all specific maternal characteristics had a 10-15% increase in LBW risk in 2000-2006 and a 20-25% increase in 2007-2014, except among migrants, for which LBW risk remained lower than in 1995-1999 but increased after the crisis. The increasing LBW risk coincides with a deceleration in gross domestic product growth rate, reduction in health expenditure, social protection allocation on family/children support and sickness.

Breastfeeding initiation and the type of breastfeeding practice were similar for native Portuguese and migrant mothers. The migrants had significantly higher median duration in months of any breastfeeding (6.0, 95% CI=5.4,6.6) and exclusive breastfeeding (4.0, 95% CI 3.8,4.2) than native Portuguese mothers (4.0, 95% CI 3.8,4.2 and 3.0, 95% CI 2.9,3.0). Migrant mothers who resided in Portugal for either ≤ 5 years (5.0, 95% CI 3.9,6.1 and OR 4.0, 95% CI 3.8,4.2) or > 5 years (6.0, 95% CI 5.5,6.5 and 4.0, 95% CI 3.7,4.3) years had similar duration of any breastfeeding or exclusive breastfeeding, in both cases higher than the native Portuguese mothers. No significant differences were found when world regions were compared.

Prevalence of obesity at 4 years was greater in males (18.5%) than females (14.7%). At 7 years, proportion of male (16.2%) and female (15.6%) obese children was similar. Systolic and diastolic blood pressure variation between 4 and 7 years were similar for males (7.3 ± 9.87 and 12.6 ± 10.25 mmHg) and females (7.0 ± 9.79 and 12.1 ± 10.03 mmHg). Proportion of children classified, as either systolic or diastolic hypertension in both evaluations was less for males (23, 1.2%) than females (65, 3.3%). Obesity at 4 or 7 years is the only factor that significantly predicts hypertension at either four (13.4, 95% CI=6.8-26.6) or seven years (9.3, 95% CI=4.7-18.4). Association between maternal country of birth and hypertension: at four years (1.5, 95% CI=0.5-4.0) and seven years (0.6, 95% CI=0.2-2.2) evaluation with Portuguese as reference category.

Both maternal and child responses showed a high prevalence of non-violent discipline (>85.0%), psychological aggression (>75.0%) and corporal punishment (>70.0%) by Portuguese or non-Portuguese mothers. Prevalence of severe and extreme physical assault was generally low according to maternal self-reporting for Portuguese (6.2 and 3.5%) and non-Portuguese (7.6 and 6.7%). Migrant children reported greater proportion (9.9%) of severe physical assault compared to the Portuguese (8.2%). Children's report showed that maternal application of extreme physical assault was greater for non-Portuguese (25.9%) compared to Portuguese children (19.8%). Disciplinary scale with the highest past year chronicity is maternal response for non-violent discipline in Portuguese (35.4 ± 23.52 times/year) and non-Portuguese (32.6 ± 22.64 times/year).

In conclusion, there is a difference between migrant and native Portuguese children depending on the evaluated factor and their stage of growth and development. Migrant mothers presented a lower risk of low birthweight and small for gestation and data suggest a healthy immigrant effect. Time changes in selected socio-demographic and obstetric factors were characterized by divergent trends and rate of change for Portuguese and non-Portuguese mothers between 1995-2014. There was a significant increase in the proportion of mothers that were aged ≥ 35 years and tertiary educated. Among non-Portuguese multiparity became less frequent, while caesarean section rates appreciated. Remarkably, the 2007-2008 global financial crisis was associated with a significant increase in LBW, particularly among infants of non-Portuguese mothers. It is not possible to conclusively propose a mediatory mechanism on how the financial crisis resulted in a higher rate of LBW and to what extent the resilience of available health and social responses buffered the effect of adverse individual or social level exposures. Further research will be required to improve the understanding of the role of particular factors, such as maternal nationality, fertility behaviour and the amplification of late maternity, substance abuse and mental stress, in the variation of LBW during periods of economic depression.

We observed that maternal country of birth does not influence breastfeeding initiation and type of feeding practice. However, migrant mothers have longer breastfeeding duration of either exclusive or any breastfeeding, which was not changed by length of residence in Portugal. Maternal country of birth was not associated with hypertension at 4 and 7 years. At seven years, high proportion of mothers performed at least a form of disciplinary acts on their children during the preceding year. Past year prevalence of corporal punishment by all maternal categories is high. Migrant compared to Portuguese children, reported higher prevalence and chronicity of maternal application of extreme physical assault.

Our study has recognized the predictive role of maternal country of birth in the determination of adverse pregnancy outcomes. But this variable is currently not included in the Portuguese national birth register. Our findings also underscore the limitation in sufficiency for some other important indicators not in the current national birth register of Portugal. Availability of the factors is required to exhaustively explain causal mechanisms for temporal changes in adverse pregnancy outcomes. Monitoring of these relevant risk factors will require inclusion in routine perinatal health surveillance system or innovative approaches involving clinical data linkage with the birth registration system. Consequently, future studies can be designed to examine feasibility of routine monitoring of additional aetiologic factors for adverse pregnancy outcomes.

An important public health implication of our study is that the duration of any breastfeeding and exclusive breastfeeding were below WHO recommendations in native Portuguese and migrant mothers. We recommend strengthening social policies aimed at maternity protection for vulnerable mothers and health system maintenance of social equity in perinatal healthcare. Participants of this study are members of a birth cohort assessed during mid-childhood. It will be remarkable that future evaluations investigate their mental health as well as disciplinary practices towards their offspring and also compare with that of their parents.

Resumo

Os objetivos da investigação em desenvolvimento infantil são descrever as diferentes fases de desenvolvimento; explicar o que causa alterações de desenvolvimento; prever e predizer etapas posteriores de desenvolvimento com base em características passadas ou presentes; e intervir usando esse conhecimento para melhorar a qualidade de vida das crianças. Os efeitos da migração internacional na saúde dos migrantes de primeira geração estão bem documentados mas é importante entender se, quando e como a migração afeta o crescimento e o desenvolvimento das crianças migrantes.

A revisão da literatura mostrou que nunca houve nenhum estudo abrangente e longitudinal sobre o crescimento e desenvolvimento de crianças migrantes de segunda geração em Portugal. Esta tese avaliou a hipótese de não haver diferenças no crescimento e desenvolvimento entre filhos de migrantes e nativas portuguesas. Diferentes dimensões de crescimento e desenvolvimento foram determinadas durante as fases pré-natal, pós-natal precoce e infantil de suas vidas.

Os objetivos específicos desta tese foram: 1. Comparar fatores de risco e prevalência de resultados adversos da gravidez em nativas e migrantes; 2. Comparar a tendência de 20 anos de fatores de risco para resultados adversos da gravidez em mães portuguesas e não portuguesas, utilizando os dados nacionais do registo de nascimento de Portugal; 3. Determinar o impacto da crise financeira global de 2007-2008 sobre o baixo peso ao nascer em Portugal; 4. Avaliar o efeito do país materno de nascimento nas práticas de amamentação; 5. Estudar a evolução da pressão arterial de crianças entre 4 e 7 anos e determinar a prevalência de hipertensão e seus preditores aos 4 e 7 anos; 6. Comparar práticas disciplinares parentais de mães nativas e migrantes nas perspectivas materna e da criança. Foram utilizados dados de duas fontes, a coorte de nascimento Geração XXI e o registo nacional de nascimentos de Portugal.

Os objetivos 1, 4, 5 e 6 foram abordados usando dados de coorte de nascimento da Geração XXI, uma coorte prospectiva e fechada de mães e filhos recrutada no nascimento (2005-2006) no grande Porto. Um total de 8495 mães (91,4% dos convidados) e 8647 crianças aceitaram participar. Realizamos análise dos dados obtidos no início do estudo, e nas avaliações dos 4 e 7 anos. Foram ajustados modelos de regressão logística para avaliar a associação entre o estatuto de migrante e desfechos adversos da gravidez (Objetivo 1).

Foi utilizada regressão logística para avaliar o efeito do país materno de nascimento no início da amamentação. A estimativa de Kaplan-Meier foi usada para comparar a duração da amamentação por país materno de nascimento e tempo de residência de mães migrantes em Portugal (Objetivo 4). A associação entre variáveis preditoras (exposição) e pressão arterial de crianças (hipertensas versus normotensas) aos 4 e 7 anos foi estimada com análises de regressão logística expressas em odds ratio (OR) bruto e ajustado e intervalos de confiança de 95% (IC 95%) (Objetivo 5). As estratégias disciplinares dos pais foram avaliadas para 5277 crianças e suas mães usando uma versão em português do questionário *Parent-Child Conflict Tactic Scales* aos sete anos de idade. A prevalência e cronicidade da prática disciplinar parental referida ao ano anterior foram comparados entre portugueses e não-portugueses. (Objetivo 6)

Foram ainda estudados 2 105 497 nascimento (1995-2014) obtidos no Instituto de Estatística de Portugal para responder aos objetivos 2 e 3. A análise de tendência temporal utilizando o método de regressão Joinpoint foi realizada para identificar tendências (Joinpoints) e comparar taxa de prevalência de fatores sócio-demográficos e obstétricos para a última tendência expressa como alterações percentuais anuais (Objetivo 2). A análise de regressão “Joinpoint” também foi feita para identificar os anos em que as mudanças nas tendências de baixo peso ao nascer ocorreram e as mudanças percentuais anuais (APC) estimadas. O risco de baixo peso por período de tempo expresso como razões de prevalência foi calculado usando regressão de Poisson. Mudanças contextuais nos fatores sócio-demográficos e económicos foram fornecidas pelas suas tendências (Objetivo 3).

A prevalência de fatores de risco para desfechos adversos da gravidez variou entre nativas e migrantes: mães adolescentes (5,6 e 2,0%), primíparas (57,1 e 63,9%), fumadoras durante a gestação (23,0 e 19,1%), gémeos (3,2 e 8,0%) e cesariana (35,2 e 45,7%). Entre os nascimentos únicos, a prevalência de baixo peso ao nascer, prematuridade e pequeno para a idade gestacional foram 7,3 e 3,9%, 7,5 e 6,2% e 15,1 e 7,6%, respetivamente, para nativas e migrantes. As nativas apresentaram um risco ajustado significativamente maior de baixo peso ao nascer (OR 2,67; 95% CI 1,30; 5,48) e pequeno para a idade gestacional (OR 2,01; IC 95% 1,26; 3,21), mas um risco semelhante de prematuridade (OR 1,38; 95% CI 0,81; 2,34).

A proporção de nados vivos por mães não portuguesas aumentou entre 1995-99 (2,9%), 2000-04 (6,3%), 2005-09 (9,5%) e 2010-14 (9,8%). Proporção de mães com idade ≥ 35 anos entre as mães portuguesas variou de 11,1% (1995-1999), 14,4% (2000-04), 18,6% (2005-09) a 25,5% (2010-14) em comparação com as não portuguesas com 15,7 % (1995-99), 14,6% (2000-04), 16,1% (2005-09) e 19,0% (2010-14). A alteração na

frequência idade materna ≥ 35 anos teve 3 pontos em nativas (APC = 6,5% 6,2;6,9; 2005-14) e migrantes (3,3% 2,5;4,0; 2002-14). O aumento de cesariana foi superior para não-portugueses (24,0 a 36,1%) do que para as portuguesas (30,6 a 31,6%) entre 1995 e 2014.

A análise “joinpoint” identificou 3 períodos distintos (2 pontos de inflexão) com APC distintas no baixo peso, correspondendo a 1995-1999 (APC = 4,4; IC95% 3,2 a 5,6), 2000-2006 (APC = 0,1; IC 95% -0,50 a 0,7) e 2007-2014 (APC = 1,6; IC95% 1,2 a 2,0). Para não-português, foi, respetivamente, 1995-1999 (APC = 1,4; IC95% -3,9 a 7,0%), 2000-2007 (APC = -4,2; IC95% -6,4 a -2,0) e 2008-2014 (APC = 3,1; IC 95% 0,8 a 5,5). Em comparação com 1995-1999, todas as características maternas específicas tiveram um aumento de 10-15% no risco de baixo peso em 2000-2006 e de 20-25% em 2007-2014, exceto entre os migrantes, para os quais o risco de baixo peso permaneceu menor do que em 1995. 1999, mas aumentou após a crise. O aumento do risco de baixo peso ao nascer coincide com uma desaceleração da taxa de crescimento do produto interno bruto, redução nos gastos com saúde, alocação da proteção social no apoio à família/crianças e doenças.

O início da amamentação e o tipo de prática da amamentação foram semelhantes entre as mães nativas portuguesas e migrantes. A duração mediana da amamentação em meses foi significativamente maior em migrantes considerando qualquer tipo de amamentação (6,0; 95% IC = 5,4;6,6) e aleitamento materno exclusivo (4,0; IC95% 3,8;4,2) do que as mães portuguesas (4,0; IC 95% 3,8;4,2 e OR 3,0; IC 95% 2,9;3,0). Mães migrantes que residiam em Portugal há ≤ 5 anos (5,0; IC95% 3,9;6,1 e 4,0; IC95% 3,8;4,2) ou > 5 anos (6,0; IC95% 5,5;6,5 e OR 4,0; IC95% 3,7;4,3) anos apresentaram duração semelhante do aleitamento mas em ambos os casos maior que as mães portuguesas nativas. Não foi encontrada diferença significativa quando foram comparadas as regiões do mundo.

A prevalência de obesidade aos 4 anos foi maior no sexo masculino (18,5%) do que no feminino (14,7%). Aos 7 anos, era semelhante: (16,2% e 15,6%, respetivamente). A variação da pressão arterial sistólica e diastólica entre 4 e 7 anos foi semelhante nos rapazes ($7,3 \pm 9,87$ e $12,6 \pm 10,25$ mmHg) e raparigas ($7,0 \pm 9,79$ e $12,1 \pm 10,03$ mmHg). A proporção de crianças classificadas com hipertensão sistólica ou diastólica em ambas as avaliações foi menor para os rapazes (23,2%) que para as raparigas (65,3%). A obesidade aos 4 ou 7 anos é o único fator que prediz significativamente a hipertensão aos quatro (13,4; IC 95% = 6,8-26,6) ou sete anos (9,3; IC 95% = 4,7-18,4). Associação entre país de nascimento materno e hipertensão: avaliação

aos quatro anos (1,5; IC95% = 0,5-4,0) e sete anos (0,6; IC95% = 0,2-2,2) com mães nativas como categoria de referência.

Ambas as respostas, materna e infantil, mostraram alta prevalência de disciplina não violenta (> 85,0%), agressão psicológica (> 75,0%) e castigo corporal (> 70,0%) por mães portuguesas ou não portuguesas. A prevalência de agressão física grave e extrema foi geralmente baixa de acordo com o auto reportado por mães portuguesas (6,2 e 3,5%) e o não-portuguesas (7,6 e 6,7%). Crianças migrantes reportaram maior proporção (9,9%) de agressão física severa em relação a portuguesas (8,2%). O relatório das crianças mostrou que a aplicação materna de agressão física extrema foi maior para não-portugueses (25,9%) em comparação com crianças portuguesas (19,8%). Escala disciplinar com maior cronicidade do último ano é a resposta materna para a disciplina não violenta em português ($35,4 \pm 23,52$ vezes / ano) e não-português ($32,6 \pm 22,64$ vezes / ano).

Em conclusão, existe uma diferença entre crianças migrantes e nativas portuguesas dependendo do fator avaliado e da fase de crescimento e desenvolvimento. Mães migrantes apresentaram menor risco de baixo peso ao nascer e de crianças pequenas para a idade gestacional, sugerindo um efeito do migrante saudável. As mudanças temporais em fatores sócio-demográficos e obstétricos selecionados foram caracterizadas por tendências divergentes entre 1995-2014. Houve um aumento significativo na proporção de mães com idade ≥ 35 anos e com nível de educação superior. A multipariedade tornou-se menos frequente nas nativas, enquanto aumentaram as taxas de cesariana. Notavelmente, a crise financeira global de 2007-2008 foi associada a um aumento significativo no baixo peso, particularmente entre os bebés de mães não portuguesas. Não é possível propor de forma conclusiva um mecanismo de mediação para o efeito da crise financeira e em que medida a resiliência das respostas de saúde e sociais disponíveis amorteceu o efeito de exposições adversas a nível individual ou social.

Observamos que o país de nascimento materno não influencia o início da amamentação e o tipo de prática alimentar. No entanto, as mães migrantes têm uma duração mais longa de aleitamento materno exclusivo ou qualquer amamentação, o que não foi alterado pela duração da residência em Portugal. O país materno de nascimento não se associou com hipertensão aos 4 e 7 anos. Aos sete anos, uma alta proporção de mães utilizou pelo menos uma forma de atos disciplinares com os filhos, durante o ano anterior. A prevalência do ano passado de punição corporal por todas as categorias maternas é alta. Migrantes, em comparação com

crianças filhas de portuguesas, relataram maior prevalência e cronicidade da aplicação materna de agressão física extrema.

O estudo reconheceu o papel preditivo do país materno de nascimento na determinação de resultados adversos da gravidez. Mas esta variável não está atualmente incluída no registo nacional de nascimento – só a nacionalidade. Os nossos resultados também sublinham a importância de alguns outros indicadores que não constam no atual registo nacional de nascimento de Portugal. A disponibilidade desses fatores é necessária para explicar exhaustivamente os mecanismos causadores de mudanças temporais em desfechos adversos da gravidez. O monitoramento desses fatores de risco relevantes exigirá a inclusão no sistema perinatal de vigilância sanitária de rotina ou abordagens inovadoras envolvendo a vinculação de dados clínicos com o sistema de registo de nascimento. Consequentemente, estudos futuros podem ser planejados para examinar a viabilidade do monitoramento rotineiro de fatores etiológicos adicionais para resultados adversos da gravidez.

Uma importante implicação para a saúde pública de nosso estudo é que a duração de qualquer amamentação e aleitamento materno exclusivo estava abaixo das recomendações da OMS em nativas e mães migrantes. Recomendamos o fortalecimento de políticas sociais voltadas à proteção da maternidade para mães vulneráveis e à manutenção, por parte do sistema de saúde, da equidade social na assistência perinatal. Os participantes deste estudo são membros de uma coorte de nascimento avaliada durante a metade da infância. Será notável que futuras avaliações investiguem sua saúde mental, bem como práticas disciplinares em relação a seus filhos, e também se comparem com a de seus pais.

1.Introduction

1.1 International migration: The causes, process and consequences

A migrant is an individual who has resided in a foreign country for more than one year irrespective of the causes, voluntary or involuntary, and the means, regular or irregular, used to migrate.[1] Migrants include “persons, and family members, moving to another country or region to better their material or social conditions, and to improve the prospect for themselves or their family”.[1, 2] Immigrants constitute a heterogeneous group with respect to their ethnic features, historical roots, religion, culture, values, notions, migration history, and practices concerning health.[3-5] Fundamentally, the relocation of immigrant families to a contrasting physical environment, socio-cultural setting, administrative and legal jurisdiction has implication for risk exposure, access to healthcare and health outcomes.

International migration is a process structurally central to sending and receiving societies.[6] Migration has usually been considered from a spatial (geographic) perspective, but more recent studies have also investigated the impact of social or occupational movement (social mobility) alone, or in combination with geographic migration, and tested whether such movements are selective or random for a number of biological traits.[7] The need to migrate is usually a function of the complex interaction of economic, social, familial and political factors in home country. A decreased labour demand triggers changes in migrant selectivity, which is consistent with economic explanation for decline in international migration during recession.[8]

The denial of access to education, employment, goods and services and the lack of respect for basic human rights are considered most important issues for migrants.[6] Meanwhile, in the receiving country, the reality of permanence, especially with second-generation migrants, creates social and cultural dilemmas--migrants become more assertive of their economic rights, and natives react negatively to the economic competition.[9] It is noted that in such circumstances, the social and economic stability of the country depends upon whether prevailing demographic trends will lead to a fragmented and divisive society or to a stronger nation built upon diversity. [10]

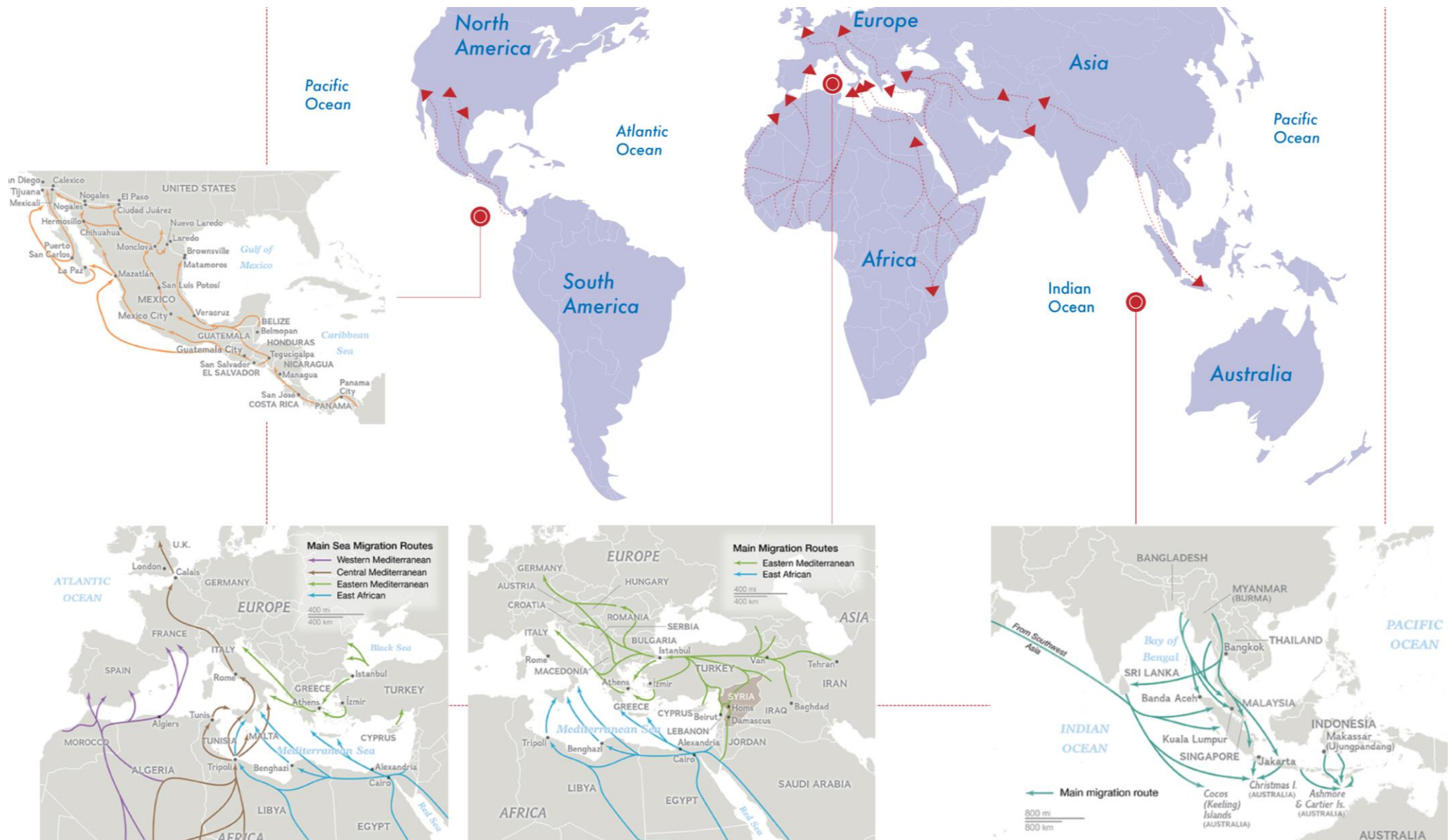


Figure 1. Major worldwide migration flows and routes in the 2000s (Source: National Geographic; Missing migrant project. International Organization for Migration; UNHCR; i-MAP, Regional Mixed Migration Secretariat)

Migration entails change of environment and migrant groups regardless of their origin or generation have common problems.[11],[12] The standard cohort-component model considers the migrant population arrayed into four generations: a foreign-born first generation (the immigrants), a second generation (sons and daughters of immigrants), a third generation (grandsons and granddaughters of immigrants), and fourth-and-higher generations.[13] There are mixed findings about the social conditions of different migrant generations. Some studies indicate that even when controlling for qualifications, both first- and second-generation immigrants are at a disadvantage for employment.[14] However, this pattern has been challenged as being a cross-sectional observation driven by biases from declining arrival cohort skill level and departures of negatively selected return migrants.[15] Another perspective is seen in a setting where social situation of foreigners is characterized by increasing segregation. Yet the situation of the second generation has clearly improved to a small degree, but compared with natives of the same age group their occupational success is limited.[16]

Table 1. Generations of immigrant and integration processes: Several conceptualizations, Rumbaut 2005

	First Generation (1)	One half Generation (1.5)	Second Generation (2.0)	Two and half Generation (2.5)	Third and beyond Generation
Definition	Foreign born or born in the country of origin, arrived with 14 years old or more at the destination country	Born in the country of origin, arrived with less than 14 years old to the destination country	Born in the country of destination from at least one of the parents	Those with one native parent and one foreign-born parent	Born in the country of destination of both parents
Integration	Mostly oriented to home country	Mixed orientation (home or host country). It depends on a great variety of circumstances.			

Generally, it has been observed that assimilation patterns vary substantially across sending countries and persist in the second generation.[15] Hence, diversity is encouraged to cement the integration progress of migrants and foster stronger identification with host country in the second and subsequent generations.[17] Worldwide migratory patterns have led to an increasing interest in acculturation processes and it has been demonstrated that second generation migrants are more highly acculturated and perceive less ethnic

discrimination than first generation migrants.[18] Empirical evidence also show that cultural and social advancement from first to the second generation is largely driven by good performance and outcomes of youths from professional immigrant families. For immigrants at the other end of the spectrum, average socioeconomic outcomes are driven down by the poorer educational and economic performance of children from unskilled migrant families, who are often handicapped, further by an unauthorized or insecure legal status. From a policy viewpoint, these children must be the population of greatest concern.[19]

1.2 Demographic transition in Portugal: Perspectives and projections

The presence of foreigners, particularly in Lisbon was obvious as early as the late 15th century. The strong revival of Portugal's migration streams began in the 1970s with an explosion of immigration spurred mainly by the process of decolonization and subsequent political and military instability in the PALOP states.[20] A new migration cycle emerged from the mid-1980s to the late 1990s, driven to a large degree by Portugal's increasing demand for labor. The new cycle was marked by a subtle but increasing trend towards diversity.[20] However, long term and settled migration has been linked to former colonial ties up to 1975, as consequence, in 2009 almost 50% of foreign-born residents in Portugal came from Brazil and Portuguese speaking African countries.[21] In this context, cultural gap or linguistic barriers are not expected for the majority of immigrant mother once they shared with native women the same language and most often similar genetic and behavioral characteristics.[22]

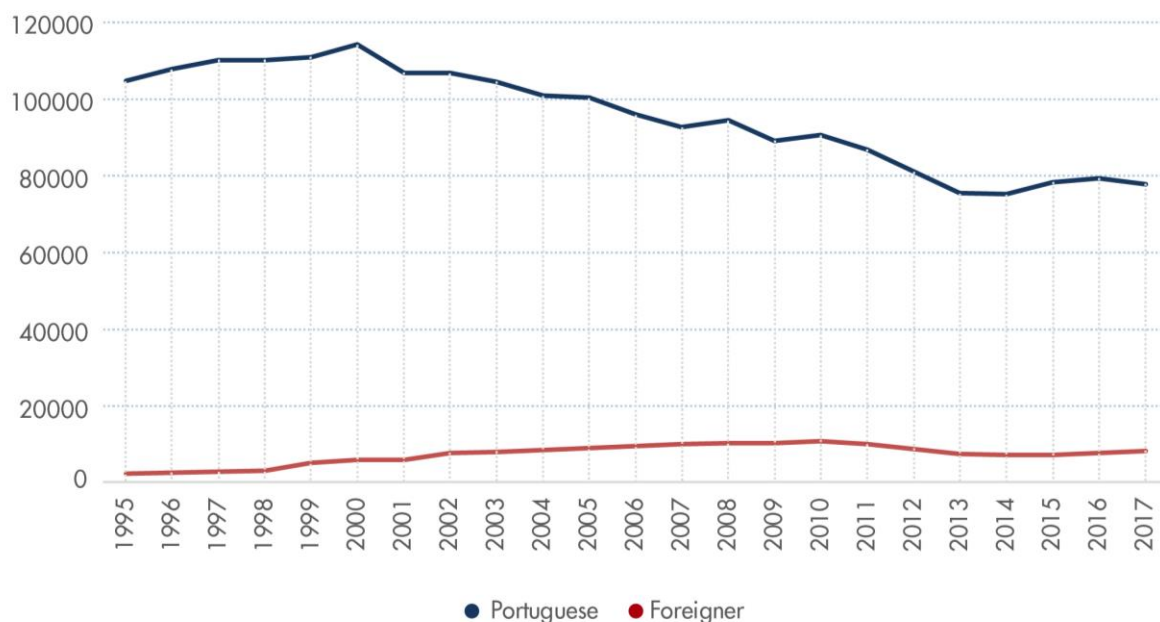


Figure 2. Live births of mothers resident in Portugal: Total and by mothers nationality (1995 – 2017), Source: INE.

In the last twenty years there has been an increase in foreigners as a percentage of resident population in Portugal, which rose from 1.8 (1998) to 3.8% (2008) in ten years. This is also reflected in the proportion of live birth recorded between 1995-2017 (Figure 2). In 1995, there were only 2,361 (2.2%) out of total of 107,097 live births by mothers with foreign nationality. But in 2017 there were 77,838 live births in the country and immigrant mothers accounted for 8,316 (9.7%).

1.3 Immigrant status as a social determinant of health

The relationship between migration and health is complex with immigrant-related inequalities in health largely influenced by socioeconomic position. These disparities can be observed at both individual and population levels.[9] Differences have been described in health outcomes and health service utilization between migrants and citizens of host countries.[23] However, the differences cannot be applied to all migrants uniformly because of the variety of backgrounds and circumstances of migrants.[9]

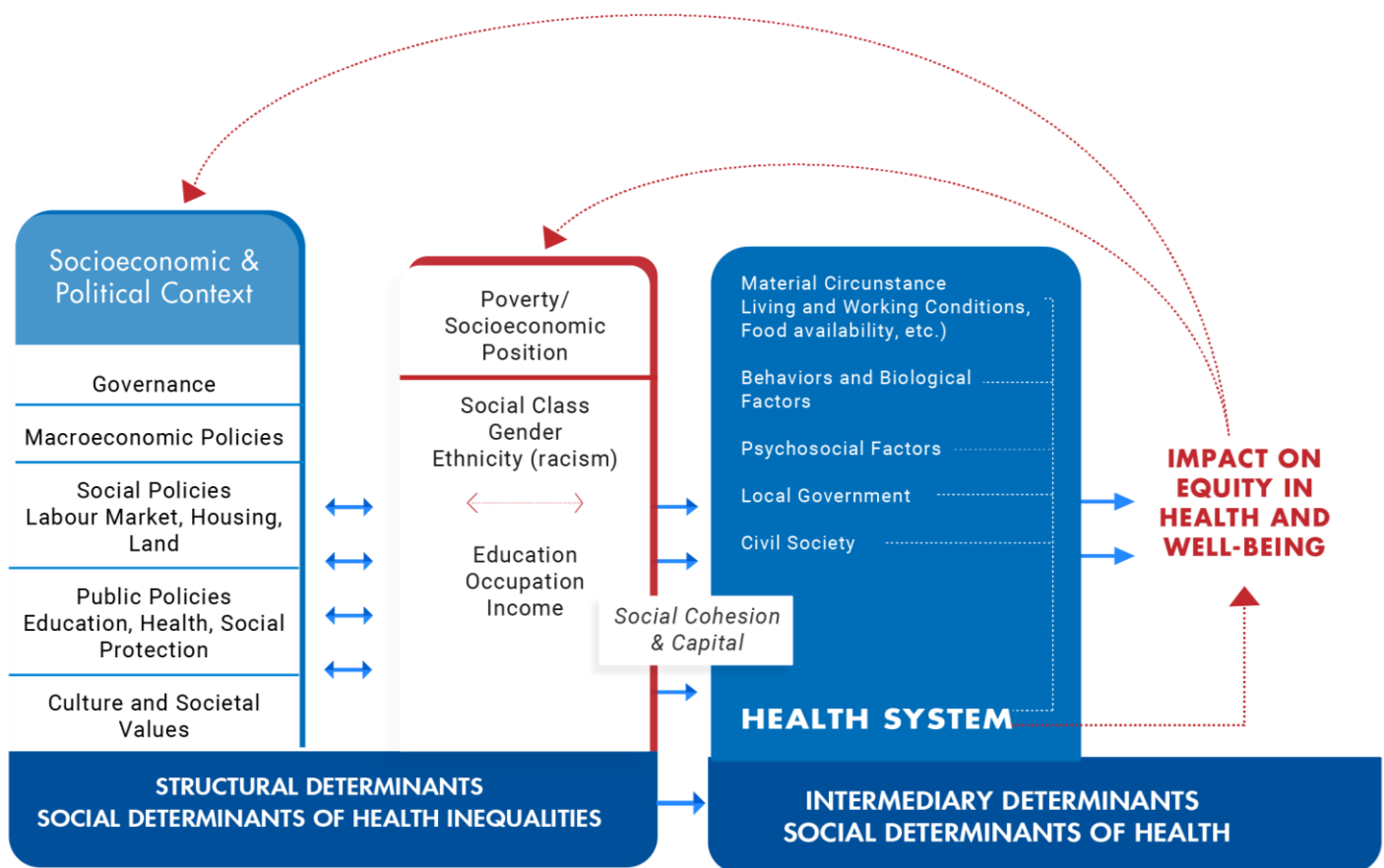
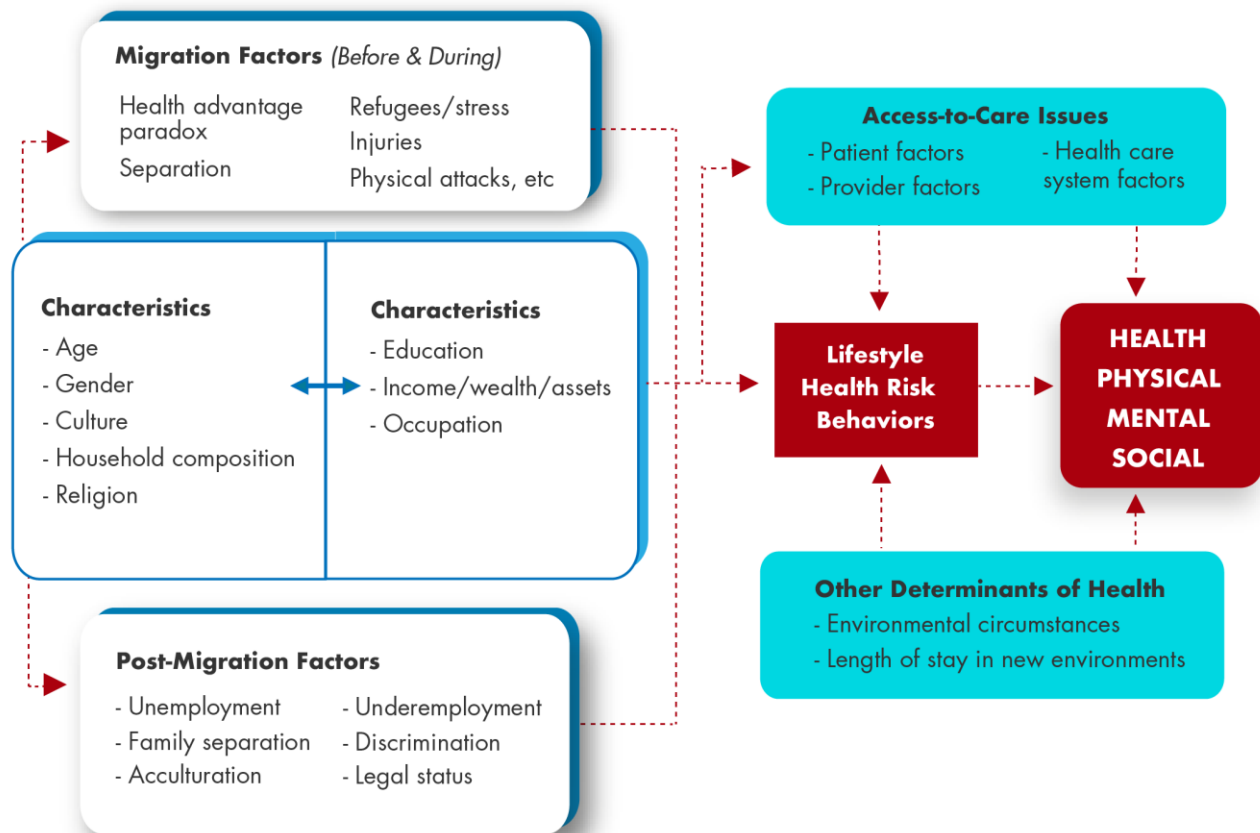


Figure 3. Social determinants of health and pathway to inequity in health

Studies have shown that there is migrant selectivity with stronger and healthier persons arriving in host countries.[24-26] However, 'healthy immigrant effect' is expressed differently in various European countries, which is due to differences in health selection at migration and in immigrants' integration between these countries.[27] The association between migration and health is intermediated by individual and contextual factors specific to migrants. Migration across health and disease disparities influences the epidemiology of certain diseases globally and in nations receiving migrants. While specific disease-based outcomes may vary between migrant group and location, general epidemiological principles may be applied to any situation where numbers of individuals move between differences in disease prevalence. Conceptually, immigration status is associated with variation in risk behaviour and exposure, access to healthcare and general health outcomes.



Adapted from: Noh S. et al. *Centre of Excellence for Research in Immigration and Settlement (CERIS) in Toronto and Canadian Heritage, 2001.*
& Viruell-Fuentes EA. *Social Science & Medicine*. 2007;65:1524-1535.

Figure 4. Pathway of migration and the determination of health

Studies examining the role of migration and health are largely consistent with healthy-migrant, acculturation and migration-as-rapid-health-transition theories.[28] Migrant mortality does not conform to a single pattern of convergence towards prevalence rates in the host population.[29] First-generation immigrants have lower all-cause and chronic-disease mortality than the host population. This mortality advantage wears off with length of stay and is more marked among non-Western than Western first-generation immigrants. As for second-generation immigrants, the picture is gloomier, with a mortality disadvantage that disappears after control for socioeconomic position. The convergence of the mortality profile of second-generation immigrants towards that of the host population with similar socioeconomic position indicates the need for policies simultaneously addressing different areas of deprivation.[28],[30]

A. Contrasting risk behaviour, exposure and health transition

Compared to the population of a host country, migrants tend to have different health risks and health behaviour.[31],[32] In some countries, immigrants seem to enjoy a better health than the native-born at their time of arrival to the host country. This has been ascribed to the “healthy immigrant effect” that healthier persons migrate but also due to a strict immigration policy.[6, 11-13] The “healthy migrant effect” is known to last over decades and extends into the second generation.[33] This is reinforced by 'unhealthy re-migration effect' in which socially successful migrants with a lower mortality risk stay in the host country while less successful ones return home even before becoming manifestly ill.[33] Nevertheless, changes in the prevalence of a risk factor for many chronic diseases showed a decrease over the generations. In the second generation, prevalence partly converged with those of the comparative host population or were even higher, which is described as a "health transition".[31],[29],[34]

In many countries immigrants constitute a potentially socially disadvantaged group with lower educational levels, lower employment rates, lower income, lower wealth, and residence in more deprived neighborhoods than native-born.[6, 12, 14-17, 19, 20] There is substantial residential segregation and deprivation at neighborhood level for migrants in some cities with implication for social cohesion, while a greater degree of dispersion is observed in others.[35],[17] Both minority status and ill health are associated with high unemployment probability in Europe.[36-39] Some migrant receiving countries have policies that ensure equal opportunities in the interest of solidarity between native and immigrant children and youth; offering the children bicultural teaching; removing their employment disadvantages.[36] Indeed, the school has an important role in the engagement and mediation effect of acculturation.[37] Unfortunately, in some settings school performance, bullying, language mastery, social integration and access to training plague migrants.[38] This circumstance requires societal support of health promoting initiatives through public policy, especially for children and for the poor, are important efforts for improving health and for realizing the economic benefits of health improvement.[39] Recent observations revealed disparities in smoking behaviour according to individuals' migration background.[40] There are indications of convergence across generations towards the prevalence rates in the host population for smoking among male and female migrants.[31],[29]

B. Health seeking behaviour, access and utilization of health services

Evidence from shows migrants experience inequalities in healthcare access and utilization.[41, 42] A great concern is also focused on a problematic situation for older migrants, who can be characterized by poverty, lack of knowledge of the healthcare system, generation conflicts and social exclusion.[43]

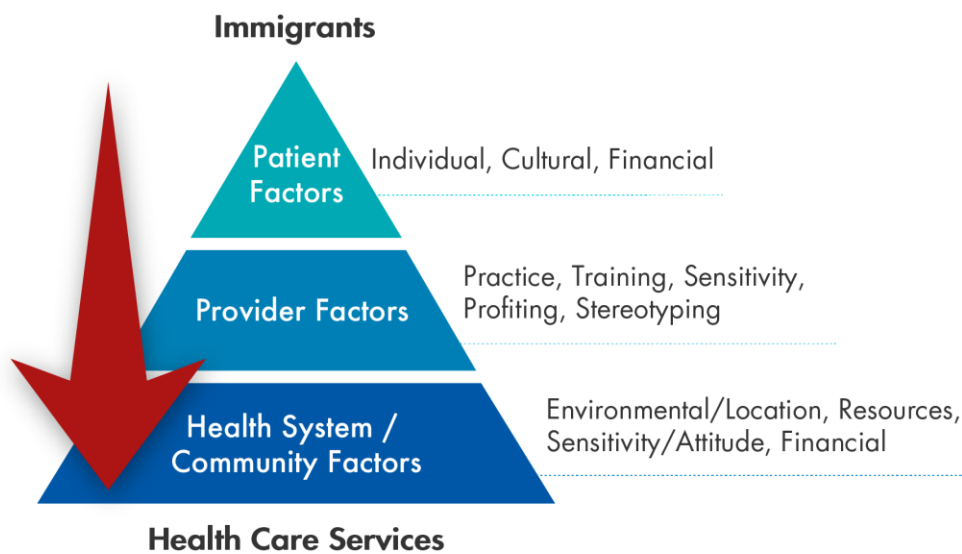


Figure 5. Barriers of access to healthcare for immigrants (Adapted from Rodriguez et al. 2009. Trauma Violence Abuse. 10(4): 358-378)

C. Marriage, fertility and reproductive behaviour

In Europe, residential context influences are associated with the age timing ideals for family formation of all migrants, but origin influences seem to be associated with the ideals of only the most recent migrants.[44] It has been shown that not only second-generation migrants (SGMs) but also first-generation migrants (FGMs) who migrated at an early age tend to differ from the sexual patterns of FGMs who migrated at an older age. Generational differences in sexual behaviour could be explained by acculturation and increased identity with the values of the host country.[45]

Migration appears to be increasing with family cohesion being threatened by migration policies and contemporary migration patterns.[6] Accordingly, a generational variation has been seen in the circumstances of migrant families. The first period shows first-generation migrants, whose family structure is still traditional and women's role enters into conflict with the new socio-economic reality." The second period is characterized by an increase in the percentage of married female emigrants; in the third period an increase in the percentage of single females is noted.[46] Comparisons of marriage cohorts suggest that second generation marry increasingly into the native stock, they marry increasingly out of their national origin group, and the national boundaries that separate them have become weaker over time. At the same time, it is found that educational homogamy has increased across cohorts.[47] Family size is smaller among migrants marrying after migration and in heterogamous marriages. Significant differences in birth intervals

are found when marriage occurred before or after migration, between generations, and between homogamous and heterogamous marriages.[48]

D. Health outcomes of immigrants

There is a heterogeneous relationship between immigration status and health outcomes.[34]

a. Perinatal risk and birth outcomes

Migration is associated with maternal stress and anxiety due to loss of traditional social entourage and environment with consequence on maternal exposure during pregnancy and birth outcomes.[6] It is expected that optimal prenatal care in host country can positively modify pregnancy outcomes. But the phenomenon known as “maternal migration effect” has been described in first generation migrants who retain pre-migration childbearing experiences or hearsay, which could pose negative consequences to maternity outcomes in the host setting, even if women have unhindered access to well-equipped care facilities.[49, 50] Furthermore, prenatal care utilization by non-western mothers in industrialized western countries is characterized by generational differences.[51] Compared with second-generation mothers, more first-generation mothers begin antenatal care after the first trimester of pregnancy. Thus, first generation women are less likely to receive timely health educational advice or to benefit from screening opportunities than second-generation women.[52] It has been observed that multiparity is more frequent among migrants than non-migrants, and parity and length of stay have been shown to be important factors associated to preterm delivery in some host countries.[28-32, 53] However, conflicting results were found showing that preterm delivery tend to occur more frequently in migrant women, while other studies show that maternal immigrant status is associated with low risk of preterm delivery.[54-61] Birthweight is also associated with maternal immigration status but exhibiting mixed findings.[59-61] Basically, the differences in pregnancy outcomes according to maternal immigration status is mediated by environmental or individual factors, i.e. being unmarried, prenatal care, smoking, drinking alcohol and using drugs, and partly by their inherently different growth pattern.[60-64]

b. Mental health

Many studies have identified the potentially important role of migration as risk factor of mental health problems like psychosis, schizophrenic disorders, bipolar affective disorders, suicide attempts and childhood autism.[65],[66],[49],[50],[67],[68],[69],[70],[71],[72],[73],[74],[75] Specifically, evidence synthesis has shown an increased risk for schizophrenia among first- and second-generation migrants especially high risk for

migrants from countries where the majority of the population was Black.[50] In Europe, first-generation European Union (EU) and non-EU migrants experience higher levels of depression, while second-generation migrants and natives show similar risk profiles.[76] It has been observed that first- and second-generation female migrants are more likely to suffer from depressiveness than non-migrant females. In this model a history of migration is shown to be an independent risk factor for depressiveness.[69] However, there studies that show first or second generation migrants did not have an increased risk of transition to psychosis.[77] Compared with non-migrants, migrants are known to report fewer somatic and violence-related symptoms.[78]

There is limited evidence of gender making an impact on the migration-health linkage.[79] Nevertheless, migrant women appear to be more likely to have worst mental health indicators as postpartum depression than national women.[80] The association between anxiety, depression, and physical ill health has been found to be significant for both males and females, but tend to be more pronounced for females.[79] Female migrants of second generation seem to be at risk with regard to suicidal behavior. Violence seems to be a significant problem in suicidal female immigrants of both generations.[81] Essentially, it has been recognized that the risk/ protection profile is in accordance with the interpretation that, as a social phenomenon, suicide is related to social isolation.[82]

Over the last 20 years there are many studies that documented increased rates of mental disorders among migrants in European countries.[83],[65],[66] Higher levels of mental health symptoms has been observed among second-generation migrants compared with native-born peers.[37],[83],[74] But other studies migrants have been found not to differ from comparable native-born persons in their mental health.[84],[85] Although, long duration of residence renders migrant children to have increased symptoms as their native counterparts as compared to fewer symptoms of some behaviour problems in the years after their arrival.[84] The increased risk of psychiatric disorders among immigrants clearly persists into the second generation, suggesting that post-migration factors play a more important role than pre-migration factors or migration per se. The observed variability suggests that the risk is mediated by the social context.[66] It has been proposed that downward intragenerational social mobility linked with migration may be associated with vulnerability to common mental disorders in some migrant groups.[86] There is some indication that certain migrant adolescents are at risk of psychosocial mal-adaptation. Obviously, ethnic origin is an important moderator.[87] Generally, orientation towards both the heritage and the host culture has a positive effect on the mental health status of immigrants.[88]

It has been found that there is a complex relationship between contextual factors and individual level variables in examining the effect of migration generation on mental health outcomes.[89] The accumulating evidence suggests a role for social factors, which are primarily barriers to socioeconomic integration and processes of discrimination.[90],[76] These factors include unemployment, poor housing conditions, linguistic handicap, being single, inadequate social support, value differences, and unfulfilled expectations, limited residence permit or the presence of personality structures that may increase vulnerability for stress responses and mental disorders.[91],[65],[92],[93] The migrant's deficiency of the second language (L2) social network size and interconnectedness significantly determines communication-related acculturative stress (CRAS) but not a general acculturative stress.[92] Nevertheless, acculturation has been identified as a major predictor of mental health of migrants with those having integrated acculturative pattern reporting lower symptom levels.[89] Reports of some degree of ethnic discrimination by immigrants also vary according to their level of acculturation. Unfortunately, discrimination is linked to various health problems, including mental disorders like depression and also has a negative effect on the access to mental health care services.[91]

c. Cardiovascular and respiratory diseases

Previous studies have established that migration and acculturation lead to higher blood pressures and a higher prevalence rate of cardiovascular diseases.[94],[95] Migrants' acculturation is associated with an enhanced beta-adrenergic activation pattern of the sympathetic nervous system that might put them at greater risk with regards to essential hypertension and coronary heart disease.[94] In some categories of migrants there is persistence of an unfavourable cardiovascular risk profile in young, third to seventh generation migrated Asian Indians and supports an aggressive screening and intervention strategy.[95]

d. Dietary patterns, gastrointestinal and endocrine disorders

Dietary intake variations provide important clues particularly when examined by age and migration status. Younger migrant groups could raise and sustain high fruit and vegetable intakes but lower proportions of fat, by adopting many dietary practices from older migrants.[96] Dietary change unavoidably entails cultural loss, thus resisting healthy eating guidelines may signify resistance to racism or cultural dominance.[97] Thus, the development of eating disorders has been associated with sociocultural factors especially parenting styles.[98] Broadly, in terms of disease pattern it follows that of indigenous population after only a generation.[99] In the British context the incidence of ulcerative colitis in the South Asian population is

higher than Europeans and continuing to rise.[99],[100] Considerably, the potential of worldwide impacts of migration patterns on the risk and burden of diabetes has been recognized.[101] Second-generation immigrants with longer length of residence in receiving countries are associated with higher prevalence of diabetes and diabetes-related complications (Diabetic retinopathy, cataract etc).[101]

Obesity levels are increasing disproportionately in immigrant children worldwide.[102] It has been explained that subsequent migration to a richer society greatly increases the risks to health associated with obesity and with glucose intolerance.[103] However, it has been recommended that health promotion messages to avoid obesity need to be targeted ethnic-specifically and also focus on second-generation migrants.[102],[104] This is relevant because some migrant sub-groups had very limited participation in physical activity compared to their counterparts.[102] Additionally, there is inconclusive evidence about converging trend for the overweight and obesity prevalence from second-generation migrants towards the host population. Inter-generational and gender differences have been documented. Obesity rates among second-generation migrant men were similar to those among the native-born. Second-generation migrant women were more often obese than women born in receiving country.[104]

e. Infectious diseases

The epidemiological transition has reduced infectious diseases mortality in most European countries, yet increased migrant influx risks importing diseases. High migrant flux into European countries has resulted in changing patterns of communicable disease and collectively requires a continuous surveillance.[105] Migrants are considered an important risk group for infectious diseases presumably because of the frequent contact and transmission within migrant populations and across generations. Notably, there is a higher rate of tuberculosis in second-generation migrants as compared to native residents.[106] But it has been highlighted that surveillance systems for specific infectious diseases insufficiently capture second-generation migrants by surveillance variables of country of birth and citizenship.[106] On the whole there is recommendation for combining biological and behavioural surveillance data, which allows for a more precise definition of prevention strategies. Although, many European countries have established behavioural surveillance systems, there is little harmonization as regards the methods and indicators adopted.[107] A second-generation surveillance system of people infected with human immunodeficiency virus (HIV) has been implemented in Spain. The information obtained has helped to define and refine public health policy and document treatment effectiveness.[108]

The differential risk of migrants for viral infections of the liver have features in European literature especially from Netherlands, a country with long history of high rate of immigration.[109],[110],[111],[112],[113] An estimated high hepatitis B virus (HBV) prevalence has been observed in migrants from countries with intermediate to high prevalence.[109] First-generation migrants (FGMs) had a 13-fold greater risk of being HBsAg- and/or HBV-DNA-positive than indigenous Dutch participants.[110] Incidence of acute hepatitis B in Amsterdam in FGM and SGM is higher than in the native Dutch population.[111] Though incidence of hepatitis A virus (HAV) has declined in Netherlands over the last two decades, but it is still higher in second-generation migrant children of Moroccan and other non-western ethnic backgrounds.[112] First-generation non-Western migrants are at increased risk for HCV. Phylogenetic analysis suggests that transmission likely took place in the country of origin, causing introduction but no further transmission of endemic HCV strains in the Netherlands.[113]

f. Cancers

Cancer results from the interaction of genetic susceptibility and environmental exposures. Migration history is relevant to cancer aetiology because of change in the physical environment as well acculturation factors like food preferences and habits regarding physical activity, which are associated with non-communicable diseases including cancers.[114] There is variation in the causal pathway and burden of various cancers among migrants. Illustratively, a higher incidence rate in second-generation immigrants than in their immigrant fathers confirms the early life programming of environmental factors in the etiology of testicular cancer.[115] Considering source country and cancer risk, the results of a review indicate that cancer risk at several sites among Chinese migrants appears to be in transition, and that these findings are consistent across studies.[116] For ovarian, colorectal, cervical and thyroid cancers, differences in risk between the migrant groups had largely disappeared in their offspring, suggesting that environmental exposures, which were modified by migration, are the major causative factors.[117]

Some European studies have reported comparisons of cancer risk and burden between migrant and native populations. The risk among first-generation immigrants varied remarkably by birthplace, reflecting the risk in their countries of birth.[118] Compared with Swedish-born men, first-generation immigrants from low-risk countries had a lower risk and first-generation immigrants from high-risk countries had a higher risk of testicular cancer. In the Netherlands, mortality rates for all cancers combined have been observed to be higher among second-generation migrants, among those with younger age at migration, and those with longer duration of residence. This convergence implies that current levels of cancer mortality among

migrants will gradually increase in future years if no specific preventive measurements are taken.[119] The observed bladder cancer risks in the first-generation immigrants, the changes in risks in the second-generation immigrants, and the covariation of the risk patterns of bladder and lung cancers suggested a main contribution by tobacco smoking. The changes of incidence in second-generation immigrants, yet based on small case numbers, lend little support to the involvement of genetic factors.[120]

1.4 Contextual framework and theoretical models on role of epidemiology in studying and understanding human growth and development

This study was conducted within the context of developmental surveillance. This is defined as a flexible, longitudinal, continuous, cumulative process which includes documenting and maintaining the child's developmental history; observing the child's development and identifying potential risk and protective factors for developmental delay.[121]

1.4.1 Growth and development: concepts and context

Human growth and development are characterized and defined by the way in which we change in size, shape and maturity relative to the passage of time. These phenomena are determined by genetic and environmental influences that operate in such a way that at specific times during the period of growth one or the other may be the dominant influence.[122] The terms growth and development are often used interchangeably and it is certainly true that each depends on the other for fruition. In the normal child each parallels the other and any separation would be an artificial one. However, in literature they are distinguished with separate operational definitions. Growth refers to an increase in physical size of the whole or any of its parts. Development is relatively enduring growth and change that makes an individual better adapted to the environment, by enhancing the individual's ability to engage in, understand, and experience more complex behaviour, thinking, and emotions.[123]

The context of growth and development is global for humans either as individuals or populations. The characterizations of the patterns of human growth, the way they differ from other species, vary within and between populations are basically regulated genetically and endocrinologically. Additionally, growth and

development are related to cultural, behavioural, economic and environmental factors.[124] Hence, to fully understand human development, the contexts in which it occurs must be taken into account. As depicted below (Figure 6), children both influence and are influenced by their immediate environment. That is a bidirectional influences between child and immediate contexts i.e. “microsystems” environments. The next level is the “mesosystems”, or network of connections between the environments. At a broader level, the “exosystem” composed of contexts in which a child does not directly participate-like a parent’s place of employment or community resources. On the fourth level is the “macrosystem”, which refers to the overarching cultural context in which development takes place.[123]

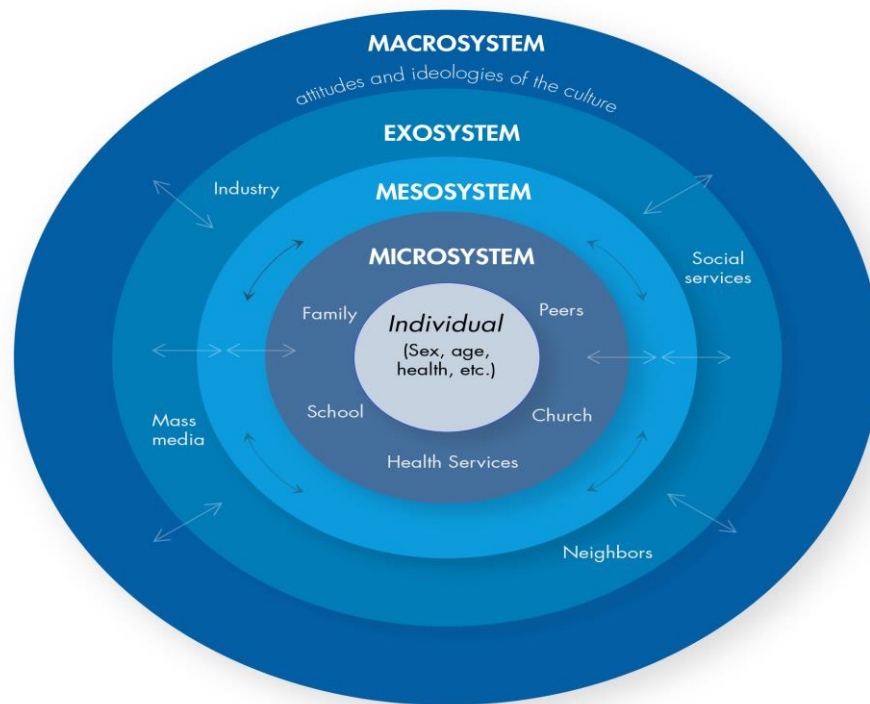


Figure 6. An ecological model of human development Source: Kopp, C, Krakow, J. Child development in a social context

There is a fifth systems parameter known as the “chronosystems” that extends beyond the environment. This concept was derived from researches implementing research designs in which time appears not merely as the property of the growing human being, but also as a property of the surrounding environment, not only over the life course, but also across historical time.[125-127] A chronosystem encompasses change or consistency over time not only in the characteristics of the person but also of the environment in which that person lives (e.g. changes over life course in family structure, socioeconomic status, employment or place of residence; migration).[128]

Two propositions specified the defining properties of ecological model of human development described above.[129] Proposition 1 state that, especially in its early phases, and to a greater extent throughout the life course, human development takes place through processes of progressively more complex reciprocal interaction between an active, evolving biopsychological human organism and the persons, objects, and symbols in its immediate environment. To be effective the interaction must occur on a fairly regular basis over extended periods of time referred to as “proximal processes”. Proposition 2 states that the form, power, content, and the direction of the proximal processes affecting development vary systematically as a joint function of the characteristics of the developing person; of the environment- both immediate and more remote-in which the processes are taking place; and nature of the developmental outcomes under consideration. Propositions 1 and 2 are theoretically interdependent and subject to empirical test. A research design that permits their simultaneous investigation is referred to as a process-person context model.[129] An example that is often cited is the classic longitudinal study by Drillien (1964) of factors affecting the development of low birthweight infants compared to those of normal weight (Figure 7).[130]

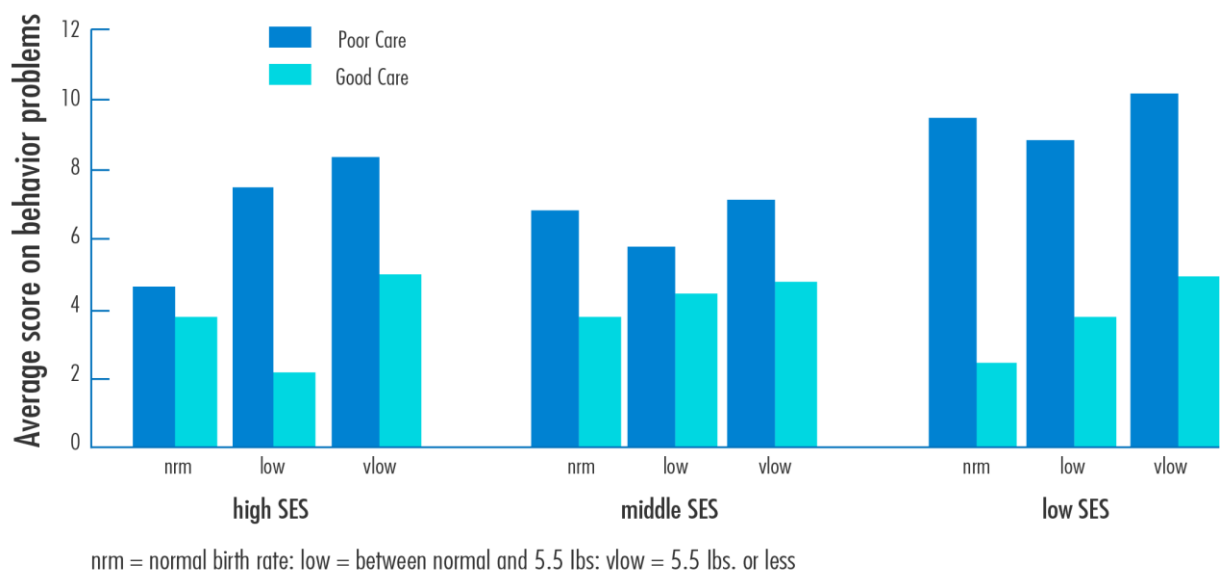


Figure 7. Behaviour problem at age 4 years (by birthweight, mother's care and social class)

Immigrant status of parents is important in the developmental process because of their peculiar social milieu in the host country.[131] The social environment is a fundamental determinant of early child development and, in turn, early child development is a determinant of health across the life course.[132] Migration is a

form of fundamental social change and disruption of life, which can be associated with health risks. Migration background is related with poor growth and developmental attributed to the higher proportion of families with a low socioeconomic status in this group.[133] Other explanations have been given in terms of genetic differences, social differences, dietary and psychological change, and the effect of “cultural bereavement”.[134, 135]

1.4.2 Demographic and epidemiologic concepts on migration and health

1.4.2.1 Migration timelines and epidemiologic transition

The improvement of understanding of status and determinants of migrant health has been achieved by applying general epidemiological principles to study the migration of people between countries with differences in social circumstances and disease prevalence. It is in the second generation that you start to see a break away of food, habits, language etc. from source population. The showers of culture are most intense on them and speed to which they do this varies and is most interesting.

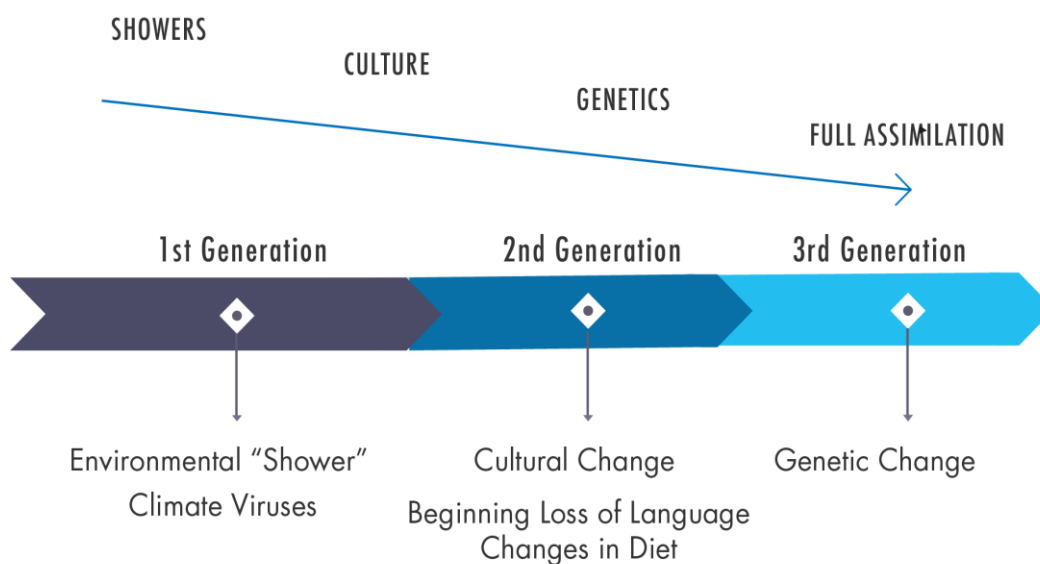


Figure 8. Migration time line (Source: Ronald E. LaPorte, Migrant Studies

<http://www.pitt.edu/~super1/lecture/lec1341/index.htm>)

1.4.2.2 Healthy immigrant effect and health inequalities

The migrant parents actually bring to task several strengths of keeping their children healthy. Studies show that migrants upon arrival tend to be healthier than those they left behind (“healthy immigrant effect”).[24, 26] Migrant parents preserve health-promoting cultural customs like breastfeeding. Subsequently, there is healthy migrant carry-over to children. In addition, many countries provide health coverage for infants and children regardless of parents’ nativity. Nonetheless, health outcomes of growth and development is linked with parental immigration status in the following ways (Figure 8).[136]



Figure 9. Pathways linking migrant status to negative child health outcomes in urban areas Source: Brockerhoff, 1995

1.4.3 Life course and social epidemiologic approaches to studying growth and development in the context of parental migration exposure

A risk factor can have an independent effect, or combinations of risk factors can have joint effects that lead to an adverse outcome. Exposure to multiple risk factors can lead to a variety of poor developmental outcomes. There can be diverse risk factors for similar outcomes (equifinality) or a common risk factor for diverse outcomes (multifinality).[137] Therefore, an effective method for studying multiple risk factors of human development in the context of parental migration requires a synergy of life course and social epidemiological approaches. Life course epidemiology shares with social epidemiology a particular interest in exposures that cluster because they are often related to an individual's or family's socioeconomic position in society.[138]

Life course epidemiology since its origins during the 1990s has immensely contributed to biological programming, birth cohort research and the study of health inequalities. Three models of life course epidemiology have since evolved: critical periods, accumulation, and pathways. Their conceptual and empirical differentiation can be difficult, but it is argued that accumulation is the underlying social process driving life course trajectories, while the critical period and pathway models are distinguished by their concern with specific types of aetiological process. Among the advantages of the accumulation model are predictive power, aetiological insights, contributions to health inequality debates and social policy implications. It is emphasised that the life course approach is not opposed to, or an alternative to, a concern with cross-sectional and current effects; major social disruption can have a large and immediate impact on health.[139]

Social structure and the life course

The life course may be regarded as combining biological and social elements, which interact with each other. Individual biological development takes place within a social context which structures life chances so that advantages and disadvantages tend to cluster cross-sectionally and accumulate longitudinally.[140] The complex relationship between life course and socioeconomic conditions in a given society has a determining effect on human health. The socioeconomic gradient emerges from a complex mixture of social and material influences operating at various levels of social aggregation and, also, a series of biological responses whose character and significance vary over the life course. Biological embedding and the "latency" and "pathways"

model incorporate the notion of a critical period in development; the pathways model emphasizes the cumulative effect of life events and the on-going importance of social/economic-psychosocial conditions throughout the life cycle.[141]

Comprehensively, the life course causal models are articulated in figure 10. The accumulation of different types of exposures (such as environmental, socioeconomic, and behavioural) may cause long term damage with exposure risk being either independent (fig 10, model a) or clustered (fig 10, model b).[138, 142] The latter is known as an accumulation model with risk clustering.[143] There is also a chain of risk model, which refers to a sequence of linked exposures that raise disease risk because one bad experience or exposure tends to lead to another and then another. Two different types of chains of risk have been conceived. One model is that each exposure not only increases the risk of the subsequent exposure but also has an independent effect on disease risk irrespective of the later exposure (fig 10, model c). When each adverse experience increases the risk of disease in a cumulative fashion this is called an “additive effect” and may be a special case of an accumulation model. Alternatively, earlier exposures have no effect on disease risk without the final link in the chain that precipitates disease onset (fig 10, model (d)). Such a “trigger effect” describes the situation when it is only the final link in the chain that has a marked effect on disease risk.[138]

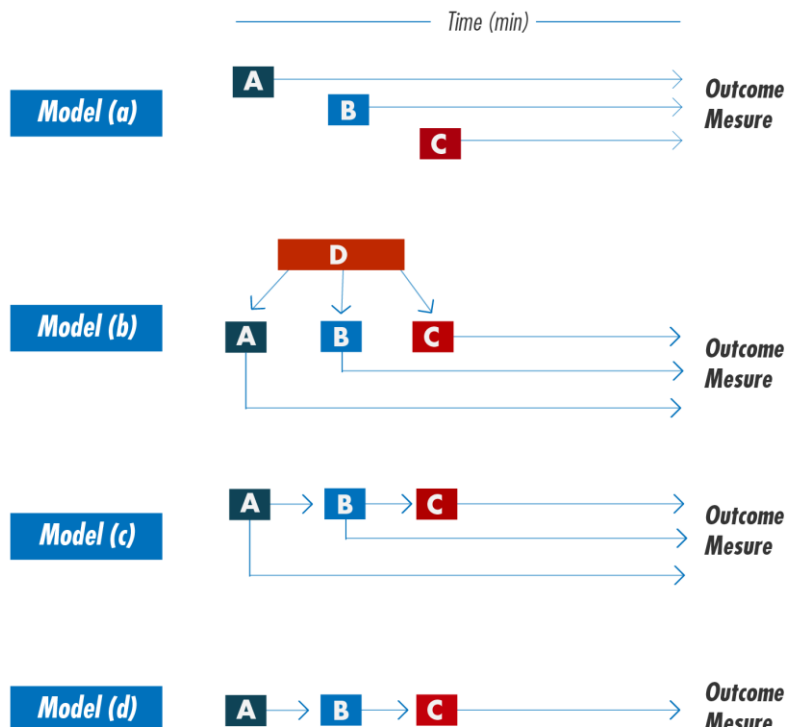


Figure 10. Life course causal models
(Source: D Kuh et al. J Epidemiol
Community Health 2003; 57:778-783)

Epidemiology's major contribution to developmental research is the application of birth cohorts, linked register datasets and epidemiological archaeology as veritable tools for studying human growth and development.[144, 145] Birth cohorts have extended our understanding of human development, social inequalities, and health inequalities. In this approach of studying growth and development measurements are repeatedly done on the same group or individuals at definite age intervals. This is the best way to study the growth of any individual child. It is necessary that the measurements must be correct and accurate. Since the longitudinal study provides a series of measurements for each individual at different age levels. Therefore, the following range of epidemiological studies could be conducted with the available data:

- **Social epidemiology and Social inequalities in health:** relationship between child health and parent socio-economic characteristics (education, income, housing etc.). Results from some birth cohorts have shown inequalities from the early stages of life and across a range of health indicators. Example of investigations in this theme will include evaluating the relationship between birth weight and socioeconomic disadvantage during childhood
- **Perinatal epidemiology:** determination of relationship between migrant status and neonatal and infant health outcomes (prenatal and perinatal risk assessment)
- **Nutritional epidemiology:** Evaluation of infant and childhood feeding practices, longitudinal assessment of physical activity, body size, body composition, and fat distribution
- **Natural history of disease:** Progress has been made in understanding the extent to which childhood illness and deficits in development persist into adult life.
- **Relationships between health and social factors over time (life-course epidemiology):** As the cohort is aging, the collected data will make contribution to the knowledge of life-course epidemiology, providing empirical evidence on outcomes associated with conditions in pregnancy or in childhood, inter-generational relationships, and predictors of adult health

Understanding the causes of health inequalities requires insights from social, behavioral and biological sciences, and a chain of reasoning that examines how the accumulation of positive and negative influences over the life course leads to health inequalities in adult life.[146] The associations between prenatal determinants and adult diseases have been recognized to be consequences of 'programming', whereby a stimulus or insult at a critical, sensitive period of early life has permanent effects on structure, physiology and metabolism.[147] Furthermore, epidemiological studies have indicated that many perinatal

manipulations are associated with reorganization of the central neural pathways that regulate food intake, energy expenditure and storage in ways that enhance the development of obesity and diabetes in offspring.[148] The critical phases for adult obesity development include time periods between conception and adolescence. So a life course approach to chronic disease prevention includes the study of maternal diet during pregnancy, intrauterine exposures, postnatal growth, and the adolescent period.[149] A healthy diet is important for optimal growth and development in children with separate growth patterns demonstrated for immigrant children especially those emigrating developing countries.[150],[151]

The early child health consequences of social deprivations are multiple, and often set a newborn child on a life-long course of disparities in health outcomes.[152] For example childhood intelligence is an important determinant of health outcomes in adulthood. A child's and her/his family's social conditions are strong predictors of cognitive ability in childhood.[153] The aetiology of a child's cognitive ability is complex, with research suggesting that it is not attributed to a single determinant or even a defined period of exposure. Among behavioural factors related to diet and lifestyle choices of the mother, breastfeeding was the most studied, showing consistent positive associations with cognitive ability.[154] Recent work in biodemography has suggested that lifetime exposure to infection and inflammation may be an important determinant of later-life morbidity and mortality. The differential exposure and/or susceptibility to infections may be one mechanism through which early social factors get embodied and shape later-life health outcomes.[155]

1.5 Research Gaps

The goals of child development research are to describe the different stages of development; explain what causes developmental change; to predict or forecast later stages of development based on past or present characteristics; and to intervene using this knowledge to enhance the quality of children's lives.[123] The health effects of international migration on first generation migrants have been well documented. It is also important to understand whether and how migration improves or diminishes the growth and development of the migrant children. Studying second-generation migrant children will provide insight into the role of immigrant status as a social determinant of health in childhood. Precisely, the experience of the second-generation migrant is more complicated because they have to adapt both to the culture of their parents and host culture.[156] Basically, three issues require examination: (i) in what aspects and to what degree do 'immigrants' differ from the native population?; (ii) in what aspects and to what degree do 'immigrants' differ amongst themselves according to their country of origin?; and (iii) how do 'second-generation immigrants'

and recently-arrived immigrants differ from those who have been in host country for a considerable length of time?[157]

The early years are important in laying the foundations for health and wellbeing throughout life, and to ensure equity of health and developmental outcomes for children of all backgrounds.[158] Migration in the era of economic problems when health is considered a human right in Europe presents new policy challenges. Therefore, it is relevant to monitor contemporary growth and development of the migrant children born in Europe. This will enable exploring effects of contextual socioeconomic changes on migrant health by identifying health outcome alterations as compared with the local population. Presently, there are minimal documentary reports of research studies addressing this perspective.

Although, there are isolated studies that have investigated the association between maternal country of birth (immigration status or nationality) and certain outcomes or compared second-generation migrants and their native born peers. But there are few that employ longitudinal studies to investigate growth and development of second-generation migrants through life long longitudinal observation of prenatal, postnatal and early childhood exposure and outcomes. Life course observation enables identification of intervention points—critical points (life course approach).

Indeed, much is known about the difference in outcomes between migrants and natives but little is known about how the difference occurs. A lot of studies on second-generation migrants are cross-sectional limited by inability to establish temporal or dose-response relationships. Obviously, an epidemiological approach of longitudinal observation provides insight into temporal association as well as an objective assessment of the comparative growth and development of migrant and native children. Since these children share the same environment and many other health-determining factors (including access to healthcare service) except in their immigration status. Many studies have shown the relative high burden of some mental health problems among immigrants in Europe. Research gap persist about specific risk factors of psychiatric disorders like autism and schizophrenia.[71],[49],[90],[75] The mechanisms by which social factors exert their influence remain unknown especially the temporal relationship between exposure to social defeat and (or) social adversity and the development of psychotic symptoms.[90]

In the past three decades there has been an increase in the number of migrants in Europe and some of them staying permanently. This development triggers the necessity for inquiries about inequalities in growth and

development of second-generation migrant children. Contextually, the socio-economic and political developments of the new millennium may interact with time changes of diverse migrant flows to modify risk factors of perinatal health. Currently, there is limited knowledge on effect of the 2008 economic crisis on birth outcomes of migrant mothers. The contextual time changes of risk factors for adverse pregnancy outcomes of migrant mothers have not been extensively studied in European settings. It is pertinent to also examine the influence of healthy migrant effect on breastfeeding because there are few contemporary studies. The "shower" of culture hits the second-generation migrants the most with language, food, physical activity, cultural conflict etc. Biological outcome like blood pressure of the second-generation migrant children has not been well studied, considering that it is determined by genetic, perinatal and environment exposures. Furthermore, culture is associated with pattern of parental disciplinary practices but few European studies investigated this theme. Certainly, these contextual research gaps directed our rationale for selecting the evaluation points and variables for this study.

Literature review showed that there has never been any comprehensive and longitudinal study of growth and development of second-generation migrant children in Portugal. Nevertheless, few studies have focused on maternal country of birth and outcomes relating to perinatal and child health outcomes. This study was conducted to generate more evidence on this subject by evaluating the biological and social exposures and their association with health and social outcomes during childhood by using longitudinal data. Additionally, the study was done to derive knowledge of environmental, social and health system experiences of international migrant women who had arrived and given birth in Portugal before and post-2008 economic recession. Finally, the longitudinal profile of the growth and development of their children during first seven years of life was documented.

1.6 Main hypotheses/ research questions

In this study we explored the role of parental immigration status in the growth and development of second-generation migrant children in Portugal. We adopted a longitudinal and cross-sectional comparison of second-generation immigrants and native Portuguese children from conception until seven years. This enabled us address the major hypothesis: There is no difference in the growth and development of second-generation migrant and native Portuguese children. The two broad questions we focused on were: Do second-generation migrant children grow and develop like native Portuguese? And are the determinants of growth and development of second-generation migrant children comparable with those of native

Portuguese children? We used a combination of the ecological model of human development (including chronosystems context), healthy immigrant effect and migrant acculturation to test and explain these hypotheses.

Hypothesis 1: There is no difference in prevalence and relevant risk factors of adverse pregnancy outcomes between migrant and native-born mothers.

Hypothesis 2: There is no difference in time variation of prevalence and risk factors for adverse pregnancy outcomes between migrant and native-born mothers.

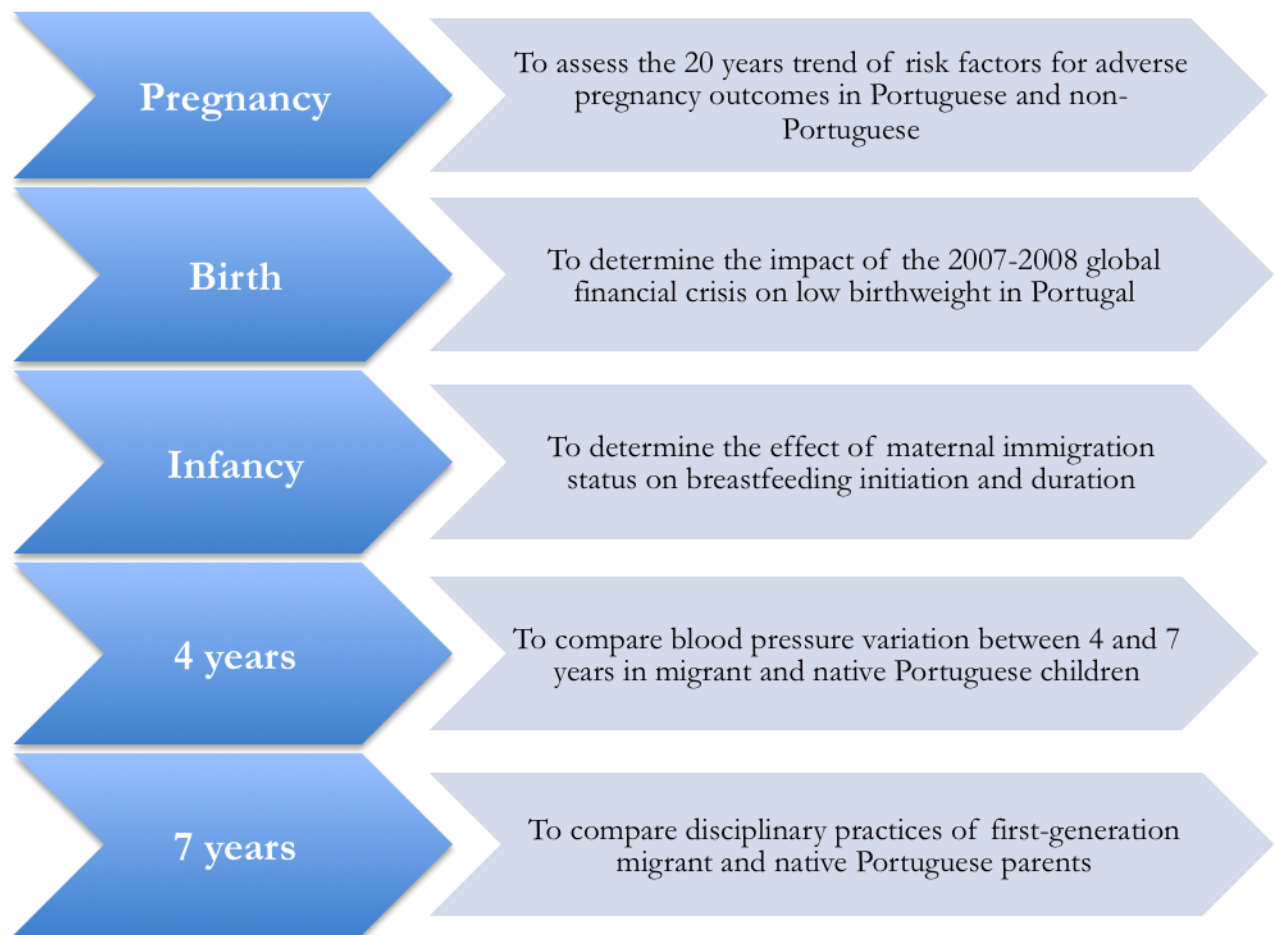
Hypothesis 3: The global financial crisis has no impact on low birthweight in Portugal.

Hypothesis 4: Maternal country of birth has no effect on breastfeeding practices.

Hypothesis 5: Maternal country of birth has no effect on blood pressure during childhood

Hypothesis 6: There is no difference in parental disciplinary practices between Portuguese and first generation immigrant mother

2. Specific objectives



3. Results

3.1 Paper I

Kana MA, Peleteiro P, Correia S, Barros H. Adverse Pregnancy Outcomes: A comparison of risk factors and prevalence in native and migrant mothers of Portuguese Generation XXI Birth Cohort. *Journal of Immigrant and Minority Health*.



Adverse Pregnancy Outcomes: A Comparison of Risk Factors and Prevalence in Native and Migrant Mothers of Portuguese Generation XXI Birth Cohort

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Abstract

Epidemiological studies report conflicting findings regarding association between maternal immigration status and pregnancy outcomes. In this study we compared risk factors and prevalence of adverse pregnancy outcomes in native Portuguese and migrants. Cross-sectional analysis was conducted using information collected at delivery from the participants of Generation XXI birth cohort. Logistic regression models were fitted to assess the association between migrant status and adverse pregnancy outcomes. Prevalence of risk factors for adverse pregnancy outcomes varied between native Portuguese and migrants: teenage mothers (5.6 and 2.0%), primiparae (57.1 and 63.9%), smoking during pregnancy (23.0 and 19.1%), twins (3.2 and 8.0%), and caesarean section (35.2 and 45.7%). Among singleton births, prevalence of low birthweight, preterm birth and small for gestational age were 7.3 and 3.9%, 7.5 and 6.2%, and 15.1 and 7.6%, respectively for native Portuguese and migrants. The native Portuguese had an adjusted significantly higher risk of low birthweight (OR 2.67, 95% CI 1.30, 5.48) and small for gestational age (OR 2.01, 95% CI 1.26, 3.21), but a similar risk for preterm birth (OR 1.38, 95% CI 0.81, 2.34). Migrant mothers presented a lower risk of low birthweight and small for gestation and data suggest a healthy immigrant effect.

Keywords Migrants · Portuguese · Risk factors · Adverse pregnancy outcomes

Background

Maternal immigration is an important social determinant of perinatal health but results of epidemiological studies are conflicting regarding specific association with pregnancy outcomes [1–7]. Differences between migrants and natives have been attributed to both contextual and individual-level factors [2]. Dependent on setting, at any point in time

foreign-born mothers could be exposed to similar or different contextual circumstances as their native peers [8]. However, individual-level risk factors have been significantly implicated in unfavorable outcomes [9]. Profoundly, individual biological, behavioural and socio-economic factors could interact to predict direction of association between immigration status and adverse pregnancy outcomes [2, 4, 10, 11].

Healthy immigrant effect considered basis for immigrants experiencing similar or better health outcomes than native-born has limited generalizability [12]. Evidence synthesis has shown that in countries with a weak integration policy immigrant mothers showed a clear disadvantage for low birth weight, pre-term delivery and perinatal mortality [13]. The generational shift in socio-demographic composition of migrant and native-born population observed during the last few decades has been related with changes in perinatal health outcomes for some European nations [2, 6, 14–16]. There are observations of time-based variation in adverse pregnancy outcomes with unequal trends for migrants and natives as host country socio-economic factors evolve [17–19]. Presently, few time-trend studies investigated fluctuations in distribution of individual risk factors with

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contemporary time change of adverse perinatal outcomes [14, 20–22]. Cross-sectional studies have complemented with knowledge of interaction of specific risk factors for adverse pregnancy outcomes but there is less understanding about multiple risk factors interactions with immigration status [4, 6, 11, 23–26].

The concurrent assessment of magnitude and distribution of multiple individual-level risk factors is relevant to identify and monitor risk factors that are sensitive to sudden or gradual time changes. Conventionally, the national vital statistics system of European nations is basis for monitoring perinatal health and detecting emerging trends [27]. However, it is limited by absence of certain risk factors for adverse pregnancy outcomes with causal relevance not included as indicators. Therefore, in this study we used a Portuguese population-based birth cohort to compare risk factors and prevalence of adverse pregnancy outcomes in native Portuguese and migrants. Additionally, we determined the association between maternal country of birth and adverse pregnancy outcomes.

Methods

Study Design and Population

The Portuguese Generation XXI birth (GXXI) cohort is a closed cohort of children assembled at birth in Porto metropolitan area (North of Portugal) between April 2005 and August 2006. In this birth cohort puerperae were consecutively recruited at five public maternities located in Porto, Matosinhos, Valongo, Maia, Gondomar and Gaia [28]. During recruitment of the birth cohort information was collected on maternal social, demographic and obstetric characteristics, as well as parental lifestyle (e.g. diet, smoking, alcohol consumption, physical activity) during intrauterine and in the early period of life. Data on a wide range of pregnancy outcomes and information on child health were also obtained. Exposure and outcome data were collected directly from participants by questionnaires, interviews and clinical assessments [28]. Details of the methods including data collection tools and processes are also found in <http://www.geracao21.com>. The project Generation XXI received ethical approval from the Ethical Committee of São João Hospital/ University of Porto Medical School. There was compliance with the Helsinki Declaration and the current national legislation. The Portuguese Data Protection Authority also approved the study [29]. Written informed consent was obtained from all participants during data collection.

The five public maternities of metropolitan Porto accounted for 10.3% of all births in Portugal during recruitment period of the GXXI birth cohort (Additional file 1). A total of 8495 mothers (91.4% of those invited) and 8647

children (singletons and multiple births) were enrolled at baseline. In this study we included only births with information about maternal country of birth ($n = 8557$). The participants and non-participants were similar in the key socio-demographic characteristics (Additional file 2). Our selected sample of the Generation XXI birth cohort comprised of 54.6% (8557/15667) births in the five targeted maternities and 5.6% (8557/151864) of all births in Portugal (Additional file 1). The birth cohort has similar characteristics of relevant variables in our study population with infant population of the national birth registry during the corresponding recruitment period (2005–2006).

Exposure Measurement

In the Generation XXI birth cohort a woman was classified as migrant if (a) she was born abroad and both parents were foreign-born or (b) if one or both parents were Portuguese-born but she moved to Portugal at the age of 18 or later, otherwise the participant was considered native Portuguese [30]. Migrant mothers that have resided in Portugal for 4 years or less were similar to those that have resided for longer than 4 years in their distribution of most risk factors for adverse pregnancy outcomes (Additional file 3). The migrants were categorized according to the regions of the world: 88 (1.0%) from other European countries, 190 (2.2%) from South America, 102 (1.2%) from Africa and 6 (0.1%) from other regions. In the national Portuguese birth registry women are classified according to their nationality and not their migrant status.

Adverse Pregnancy Outcome Measures

In this study we considered as adverse pregnancy outcomes; low birthweight (LBW), preterm birth and small for gestational age (SGA). In the national birth registry and GXXI birth cohort, the birth weight is recorded in grams and corresponds to the first measure of weight obtained after birth, preferably during the first hour. For this analysis the prevalence of low birthweight is defined as the proportion of singleton babies with birth weight less than 2500 g. Duration of gestation was expressed in completed weeks. Gestational age was derived by ultrasound measurements (if performed up to the 20th gestational week) and, if no such data was available it was based on last menstrual period. Infants were classified as preterm if delivered at < 37 completed weeks. Small for gestational age (SGA) and large for gestational age (LGA) were used to assess, respectively, fetal growth restriction and high fetal growth and were defined as the sex-specific birth weight < 10th or > 90th percentile for each gestational age [31]. The validity of gestational age measurement in Portuguese birth register and hospital-based data including

the period of GXXI birth cohort recruitment has been previously documented [32].

Risk Factors for Adverse Pregnancy Outcomes

In the selection of risk factors for adverse pregnancy outcomes included in the analyses, documented factors were considered [33]. Hence, the following classes of risk factors for adverse pregnancy outcomes were considered: (1) biological and constitutional factors: Infant sex, categorized as male or female, (2) socio-demographic factors: Maternal country of birth (Native Portuguese or migrant, as earlier described), age at arrival and length of residence in Portugal, maternal age, education (basic, secondary or tertiary), employment status (employed or unemployed), household income measured as Euros/month and classified as low (≤ 1000), medium (1001–1500) or high (> 1500), marital status (single or married/committed relationship), (3) obstetric factors: planned pregnancy (yes or no), conception (spontaneous or assisted reproductive technology), parity (primiparae or multiparae), prior stillbirth or low birthweight, type of delivery (normal vaginal, assisted vaginal and caesarean section), (4) nutritional factors: pre-gestational BMI (expressed as mean and categorized as underweight, normal weight, overweight and obese) and gestational weight gain, (5) maternal morbidity during pregnancy: anaemia, urinary tract infection, diabetes mellitus, hypertension, renal disease and preeclampsia, (6) cigarette smoking during any of the trimesters of pregnancy, (7) prenatal care: timing of first prenatal visit (during or after first trimester), frequency of prenatal visits and ultrasound scans, as well as prenatal diagnosis of intra-uterine growth restriction.

Statistical Analysis

Risk factors and prevalence of adverse pregnancy outcome were compared for native Portuguese and migrant mothers. Chi square and Fisher's exact tests were used to compare discrete variables, while continuous variables were compared with analysis of variance (ANOVA). We also reported OR (95% CI) for comparison of risk factors between native Portuguese and migrants (reference category). For characteristics with binary categories e.g. maternal smoking in pregnancy, the category "No" was used as reference. Multiple gestations were excluded from the regression analyses. Logistic regression was conducted to estimate the association between maternal country of birth and adverse pregnancy outcomes (low birthweight, preterm birth and small for gestational age) expressed as odds ratio (OR) with corresponding 95% confidence intervals (95% CI). Multiple regression technique was employed to adjust for maternal age, marital status, education, employment status, family income, pre-gestational BMI, gestational weight gain, parity,

assisted reproductive technique, timing of first prenatal visit, frequency of prenatal consultations and ultrasound scans, as well as smoking during pregnancy and infant sex. SPSS version 23 (SPSS Inc., Chicago, IL, USA) was used to perform all analyses.

Results

Risk Factors and Prevalence of Adverse Pregnancy Outcomes in Native Portuguese and Migrants Mothers—Results from GXXI Birth Cohort

Our study population included 8171 (95.5%) native Portuguese and 386 (4.5%) migrants mothers (Table 1). The mean age of arrival for migrant mothers in Portugal was 22.7 ± 6.55 years, while their median length of residence in Portugal at the time of birth of index child was 4 years. Proportion of teenage mothers was greater among native Portuguese (5.6%) as compared to migrants (2.1%), while percentage of mothers aged ≥ 35 years was 16.4% for native Portuguese and 17.4% for migrant mothers (OR 0.35, 95% CI 0.17, 0.73, teenage as reference). Proportion of single mothers was 5.5 and 5.8% in native Portuguese and migrant mothers. Half of native Portuguese mothers had only basic education (≤ 9 years) and 19.2% were unemployed. While 19.8% of the migrants had basic education and 24.7% were unemployed. Households with income of ≤ 1000 Euros/month were 40.6% for native Portuguese and 42.7% for migrant families (OR 1.00, 95% CI 0.85, 1.43).

The mean pre-gestational body mass index was 23.9 ± 4.31 kg/m² for native Portuguese and was 23.0 ± 3.59 kg/m² for migrants. The proportion of mothers that were either overweight or obese (BMI ≥ 25 kg/m²) was 31.4% in native Portuguese and 23.9% for migrant mothers. The risk of obesity (OR 2.56, 95% CI 1.29, 5.08) was more in native Portuguese than in migrant mothers. Mean gestational weight gain was 14.0 ± 5.93 kg for migrant mothers and 12.57.1 and 63.9% for Portuguese and migrants (OR 1.13, 95% CI 0.91, 1.39). The proportion of mothers that had their first prenatal visit after 12 weeks of gestation was 13.7% for native Portuguese and 18.0% for migrants. Twenty-two (0.3%) Portuguese and none of the migrant mothers had no prenatal visits, while 11.3% of native Portuguese and 15.8% of migrant mothers had ≤ 6 prenatal visits. The median prenatal ultrasound scans was 4 for both native Portuguese and migrant mothers. A total of 51 prenatal diagnoses of IUGR were made, which consist of 50 (0.6%) for native Portuguese and 1 (0.3%) for migrant mothers. The prevalence of gestational maternal morbidities for native Portuguese and migrant mothers were as follows: Urinary tract infection (8.7 and 7.5%), anemia (1.8 and 2.9%), gestational hypertension (0.9 and 0.3%), gestational diabetes (5.9 and 4.5%), renal

Table 1 Frequency of sociodemographic, behavioral, and clinical variables and its association with maternal country of birth (native Portuguese vs. Migrant)

Variable n (%)	Native Portuguese	Migrant	OR (95% CI)
Maternal age, years			
< 20	461 (5.6)	8 (2.0)	1
20–34	6370 (78.0)	311 (80.6)	0.36 (0.18, 0.72)*
≥ 35	1340 (16.4)	67 (17.4)	0.35 (0.17, 0.73)*
Maternal education, years			
Basic (≤ 9)	4133 (50.6)	74 (19.2)	1
Secondary (10–15)	2402 (29.4)	204 (52.8)	0.21 (1.16, 2.78)*
Tertiary (≥ 16)	1641 (20.0)	108 (28.0)	0.27 (0.20, 0.37)*
Maternal occupation			
Employed	6294 (77.7)	277 (71.9)	1.36 (1.08, 1.71)*
Unemployed	1803 (22.3)	108 (28.1)	1
Marital status			
Married or committed relationship	7647 (93.7)	359 (93.5)	1.04 (0.68, 1.57)
Single	514 (6.3)	25 (6.5)	1
Family income (euros/month)			
Low (≤ 1000)	2874 (40.6)	135 (42.7)	1.00 (0.85, 1.43)
Middle (1001–1500)	2026 (28.6)	68 (21.5)	1.54 (1.14, 2.09)*
High (> 1500)	2182 (30.8)	113 (35.8)	1
Pre-gestational BMI (kg/m ²)			
Underweight (< 18.5)	322 (4.1)	18 (5.0)	1
Normal weight (18.5–24.9)	5048 (64.9)	259 (71.5)	1.09 (0.67, 1.78)
Overweight (25–29.9)	1680 (21.6)	69 (19.1)	1.36 (0.79, 2.32)
Obese (≥ 30)	732 (9.4)	16 (4.4)	2.56 (1.29, 5.08)*
Parity			
Primiparae	4594 (57.1)	244 (63.9)	1.13 (0.91, 1.39)
Multiparae	3449 (42.9)	138 (36.1)	
Multiparae with previous stillbirth	46 (1.3)	2 (1.5)	0.53 (0.23, 1.22)
Multiparae with previous low birth weight	307 (3.9)	16 (4.2)	1.01 (0.71, 1.44)
Planned pregnancy			
Yes	5506 (67.5)	220 (57.0)	1.57 (1.28, 1.93)*
No	2646 (32.5)	166 (43.0)	1
Initiation of pregnancy			
Spontaneous	7952 (97.7)	364 (94.8)	2.34 (1.46, 3.75)*
Assisted reproductive technology	187 (2.3)	20 (5.2)	1
Gestational age at 1st prenatal consultation			
≤ 12 weeks	6878 (87.0)	310 (82.0)	0.89 (0.64, 1.23)
> 12 weeks	1032 (13.7)	68 (18.0)	1
Number of prenatal visits			
≤ 6	903 (11.6)	56 (15.1)	0.66 (0.48, 0.91)*
7–9	3277 (42.1)	168 (45.2)	0.80 (0.64, 1.01)*
≥ 10	3602 (46.3)	148 (39.8)	1
Prenatal diagnosis of intra-uterine growth restriction	50 (0.6)	1 (0.3)	1.81 (0.25, 13.22)
Urinary tract infection during pregnancy	681 (8.7)	28 (7.5)	1.19 (0.77, 1.83)
Anaemia in pregnancy	144 (1.8)	11 (2.9)	0.51 (0.27, 0.99)*
Gestational hypertension	66 (0.9)	1 (0.3)	3.07 (0.43, 22.18)
Gestational diabetes mellitus	460 (5.9)	17 (4.5)	1.03 (0.62, 1.69)
Renal disease	125 (1.6)	3 (0.8)	0.51 (0.13, 2.09)
Pre-eclampsia	64 (0.8)	2 (0.5)	2.32 (0.32, 16.85)
Maternal smoking during pregnancy	1901 (23.3)	73 (18.9)	1.30 (1.00, 1.69)*
Type of delivery			
Normal vaginal	4054 (49.7)	163 (42.8)	1

Table 1 (continued)

Variable n (%)	Native Portuguese	Migrant	OR (95% CI)
Assisted vaginal	1142 (14.0)	44 (11.5)	1.04 (0.74, 1.47)
Caesarian section	2954 (35.2)	174 (45.7)	0.68 (0.55, 0.85)*
Infant sex			
Female	4006 (49.0)	186 (48.2)	1.03 (0.84, 1.27)
Male	4165 (51.0)	200 (51.8)	1
Number of fetuses			
Singleton	7908 (96.8)	355 (92.0)	2.63 (1.78, 3.87)*
Multiple	263 (3.2)	31 (8.0)	1
Gestational age at birth (weeks)			
< 32	141 (1.7)	11 (2.8)	0.38 (0.05, 3.02)
32–36	632 (7.7)	32 (8.3)	0.58 (0.08, 4.38)
37–41	7364 (90.1)	342 (88.6)	0.63 (0.09, 4.64)
≥ 42	34 (0.4)	1 (0.3)	1
Birth weight (grammes)			< 0.05
≤ 1499	110 (1.3)	6 (1.6)	1.64 (0.66, 4.10)
1500–2499	649 (7.9)	30 (7.8)	1.94 (1.13, 3.34)*
2500–3999	7122 (87.2)	324 (83.9)	1.97 (1.30, 2.99)*
≥ 4000	290 (3.5)	26 (6.7)	1

*p-value < 0.05; some totals differ due to missing information

disease (1.6 and 0.8%) and Pre-eclampsia (0.8 and 0.5%). Prevalence of smoking during pregnancy was 23.2% for Portuguese and 19.1% for migrant mothers (OR 1.30, 95% CI 1.00, 1.69).

The prevalence of unplanned pregnancies was 32.5% in native Portuguese and 43.0% in migrants (OR 1.57, 95% CI 1.28, 1.93). Percentage of the pregnancies that were initiated by assisted reproductive technology was 2.3% for native Portuguese and 5.2% for migrants (OR 2.34, 95% CI 1.46, 3.75). The proportion of multiple pregnancies was 3.2% for native Portuguese and 8.0% for migrant mothers (OR 2.63, 95% CI 1.78, 3.87). The prevalence of cesarean section was 35.2% for native and 45.7% for migrant mothers (OR 0.68, 95% CI 0.55, 0.85). The mean head circumference for singletons was 34.2 ± 1.63 cm in native Portuguese and 34.4 ± 1.51 cm in migrants. Among all births (singleton and multiple births) mean birthweight was 3179.7 ± 495.57 g

for native Portuguese and 3318.9 ± 489.86 g for migrants ($p < 0.05$). The mean birthweight among singleton births was 3179.7 ± 495.57 g in native Portuguese and 3318.3 ± 489.86 g among the migrants ($p < 0.05$). In singletons the prevalence of low birthweight, preterm birth and small for gestational age were respectively 7.3, 7.5 and 15.1% for native Portuguese, and 3.9, 6.2 and 7.6% for migrants.

Association Between Maternal Country of Birth and Adverse Pregnancy Outcomes in GXXI Birth Cohort: Results of Regression Analyses

As shown in Table 2, native Portuguese had a significantly higher risk both crude and after adjusting for multiple confounders of low birthweight (AOR 2.67, 95% CI 1.30, 5.48) and small for gestational age (AOR 2.01 95% CI 1.26, 3.21),

Table 2 Crude and adjusted association between maternal country of birth (native Portuguese or Migrant) and adverse pregnancy outcomes in Generation XXI birth cohort (Results from a logistic regression model)

Model	OR (95% CI) ^a		
	Low birth weight	Preterm birth	Small for gestational age
Crude model	1.92 (1.12, 3.30)	1.14 (0.68, 1.91)	1.99 (1.25, 3.16)
Adjusted model	2.67 (1.30, 5.48)	1.38 (0.81, 2.34)	2.01 (1.26, 3.21)

Crude model: Native Portuguese (Reference: Migrant)

Adjusted model: Adjusted for maternal age, education, employment status, family income, parity, pre-gestational Body Mass Index, assisted reproductive technology, number of prenatal visits, and smoking during pregnancy

^aOdds Ratio (OR) and 95% Confidence Interval (95% CI)

while the risk for preterm birth was insignificant (AOR 1.38 95% CI 0.81, 2.34).

Discussion

Our cross-sectional findings indicate similar biological, obstetric and socio-demographic factors in native Portuguese and migrants but also differences in the distribution of certain categories of key risk factors for adverse pregnancy outcomes like maternal age, education, employment, parity, pre-gestational body mass index and pregnancy weight changes, smoking during pregnancy, prenatal care (timing of first visit and frequency of visits) and caesarean section delivery. These risk factors can, independently or interacting with others, influence adverse pregnancy outcomes. Indeed, the results of this study showed that migrants presented a lower risk of some adverse pregnancy outcomes (low birth-weight and small for gestational age), even after adjustment for those important covariates. Thus, suggesting a “healthy migrant effect” because of better indicators in the migrants.

We noted that migrant mothers presented a relatively low median residency time in Portugal but those that recently arrived were similar to those with lengthier stay regarding well recognized risk factors of adverse pregnancy outcomes. It is plausible that relevant exposures of host country have not become sufficiently exertive. Although, the native Portuguese mothers had greater risk of LBW and SGA than the migrants. The risk factors for adverse pregnancy outcomes were not uniformly higher for native Portuguese mothers. A higher caesarean section rate was observed among the migrants of the GXXI birth cohort, which is accounted by the preference for this delivery method in Brazilian mothers as documented [30]. In the context of the study setting and time of the study, the Brazilians constituted half of migrant population in the GXXI birth cohort. Their predominant representation in the migrant population is mainly due to historical, linguistic and cultural ties of their country with Portugal, which facilitated migratory movements.

The difference in preterm birth prevalence and risk based on maternal country of birth could be due to maternal age. We observed a comparative proportion of native Portuguese and migrant mothers that were aged ≥ 35 years. Moreover, majority of ≥ 35 years immigrant mothers are those that have resided in Portugal for > 4 years. Considerably, more older women experience fertility postponement that has been a characteristic trend for mothers in many European countries during the recent decades [34]. Another factor that could complement this understanding is the increased use of assisted reproductive technologies that is more prevalent among older women especially primiparae. These technologies are also frequently associated with multiple pregnancies

that intensify the risk of adverse pregnancy outcomes like prematurity [16, 35, 36].

Essentially, prenatal care promotes early detection and mitigation of modifiable risk factors during pregnancy [37]. It is unclear why there is some disparity in initiation time between migrant and native Portuguese mothers considering that there is universal free access to healthcare in Portugal. It is reasonable that prenatal care for migrants is influenced by barrier factors like lack of awareness of universal healthcare or poor language fluency. These factors could apply more to the recent migrants in the country. It has been recognized that the increasing diversity of immigrants in Europe signifies added challenges during pregnancy and post-childbirth especially for those not fluent or comprehending the national language [38]. Normally, migrants are considered vulnerable with manifest health inequities or disparity in other determinants, which is challenging for the health systems to tackle [10, 39]. Immigrant mothers are regarded as vulnerable with respect to navigation of maternity care services because they might encounter barrier related difficulties [40].

The number of foreign-born mothers has increased in many European countries including Portugal over the past 2 decades [41]. An important public health implication of this development is the modification in the risk profile of immigrants by the influx of newcomers and more vulnerable; refugees and asylum seekers. Invariably emphasis should be placed on monitoring the risk factors for adverse pregnancy outcomes. Our study has recognized the predictive role of maternal country of birth not currently included in the birth register. This underscores the limitation in sufficiency of the current birth register indicators, which are required to exhaustively explain causal mechanisms of adverse pregnancy outcomes. Monitoring of these relevant risk factors will require inclusion in routine perinatal health surveillance system or innovative approaches involving clinical data linkage with the birth registration system. Consequently, future studies can be designed to examine feasibility of routine monitoring of additional aetiological factors for adverse pregnancy outcomes [35, 42].

Strengths and Limitation of the Study

The major strength of the study is that Generation XXI birth cohort we based our analysis has comprehensive information on major classes of risk factors for adverse pregnancy outcomes. An exception is specific nutritional factors (caloric, protein and micronutrient intake) and physical activity during pregnancy were not directly evaluated in this study [35]. Their potential role as individual-level risk factors for adverse pregnancy outcomes might not have been directly assessed, but pre-gestational body mass index and gestational weight gain we analysed can be considered as proxies.

Although, the whole sample size of the study is large but the proportion of migrants was comparatively smaller. The small sample size of migrant population could be a limitation for generalization and external validity of our results. Nevertheless, the findings are relevant for inference within the context of Portugal since the birth cohort we based our analysis denotes the distribution of migrant maternal population at the time of recruitment. The Generation XXI birth cohort consisted of 54.6% of all deliveries during participant recruitment (2005–2006) in Porto metropolitan area, which contributed to 10% of all births in Portugal for same period.

Conclusion

Native Portuguese and migrants have variations in distribution of categories of maternal age, education, and employment, parity, and smoking during pregnancy, prenatal care (timing of first and frequency of consultations) and type of delivery. We observed an association between maternal country of birth and adverse pregnancy outcomes. Migrant mothers had a lesser risk of low birthweight and small for gestation, which suggests a healthy immigrant effect. This association is not significantly affected by other risk factors of adverse pregnancy outcomes.

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Author Contributions HB was responsible for the design and assembling of Generation XXI birth cohort. MK and HB conceived and designed the study and analysis. MK, SC and HB prepared the datasets and analysed the data. MK drafted the manuscript. HB reviewed, edited and revised the manuscript as well as supervised all the processes. All authors interpreted data and revised the manuscript critically for intellectual content. Finally, all the authors read and approved the final version.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no competing interests.

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Supplementary files

Supplementary Table 1: Maternal and infant characteristics by maternal country of birth in Portugal, Greater Porto Metropolitan Area and GXXI birth cohort

Variable n (%)	Portugal		Greater Porto Metropolitan Area		GXXI Birth Cohort		p-value
	Portuguese	Non-Portuguese	Portuguese	Non-Portuguese	Portuguese	Non-Portuguese	
Maternal country of birth	138805 (91.4)	13059 (8.6)	14979 (95.6)	688 (4.4)	8171 (94.5)	386 (4.5)	0.30
Maternal age, (years) mean ($\pm$)	29.3 (5.49)	28.5 (5.71)	29.4 (5.59)	28.4 (5.22)	28.9 (5.63)	29.3 (5.18)	1.00
<20	6722 (4.8)	624 (4.8)	771 (5.1)	21 (3.1)	461 (5.6)	8 (2.1)	0.90
20-34 years	108709 (78.3)	10372 (79.4)	11590 (77.4)	582 (84.6)	6370 (78.0)	311 (80.6)	
≥ 35 years	23374 (16.8)	2063 (15.8)	2618 (17.5)	85 (12.4)	1340 (16.4)	67 (17.4)	
Marital status							
Married or committed relationship	130742 (94.2)	11844 (90.7)	14001 (93.5)	655 (95.2)	7647 (93.7)	359 (93.5)	0.90
Single	8063 (5.8)	1215 (9.3)	978 (6.5)	33 (4.8)	514 (6.3)	25 (6.5)	
Maternal education, years							
≤ 9 (Basic)	67411 (48.6)	6013 (46.2)	7738 (51.7)	245 (35.9)	4133 (50.6)	74 (19.2)	<0.05
10-15 (Secondary)	34255 (25.7)	4736 (36.4)	3300 (22.0)	275 (40.3)	2402 (29.4)	204 (52.8)	
≥ 16 (Tertiary)	37057 (24.7)	4736 (36.4)	3935 (26.3)	163 (23.9)	1641 (20.0)	108 (28.0)	
Maternal occupation							
Employed	102426 (73.9)	7160 (55.1)	11045 (73.9)	353 (52.0)	6294 (77.7)	277 (71.9)	<0.05
Unemployed	11683 (8.4)	1278 (9.8)	1378 (9.2)	74 (10.9)	1552 (19.2)	95 (24.7)	
Others	24473 (17.7)	4551 (35.0)	2518 (16.9)	252 (37.1)	251 (3.1)	13 (3.4)	
Parity							
Primiparous	75415 (54.0)	7065 (54.2)	8370 (55.9)	399 (58.1)	4594 (57.1)	244 (63.9)	0.70
Multiparous	63320 (46.2)	5968 (45.8)	6599 (44.1)	288 (41.9)	3449 (42.9)	138 (36.1)	
Number of Foetus							
Singleton	135111 (97.3)	12711 (97.3)	14557 (97.2)	669 (97.2)	7908 (96.8)	355 (92.0)	0.30
Multiple	3694 (2.7)	348 (2.7)	422 (2.8)	19 (2.8)	263 (3.2)	31 (8.0)	

Type of delivery							
Vaginal	103819 (74.8)	9556 (73.2)	10985 (73.3)	525 (76.3)	5196 (63.7)	207 (54.3)	<0.05
Caesarean section	34986 (25.2)	3503 (26.8)	3994 (26.7)	163 (23.7)	2954 (36.3)	174 (45.7)	
Gestational age at birth (weeks)							
<32 (Very preterm)	1176 (0.8)	136 (1.0)	105 (0.7)	7 (1.0)	141 (1.7)	11 (2.8)	0.60
32-36 (Moderate-late preterm)	8596 (6.2)	722 (5.5)	921 (6.2)	30 (4.4)	632 (7.7)	32 (8.3)	
37-41 (Term)	124454 (89.8)	11522 (88.4)	13491 (90.1)	616 (89.8)	7364 (90.1)	342 (88.6)	
≥ 42 (Post-term)	4416 (3.2)	658 (5.0)	451 (3.0)	33 (4.8)	34 (0.4)	1 (0.3)	
Preterm births	9772 (7.0)	858 (6.6)	1026 (6.9)	37 (5.4)	773 (9.5)	43 (11.1)	0.60
Birth weight (grammes), mean (±)	3179.3 (510.00)	3267.3 (553.52)	3180.5 (504.67)	3256.9 (548.23)	3144.8 (534.89)	3224.2 (589.92)	1.00
<1500	1217 (0.9)	138 (1.1)	118 (0.8)	8 (1.2)	110 (1.3)	6 (1.6)	0.90
1500-2499	9309 (6.7)	764 (5.9)	1013 (6.8)	42 (6.1)	649 (7.9)	30 (7.8)	
2500-3999	122748 (88.4)	11207 (85.8)	13293 (88.7)	591 (85.9)	7122 (87.2)	324 (83.9)	
≥4000	5531(4.0)	950 (7.3)	555 (3.7)	47 (6.8)	290 (3.5)	26 (6.7)	
Low birth weight	10526 (7.6)	902 (6.9)	1131 (7.6)	50 (7.3)	759 (9.3)	36 (9.3)	0.90
Infant sex							
Male	71649 (51.6)	6769 (51.8)	7642 (51.0)	360 (52.3)	4165 (51.0)	200 (51.8)	1.00
Female	67156 (48.4)	6290 (48.2)	7337 (49.0)	328 (47.7)	4006 (49.0)	186 (48.2)	

Greater Porto Metropolitan Area = Porto, Matosinhos, Valongo, Maia, Gondomar and Gaia

Supplementary Table 2: Comparisons of key socio-demographic characteristics of participants and non-Participants

Variable, n (%)	Participants, n= 8557	Non-Participants, n= 90	p-value
Maternal age, years			
<25	469 (5.5)	2 (2.2)	0.39
25-34	6681 (78.1)	72 (80.0)	
≥35	1407 (16.4)	16 (17.8)	
Maternal education, years			
Basic (≤ 9)	4205 (49.1)	23 (25.6)	<0.05
Secondary (10-15)	2609 (30.5)	24 (26.7)	
Tertiary (≥16)	1743 (26.6)	43 (47.8)	
Maternal occupation			
Employed	6571 (77.5)	45 (72.6)	0.63
Unemployed	1911 (22.5)	17 (27.4)	
Family income			
Low (≤1000)	3010 (40.7)	14 (36.8)	0.88
Middle (1001-1500)	2098 (28.3)	11 (28.9)	
High (>1500)	2295 (31.0)	13 (34.2)	
Type of delivery			
Normal vaginal	4217 (4217)	52 (58.4)	0.23
Assisted vaginal	1186 (13.9)	11 (12.4)	
Caesarian section	3128 (26.7)	26 (29.2)	
Sex of child			
Female	4192 (49.0)	44 (48.9)	0.99
Male	4365 (51.0)	46 (51.1)	
Low birthweight	795 (9.3)	10 (11.1)	0.55

Some variables have missing records

Supplementary Table 3: Risk factors and prevalence of adverse pregnancy outcomes in migrant mothers of GXXI by length of residence in Portugal

Variable n (%)	Less than or equal four years	More than four years	P-value
Maternal age (years)			
<20	7 (4.8)	1 (0.5)	<0.05
20-34 years	133 (90.5)	156 (76.1)	
≥35 years	7 (4.8)	48 (23.4)	
Marital status			
Married or committed relationship	135 (92.4)	190 (93.1)	0.68
Single	11 (7.6)	14 (6.9)	
Maternal education, years			
≤9 (Basic)	30 (20.4)	40 (19.5)	0.01
10-15 (Secondary)	92 (62.3)	102 (49.8)	
≥ 16 (Tertiary)	25 (17.0)	63 (30.7)	
Maternal occupation			
Employed	87 (59.2)	159 (77.9)	0.01
Unemployed	60 (40.8)	45 (22.1)	
House income (Euros/month)			
<1000	68 (58.1)	61 (34.9)	<0.05
1001-1500	20 (17.1)	46 (26.3)	
>1500	29 (24.8)	68 (38.9)	
Parity (Primiparae)	76 (54.3)	104 (55.6)	0.81
Pre-gestational BMI ≥25Kg/m²	31 (23.2)	42 (21.6)	0.31
>9kg weight gain during pregnancy	101 (83.5)	127 (14.2)	0.59
Maternal smoking during pregnancy	29 (19.7)	41 (20.0)	0.95
Gestational hypertension	0 (0.0)	1 (0.6)	0.57
Less than or equal to 2 ultrasound scans	11 (9.9)	8 (4.1)	0.14
Less than or equal 6 prenatal visits	88 (62.0)	121 (61.1)	0.99
Type of delivery (Caesarean section)	24 (17.0)	30 (15.2)	0.91
Multiple births			
Preterm births	7 (4.8)	14 (6.8)	0.42

Low birth weight	6 (4.1)	7 (3.4)	0.74
Infant sex			
Female	72 (49.0)	109 (53.2)	0.44
Male	75 (51.0)	96 (46.8)	

3.2 Paper II

Kana MA, Peleteiro P, Correia S, Barros H. Time changes in prevalence of risk factors for adverse pregnancy outcomes among immigrant mothers in Portugal, 1995-2014

Time changes in prevalence of risk factors for adverse pregnancy outcomes among immigrant mothers in Portugal, 1995-2014

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Abstract

Background

Time-trend disparity in adverse pregnancy outcomes between foreign and native-born mothers has been well documented. But time changes in individual-level risk factors for adverse pregnancy outcomes have not been given the needed attention. This study compared 20 years trend of risk factors for adverse pregnancy outcomes in Portuguese and non-Portuguese mothers.

Methods

We studied 2,105,497 live births from Portuguese national birth registry (1995–2014). We compared maternal and infant characteristics in Portuguese and Non-Portuguese at four periods (1995–1999, 2000–2004, 2005–09 and 2010–2014). Time-trend analysis using Joinpoint regression method was performed to identify trends (Joinpoints) and compare time changes in prevalence rate of socio-demographic and obstetric factors for the latest trend expressed as annual percent changes (APC).

Results

Proportion of live births by non-Portuguese mothers increased between 1995–99 (2.9%), 2000–04 (6.3%), 2005–09 (9.5%) and 2010–14 (9.8%). Proportion of mothers aged ≥ 35 years among Portuguese mothers varied from 11.1% (1995–1999), 14.4% (2000–04), 18.6% (2005–09) to 25.5% (2010–14) compared to non-Portuguese with 15.7% (1995–99), 14.6% (2000–04), 16.1% (2005–09) and 19.0% (2010–14). The rate of change in maternal age ≥ 35 years had 3 Joinpoints in both Portuguese (APC=6.5% 6.2,6.9; 2005–14) and non-Portuguese (3.3% 2.5,4.0; 2002–14). The increase in caesarean section rate was more for non-Portuguese (24.0 to 36.1%) than the Portuguese (30.6 to 31.6%) between 1995 and 2014.

Conclusion

Time changes in socio-demographic and obstetric factors were characterized by divergent trends and rate of change in Portuguese and non-Portuguese mothers between 1995–2014.

Keywords: Immigrants; Portuguese; Risk factors; Adverse pregnancy outcomes

Background

Adverse pregnancy outcomes, such as low birthweight (LBW) including its constituents, intrauterine growth restriction and preterm birth, have lifelong health effects.[1, 2] Previous studies have recognized contextual and individual-level factors as major determinants of progression and outcome of pregnancy.[3, 4] Evidence of social inequality has been observed from synthesis of multi-level evaluation of these relationships.[5] At the individual level, maternal socioeconomic disadvantage has been observed to be associated with an increased risk of unfavourable pregnancy outcomes.[5, 6] Nevertheless, the causal relationship is not direct and consistent because of mixed associations between socioeconomic status, race/ethnicity, and some intermediary factors (e.g. psychosocial factors) with pregnancy outcomes.[4]

Studies show that maternal immigration status is an important social determinant of perinatal health, but results regarding its association with pregnancy outcomes are conflicting.[4, 7-11] Some studies show migrant mothers having similar or even better outcomes than those from the receiving country i.e. the healthy immigrant effect.[12-14] Similarly, raised risk of adverse outcomes for the migrant groups has been reported.[10, 15] Specifically, the impact of individual biological, behavioural and socioeconomic factors in the causal pathway of favorable or unfavourable outcomes in migrant mothers has not been fully comprehended.[6] Furthermore, the role of these mediators in explaining the differences in adverse pregnancy outcomes in migrant and native-born mothers as the socioeconomic conditions evolve in host country is also poorly understood.

The rate of adverse pregnancy outcomes could be influenced by period variation in demographic, economic and social structure of the society or condition of the maternal population including access to healthcare.[16, 17] During the last few decades many European countries experienced an increase in female migrants of childbearing age at a time of socioeconomic changes with perinatal impact.[10, 18, 19] In Portugal, it was observed that the 2007-2008 global financial crisis and austerity measures were associated with household food insecurity, poor health outcomes and affected healthcare access.[20] [21, 22] This underscores the significance of assessing temporal differences in the prevalence of individual risk factors and concurrent variation in adverse pregnancy outcomes of native and foreign-born mothers.[23] But there is lack of studies about temporal trend of individual-level risk factors for adverse pregnancy outcomes in migrants. Therefore, we investigated the 20 years trend of risk factors for adverse pregnancy outcomes in Portuguese and non-

Portuguese mothers. The primary objective was to compare the mediators of differences in adverse pregnancy outcomes in Portuguese and non-Portuguese. Additionally, we examined time trends of risk factors for public health surveillance and programming.

Methods

Study design and data source

We performed time-trend analysis using the Portuguese national birth registry. The annual individual data concerning maternal socio-demographic, obstetrics and birth characteristics were obtained from Statistics Portugal - Instituto Nacional de Estatística (INE) - for the period 1995 to 2014. The National Institute of Statistics of Portugal approved the study. The data was anonymously analyzed and it complies with the data protection policy of Portugal.

Study population

The study population from the national birth registry (1995-2014) that consisted of 2,105,497 recorded live births. We excluded records for which maternal nationality ($n=109$) and birth weight ($n=2976$) were missing or registered as $<500\text{g}$ or $>6000\text{g}$ ($n=3007$). Maternal nationality is measured at the moment of birth and recorded according to each individual country, but in this study it is classified as Portuguese or non-Portuguese. The non-Portuguese were further classified as Angola, Cape Verde, Guinea Bissau, Brazil, Sao Tome and Principe, China, Romania, Ukraine and other non-Portuguese. The eight named countries contributed $>70\%$ of all births by non-Portuguese in all the periods over the 20 years observation for this study.

Risk factors for adverse pregnancy outcomes

In the selection of risk factors for adverse pregnancy outcomes included in the analyses, documented factors were considered.[24] Hence, based on available information in the national birth registry the risk factors for adverse pregnancy outcomes were categorized as indicated: (1) Socio-demographic factors: Maternal nationality (Portuguese or non-Portuguese), maternal age (<20 , $20-34$ and ≥ 35 years), education (basic, secondary or tertiary), occupation (employed or unemployed), marital status (single, married or committed relationship or others) (2) Obstetric factors: Parity (primiparous or multiparous), type of delivery (vaginal or caesarean section) and place of delivery (hospital vs. non-hospital). The validity of the variables (gestational age) measured and recorded in the birth register has been evaluated and documented.[25]

Statistical analysis

The time-trend of adverse pregnancy outcome (LBW) using the Portuguese birth registry has already been reported.[19] For this study, we compared proportions of defined categories of maternal and infant characteristics between Portuguese and Non-Portuguese at four periods (1995-99, 2000-04, 2005-09 and 2010-14).[19] Considering that we are working with large samples, measures of effect size were preferred over significance tests to remove the dependence on sample size and the associated high probability of significant differences. We used Cohen's d effect sizes, which indicate the magnitude of differences between groups independent of sample size were values of 0.10, 0.30 and 0.50 or greater, which were considered small, moderate and large effect sizes, respectively.[26]

We performed a 20 years (1995-2014) time-trend analysis of risk factors for adverse pregnancy outcomes using the national birth registry. We analysed trends for categories of documented risk factors for adverse pregnancy outcomes with greater burden in Portugal during the study period.[27] These included age ≥ 35 years, single, tertiary educated, employed and primiparous mother, multiple pregnancy, non-hospital and caesarean deliveries. We then studied the trends and estimated the annual percentage changes (Table 1) by employing a Poisson Joinpoint regression model.[28] The procedure models the counts in the numerator and denominator for each time period rather than the pre-calculated rates. In essence, this approach is equivalent to having data at the individual level with sample size equalling the number of individuals in the denominators of the rates instead of the number of time periods for which rates are available. A Joinpoint represents a knot at which an important change in the temporal trend occurs; Jointpoints are estimated iteratively and do not require the specification of an a priori hypothesis about the location of the knots to be tested. Weighted least squares to account for heteroscedasticity was included to fit a loglinear Poisson Joinpoint regression model that was used. We also allowed for autocorrelation of the residuals to account for the fact that the observed rates are not independent.[29]

The Poisson regression analysis was performed using the Joinpoint Regression Program, Version 4.2.0. [30] The software fits the simplest Joinpoint model that the data will allow using a series of permutation test. The estimated annual per cent change (APC) and their 95% confidence intervals (CI) were computed by fitting a regression line to the natural logarithm of the rates using calendar year as a regressor variable (i.e., given $y = \ln(\text{number of mothers aged } \geq 35 \text{ years})$ and $y = \ln(\text{total of birth}) + a + bx$ and $x = \text{calendar year}$, the APC is estimated as $100 \times (e^b - 1)$).[30] The Poisson Joinpoint regression model was done for each variable and

unadjusted for covariates, as the purpose of our analysis was to compare trends of the selected risk factors in Portuguese and non-Portuguese.

The final number of Joinpoints was determined by comparing the best model with each number of change points using permutation tests.[29] The resulting graph for the best model had one or more Joinpoints and it is a scatter plot of annual prevalence of risk factors for adverse birth outcome from 1995 to 2014 (Figures 1 and 2). We compared the differences in number of Joinpoints and annual percent changes (APCs) for each factor between Portuguese and non-Portuguese using the latest trend e.g. for maternal age ≥ 35 years, Portuguese (2005-14, 3 Joinpoints) and non-Portuguese (2002-14, 3 Joinpoints). For all factors the latest trend included 2008 and/or the succeeding period, which coincided with the global financial crisis. We did not make comparisons using pooled estimates because the time period (20 years) was too long. In addition, the comparison of annual percent changes (APCs) or the Joinpoints between Portuguese and non-Portuguese did not correspond to the same period for some factors.

Results

Maternal and infant characteristics of live births according to maternal nationality in Portugal, 1995–2014

A total of 2,105,497 live births were included in the 20 years observation for this study. The proportion of live births by non-Portuguese mothers progressively increased between 1995-99 (2.9%), 2000-04 (6.3%), 2005-09 (9.5%) and 2010-14 (9.8%). Nine nationalities (Angola, Cape Verde, Guinea Bissau, Brazil, Sao Tome and Principe, China, Romania and Ukraine) accounted for 72.4% (1995-1999), 74.6% (2000-2004), 76.8% (2005-09) and 75.5% (2010-2014) of live births by non-Portuguese mothers. There was a steady progression in proportion of live births by Brazilian mothers in Portugal from 0.3% (1995-99), 1.0% (2000-04), 3.1% (2005-09) and 3.0% (2010-14).

The mean age of Portuguese mothers has steadily increased from 27.6 ± 5.48 years (1995-99), 28.5 ± 5.55 years (2000-04), 29.5 ± 5.53 years (2005-09) and 30.6 ± 5.58 years (2007-14). While, there was no remarkable change for non-Portuguese mothers: 28.4 ± 5.86 (1995-99), 28.2 ± 5.76 years (2000-04), 28.6 ± 5.73 years (2005-09) and 29.1 ± 5.86 (2010-14). The proportion of mothers that were aged ≥ 35 years among Portuguese mothers increased from 11.1% (1995-1999), 14.4% (2000-04), 18.6% (2005-09) and 25.5% (2010-14)

compared to non-Portuguese with 15.7% (1995-99), 14.6% (2000-04), 16.1% (2005-09) and 19.0% (2010-14). The proportion of primiparity among non-Portuguese increased over the 20 years period of observation, 46.1% (1995-99), 53.8% (2000-04), 54.5% (2005-09) and 52.4% (2010-14). Among the Portuguese mothers it was 53.7% (1995-99), 54.7% (2000-04), 54.3% (2005-09) and 54.9% (2000-14) respectively. The increase in proportion of tertiary educated mothers was greater for Portuguese (29.9 to 55.4%) than non-Portuguese (34.1 to 42.8%) between 1995 and 2014. The proportion of employed mothers was always higher among Portuguese (63.2%, 1995-99; 72.4%, 2000-04; 74.7%, 2005-09; 71.6%, 2010-14) than their non-Portuguese peers (47.4%, 1995-99; 56.6%, 2000-04; 55.2%, 2005-09; 49.0%, 2010-14).

There was no remarkable variation in the prevalence of multiple pregnancies, which was similar for Portuguese and non-Portuguese during all the time periods, 1995-99 (2.2 and 2.8%), 2000-04 (2.4 and 2.6%), 2005-09 (2.8 and 2.7%) and 2010-14 (3.1 and 2.9%). The percentage of non-hospital deliveries was similarly low for Portuguese and non-Portuguese in 1995-99 (1.1 and 1.5%), 2000-04 (0.6 and 0.8%), 2005-09 (1.0 and 1.2%) and 2010-14 (1.0 and 1.2%). The caesarean section rate increased significantly among non-Portuguese from 24.0% (1995-99), 26.7% (2000-04), 32.4% (2005-09) and 36.1% (2010-14). The caesarean section rate among Portuguese was respectively 30.6% (1995-1999), 29.1% (2000-04), 29.1% (2005-09) and 31.6% (2010-2014). The prevalence of preterm births among the singleton births in Portuguese and non-Portuguese was 5.7 and 6.4% in 1995-99, 5.1 and 5.8% in 2000-04, 6.7 and 6.6% (2005-09), 5.9 and 6.1% in 2010-14. The prevalence of low birthweight among Portuguese and non-Portuguese was respectively 5.5 and 7.6% (1995-99), 5.9 and 6.7% (2000-04), 6.2 and 5.6% (2005-09), 6.7 and 6.3% (2010-14).

Temporal variations in prevalence rate of socio-demographic and obstetric factors by maternal nationality in Portugal, 1995-2014

The time trends of socio-demographic and obstetric factors are shown on Figures 1 and 2. The comparison of temporal variations (Table 2) in the trend and annual percent change (APC) for Portuguese and non-Portuguese showed four patterns.

1. Similar number of joinpoints (trends) and divergent annual percent changes in the latest trend:

This was observed in the prevalence rate of maternal age ≥ 35 years with 3 Joinpoints in both Portuguese (APC=6.5% 6.2,6.9; 2005-14) and non-Portuguese (3.3% 2.5,4.0; 2002-14). There was only 1 Joinpoint for multiple pregnancy rates in Portuguese (APC=2.5% 2.2,2.8; 1995-2014) and non-Portuguese (APC=0.3% -0.4, 1.1; 1995-2014). The annual rate of non-hospital deliveries had remained low ($<1.5\%$)

for all classes of maternal nationality. Two Joinpoints were observed in Portuguese (APC=5.7% 1.8, 9.7; 2000-2014) and non-Portuguese (APC=12.7% 3.5, 22.7; 2004-2014). Between 1995 and 2014, the caesarean section prevalence rate had four irregular Joinpoints in Portuguese (APC=1.1% -4.7,2.5; 2008-14) and non-Portuguese (APC=0.2% -5.5, 6.3; 2008-14).

2. **Similar number of joinpoints (trends) and annual percent changes in the latest trend:** There were 3 Joinpoints for prevalence rate of single mothers among Portuguese (APC=18.2% 12.8, 23.8; 2008-14) and non-Portuguese (APC=14.9% (4.3-26.6; 2008-14).
3. **Dissimilar number of Joinpoints (trends) and similar annual percent changes in the latest trend:** Two Joinpoints were observed in the temporal trend of tertiary educated mothers in Portuguese (APC=5.0% 4.5-5.4; 2005-14) and four Joinpoints in non-Portuguese (APC=10% 6.6-13.5; 2010-14). There were 4 Joinpoints for trend in the prevalence rate of employed mothers among Portuguese (APC=0.1% 0.0, 0.2; 2008-14) and 3 Joinpoints in non-Portuguese (APC=-0.7% -1.2, -0.1; 2008-14).
4. **Dissimilar number of Joinpoints and annual percentage changes in the latest trend:** Portuguese mothers had only 1 Joinpoint for primiparity (APC=-1.4% -2.0, -0.8; 1995-2014), while there were 2 Jointpoints for non-Portuguese (APC=-3.0% -4.4,-1.6, 2003-14). The prevalence rate trend of preterm births for Portuguese had 3 Joinpoints (APC=-1.8% -4.1,0.5; 2008-14) and 1 Joinpoint for non-Portuguese (APC=0.5% -0.2, 1.2; 1995-2014). Low birthweight rate had 2 epochs for Portuguese (APC=1.0% 0.8, 1.2; 2000-14) and 3 epochs for non-Portuguese (APC=3.1% 0.8, 5.5; 2008-14) mothers.

Discussion

In this study, we compared time-based changes in prevalence of risk factors for adverse pregnancy outcomes between Portuguese and non-Portuguese. Our findings indicate that over the last two decades the proportion of live births by non-Portuguese especially Brazilians has increased but the constitution of the modal immigrant nationalities has remained stable. We observed divergent trends and rate of change in the evolution of the selected socio-demographic and obstetric factors in Portuguese and non-Portuguese. There were no similarities in the trends of preterm birth and low birthweight prevalence among Portuguese and non-Portuguese in this study. The average age of Portuguese mothers significantly changed with concurrently appreciation in the proportion of mothers that were aged ≥ 35 years. The caesarean section rate

among non-Portuguese significantly increased and this has been associated with Brazilian preference for this mode of delivery.[31]

Contemporary evidence shows that as socioeconomic conditions worsen in host country there is an upsurge in the prevalence of adverse pregnancy outcomes among immigrants.[19, 32] Although, the universal healthcare and perinatal health system instituted in Portugal for over two decades has contributed to improving pregnancy outcomes irrespective of maternal nativity.[33] We had documented an increase in the low birthweight rate among immigrants in 2007-2014, which contrasts with the penultimate period (1999-2006) decrease of LBW prevalence.[19] Though, there were differences in some important risk factors between native and foreign-born mothers in Portugal. From a cross-sectional perspective we demonstrated the role of healthy immigrant effect on LBW prior to 2007-2008 economic crisis.[27] We reasoned that temporal differences of LBW rates of change in Portuguese and non-Portuguese could be explained by time-based variation in risk factors and/or different reactionary modification to socioeconomic changes. Mainly because the influence of changes in contextual socio-economic situation on adverse pregnancy outcomes is mediated by its differential effect on individual risk factors for migrant and native-born mothers.

In the 20 years period of this study, we observed an increase in proportion of live births by non-Portuguese. Even though we did not detect any significant change in source countries. There could have been a cohort or period effect on the risk factors of adverse pregnancy outcome in migrants. The different wave of immigrants is indicative that new immigrants and those with lengthier duration of residence could differ in maternal risk profile. Typically, those with longer duration of residence in host country are associated with social integration and adoption of similar lifestyle choices (e.g. smoking) as the natives.[34] Nevertheless, foreign-born status being associated with adverse birth outcomes could be observed in better-educated mothers, which is the opposite of healthy immigrant effect and known as epidemiological paradox.[9] The results of this study have shown that in 2000-2014 there is an increase rate of the prevalence of tertiary educated and ≥ 35 years mothers among the non-Portuguese.

Health systems require evidence to effectively address any observed inequalities by intervening on identified risk factors for adverse birth outcomes.[10] The national vital statistics systems of European nations are used to monitor perinatal health and detect emerging trends, which require further investigation and response.[35] The periodic evaluation of surveillance systems is recommended to ensure that indicators are

being monitored efficiently and effectively. Accordingly, our time trend analysis was based on the national birth registry, which is the monitoring tool for perinatal indicators used by national health systems and for international comparison.[35, 36] Although, it is effective for appraising socio-demographic and some obstetric risk factors.[36, 37] The trends in the risk factors reported in this study might not be adequate for understanding changes in the trends of LBW. Thus, signifying limited epidemiological sufficiency of the current birth registry indicators for comprehensive description of temporal changes in risk factors for adverse birth outcomes.

Fundamentally, time-based surveillance of individual risk factors for adverse birth outcomes facilitates understanding of dynamic nature of causal associations.[34] In the future, it will be pertinent to investigate the merit for including factors like maternal country of birth, duration of residence in host country, substance use (e.g. smoking in pregnancy), obstetric morbidity and prenatal care. Further investigation will be required to determine which risk factors are relevant to be included in the birth register. But it should be acknowledged that one set of risk factors might not be sensitive for LBW, preterm birth and small for gestational age. This is because aetiologic determinants of preterm birth and intra uterine growth retardation differ, so lumping them together as LBW can hinder progress in developing preventive interventions.[1, 38] Therefore, there is need for more studies to identify composite risk factors of these adverse birth outcomes, as well as the feasibility of collecting these indicators.[35] As a complement to the birth register-based perinatal surveillance, routine hospital administration data can be used to generate a composite indicator to monitor trends in maternal morbidity during pregnancy and childbirth, particularly for quality of maternity care.[39]

Immigrants being a heterogeneous group represent different cultures and risk factor profile.[7] The association between migration and adverse birth outcomes varies by immigrant subgroup and it is sensitive to the definition of the migrant and reference groups.[7] Hence, specific studies will be needed on immigration status (documented, non-documented immigrant, refugees, asylum seekers), language fluency and ethnicity as defined by maternal place of birth and duration of residence.[40] There is evidence consistent about differential access to and utilisation of health services among ethnic minority mothers, regardless of migrant status, in particular recently arrived migrants, refugees and asylum seekers.[6] Hence, attention should be given to the specific mechanisms linking maternal risk factors to poor pregnancy outcomes for specific racial/ethnic groups.[41] Awareness of differing risks and health needs would assist

provision of appropriate pregnancy care to improve the health of women with greater risk and their babies [42]

Strengths and Limitation of the study

The 20-years time-trend analysis provided sufficient time and sample size to detect changes and make comparison between Portuguese and non-Portuguese. The application of Joinpoint regression method for time-trend analysis allowed assessment of time changes in risk factors for adverse pregnancy outcomes, and also speed with which the increase or decrease has occurred. A limitation of this analytic method is the non-adjustment for covariates, which is unnecessary for this study, because the purpose of our analysis was to compare trends of the selected risk factors. We were unable to comprehensively assess the reactionary modification of individual risk factors to socioeconomic changes in Portuguese and non-Portuguese. Because the robustness of the trend analysis to evaluate risk factor disparity and differential alteration of risk factors to socioeconomic changes depends on inclusiveness of relevant risk factors. The birth register measures only approved indicators, which limited our analysis to available risk factors. However, maternal nationality, which is the cardinal exposure variable for our study has been recorded in the national birth registry during the whole period of our observation. Unfortunately, the lack of reporting of country of birth and duration of residence in Portugal could cause misclassification in defining a migrant. In Portugal, the law did not allow recording information about ethnicity. Thus, such information was unavailable in the birth registry. The birth registry records only maternal nationality or country of origin, which might misrepresent migrants that have acquired Portuguese nationality.

Conclusion

In the last two decades the proportion of live births by non-Portuguese especially Brazilians has increased in Portugal. Time changes in selected socio-demographic and obstetric factors were characterized by divergent trends and rate of change for Portuguese and non-Portuguese mothers between 1995-2014. There was a significant increase in the proportion of mothers that were aged ≥ 35 years and tertiary educated. Among non-Portuguese multiparity became less frequent, while caesarean section rates appreciated. The sufficiency of the birth registry for perinatal surveillance is limited because some individual-level risk factors, which could assume aetiological relevance as time changed, are not currently measured.

What is known about this topic

- Contextual and individual-level risk factors determine pregnancy progression and outcome

- Maternal immigration status is an important social determinant of perinatal health, but results regarding its association with pregnancy outcomes are conflicting
- There is significant difference in time trend of adverse pregnancy outcomes between foreign and native-born mothers

What this study adds

- Immigrant and Portuguese mothers have different time changes in risk factors for adverse pregnancy outcomes between 1995-2014
- Birth register is useful for the surveillance of some socio-demographic and obstetric risk factors
- There are risk factors of adverse pregnancy outcomes not recorded in the current Portuguese birth register and could assumed aetiological relevance as time changed

Declaration of interest

The authors declare that they have no competing interests.

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Author Contribution

MK and HB conceived and designed the study and analysis. SC, MK and BP collected data and prepared the datasets. MK, BP and HB analysed the data. MK drafted the manuscript. HB reviewed, edited and revised the manuscript as well as supervised all the processes. All authors interpreted data and revised the manuscript critically for intellectual content. Finally, all the authors read and approved the final version.

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Table 1. Maternal and infant characteristics of live births in Portugal according to maternal nationality, 1995–2014

Variable, n (%)	1995-1999		2000-2004		2005-2009		2010-2014	
	Portuguese	Non-Portuguese	Portuguese	Non-Portuguese	Portuguese	Non-Portuguese	Portuguese	Non-Portuguese
Total live births by nationality	543925 (97.1)	16106 (2.9)	533144 (93.7)	36111 (6.3)	472424 (90.5)	49341 (9.5)	409703 (90.2)	44543 (9.8)
Angola		3417 (0.6)		6979 (1.2)		4576 (0.9)		3541 (0.8)
Cape Verde		3723 (0.7)		5779 (1.0)		5403 (1.0)		5017 (1.1)
Guinea Bissau		1576 (0.3)		2467 (0.4)		1370 (0.4)		1814 (0.4)
Brazil		1555 (0.3)		5973 (1.0)		16265 (3.1)		13551 (3.0)
Sao Tome and Principe		922 (0.2)		1474 (0.3)		1558 (0.3)		1523 (0.3)
China		410 (0.1)		1082 (0.2)		1795 (0.3)		1967 (0.4)
Romania		61 (0.0)		1283 (0.2)		3345 (0.6)		3533 (0.8)
Ukraine		18 (0.0)		1880 (0.3)		3456 (0.7)		2850 (0.6)
Other non-Portuguese		4424 (0.8)		9194 (1.6)		11573 (2.2)		10747 (2.4)
Maternal age (years)								
Mean ($\pm$)	27.6 $\pm$ 5.48	28.4 $\pm$ 5.86	28.5 $\pm$ 5.55	28.2 $\pm$ 5.76	29.5 $\pm$ 5.53	28.6 $\pm$ 5.73	30.6 $\pm$ 5.58	29.1 $\pm$ 5.86
<20	37297 (6.9)	1028 (6.4)	31027 (5.8)	2037 (5.6)	21718 (4.6)	2457 (5.0)	14367 (3.5)	2020 (4.5)
20-34	446271 (82.0)	12591 (78.0)	425084 (79.7)	28821 (79.8)	362372 (76.8)	38855 (78.9)	290721 (71.0)	34090 (76.5)
≥ 35	60357 (11.1)	2533 (15.7)	77033 (14.4)	5263 (14.6)	87525 (18.6)	7911 (16.1)	104615 (25.5)	8454 (19.0)
Parity								
Primiparae	292333 (53.7)	7459 (46.1)	291424 (54.7)	19440 (53.8)	255729 (54.3)	26751 (54.5)	224525 (54.9)	23317 (52.4)
Multiparae	251592 (46.3)	8726 (53.9)	241720 (45.3)	16681 (46.2)	215136 (45.7)	22313 (45.5)	184808 (45.1)	21207 (47.6)
Maternal education								
None	5361 (1.0)	370 (2.3)	3245 (0.6)	295 (0.8)	2047 (0.4)	197 (0.4)	1280 (0.3)	237 (0.5)
Literate but no formal education	6166 (1.1)	434 (2.7)	2995 (0.6)	363 (1.0)	1465 (0.3)	185 (0.4)	663 (0.2)	161 (0.4)

Primary	131813 (24.2)	3279 (20.3)	74965 (14.1)	4663 (12.9)	32931 (7.0)	3595 (7.3)	14780 (3.6)	2235 (5.0)
Secondary	237882 (43.7)	6560 (40.6)	245755 (46.1)	16756 (46.4)	200848 (42.5)	25582 (51.8)	156558 (38.2)	22103 (49.6)
Tertiary	162703 (29.9)	5509 (34.1)	206184 (39.7)	14044 (38.9)	235133 (49.8)	19794 (40.1)	236422 (57.7)	19828 (44.5)
Employment status								
Employed	343661 (63.2)	7661 (47.4)	386027 (72.4)	20441 (56.6)	349099 (74.7)	26566 (55.2)	286472 (71.6)	21022 (49.0)
Unemployed	200264 (36.8)	8491 (52.6)	147117 (27.6)	15680 (43.4)	118140 (25.3)	21595 (44.8)	113590 (28.4)	21921 (51.0)
Number of fetuses								
Singleton	532191 (97.8)	15760 (97.2)	520208 (97.6)	35200 (97.4)	459386 (97.2)	48018 (97.3)	397099 (96.9)	43275 (97.1)
Multiple	11734 (2.2)	457 (2.8)	12936 (2.4)	953 (2.6)	13038 (2.8)	1347 (2.7)	12604 (3.1)	1291 (2.9)
Place of delivery								
Hospital	538033 (98.9)	15973 (98.5)	529779 (99.4)	35870 (99.2)	467651 (99.0)	48779 (98.8)	256300 (99.0)	29361 (98.8)
Non-hospital	5892 (1.1)	244 (1.5)	3365 (0.6)	283 (0.8)	4773 (1.0)	586 (1.2)	2516 (1.0)	358 (1.2)
Type of delivery								
Vaginal	377578 (69.4)	12328 (76.0)	378138 (70.9)	26498 (73.3)	334844 (70.9)	33369 (67.6)	177051 (68.4)	18976 (63.9)
Caesarean section	166347 (30.6)	3889 (24.0)	155006 (29.1)	9655 (26.7)	137580 (29.1)	15996 (32.4)	81765 (31.6)	10743 (36.1)
Preterm	All births	35312 (6.6)	1206 (7.5)	33408 (6.3)	2479 (6.9)	38851 (8.2)	3889 (7.9)	31468 (7.7)
	Singletons	30000 (5.7)	984 (6.4)	26519 (5.1)	2036 (5.8)	30813 (6.7)	3152 (6.6)	23449 (5.9)
LBW	All births	35643 (6.6)	1447 (9.0)	38669 (7.3)	2906 (8.1)	36906 (7.8)	3506 (7.1)	35085 (8.6)
	Singletons	28941 (5.5)	1187 (7.6)	30623 (5.9)	2352 (6.7)	28196 (6.2)	2675 (5.6)	26385 (6.7)

*The effect size (Cohen's d) for comparing the four periods among Portuguese is 0.1 (Age), 0.2 (Education) and 0.1 (Employment). Among non-Portuguese it is 0.2 (Education), 0.1 (Employment) and 0.1 (Type of delivery). All other variables have Cohen's d <0.01 for Portuguese and non-Portuguese. The p value for the comparison of the four periods using the χ^2 test or analysis of variance, as appropriate, is <0.001 for all variables except number of fetuses among non-Portuguese.**Place and type of delivery data does not include data for 2013-14

Table 2. Trends in the annual prevalence of risk factors of adverse pregnancy outcomes in Portuguese and non-Portuguese mothers, 1995-2014 expressed as Annual Percent Change (APC, 95 %CI)

Variable	Portuguese								Non-Portuguese							
	Period	APC (95%CI)	Period	APC (95%CI)	Period	APC (95%CI)	Period	APC (95%CI)	Period	APC (95%CI)	Period	APC (95%CI)	Period	APC (95%CI)	Period	APC (95%CI)
Maternal age > 35 years	1995-2001	6.0 (5.3, 6.6)	2001-2005	4.2 (2.4, 6.1)	2005-2014	6.5 (6.2, 6.9)			1995-1998	4.8 (-1.4, 11.5)	1998-2002	-4.6 (-10.3, 1.4)	2002-2014	3.3 (2.5, 4.0)		
Single mother	1995-2008	3.2 (2.4-4.0)	2008-2014	18.2 (12.8-23.8)					1995-2008	-1.1 (-2.6-0.5)	2008-2014	14.9 (4.3-26.6)				
Tertiary educated	1995-2005	9.1 (8.7-9.5)	2005-2014	5.0 (4.5-5.4)					1995-1998	-3.7 (-8.4-1.3)	1998-2003	5.0 (1.7-8.3)	2003-2010	-0.8 (-2.5-0.9)	2010-2014	10 (6.6-13.5)
Employed mother	1995-1997	1.2 (-2.5-5.1)	1997-2000	5.1 (1.2-9.2)	2000-2008	0.7 (0.2-1.2)	2008-2014	-1.4 (-2.0- -0.8)	1995-2000	6.6 (4.6-8.7)	2000-2008	-0.2 (-1.3-1.0)	2008-2014	-3.0 (-4.4- -1.6)		
Primiparous mother	1995-2014	0.1 (0.0-0.2)							1995-2003	3.4 (2.5-4.4)	2003-2014	-0.7 (-1.2- -0.1)				
Multiple pregnancy	1995-2014	2.5 (2.2-2.8)							1995-2014	0.3 (-0.4-1.1)						
Non-hospital deliveries	1995-2000	-18.2 (-28.9- -5.9)	2000-2014	5.7 (1.8-9.7)					1995-2004	-9.2 (-15.5- -2.6)	2004-2014	12.7 (3.5-22.7)				
Caesarean	1995-2002	-0.8	2002-2005	-5.6	2005-2008	9.1	2008-2014	-1.1	1995-2001	5.9	2001-2005	-10.5	2005-2008	17.5	2008-2014	0.2

deliveries	2002	(-2.3- 0.8)	2005	(-15.9- 6.0)	2008	(-2.8- 22.4)	2014	(-4.7-2.5)	2001	(1.3- 10.7)	2005	(-31.3- 16.4)	2008	(-9.7- 52.9)	2014	(-5.5-6.3)
Preterm birth	1995- 2001	-3.2 (-6.1- - 0.2)	2001- 2007	6.9 (2.8- 11.3)	2007- 2014	-1.8 (-4.1-0.5)			1995- 2014	0.5 (-0.2-1.2)						
Low birth weight	1995- 1999	3.6 (2.1, 5.0)	2000- 2014	1.0 (0.8, 1.2)					1995- 2007	-2.2 (-3.3- - 1.1)	2007- 2014	2.4 (-0.2-5.0)	2008- 2014			

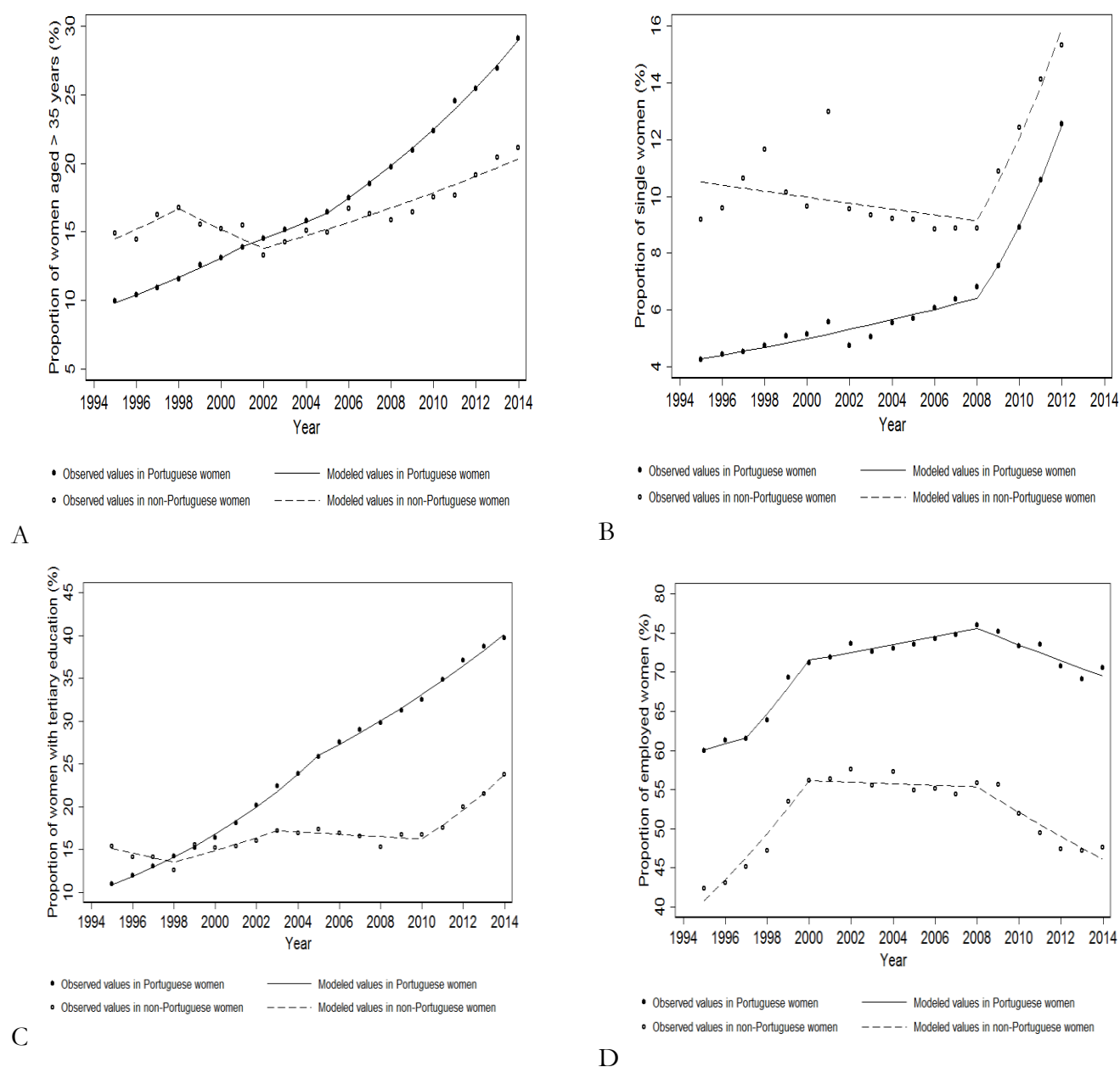


Figure 1. Trends in prevalence of socio-demographic risk factors for adverse pregnancy outcomes among Portuguese and non-Portuguese mothers in Portugal, 1995-2014: [A] $\geq$ Women aged 35 years [B] Single women [C] Tertiary educated women [D] Employed women

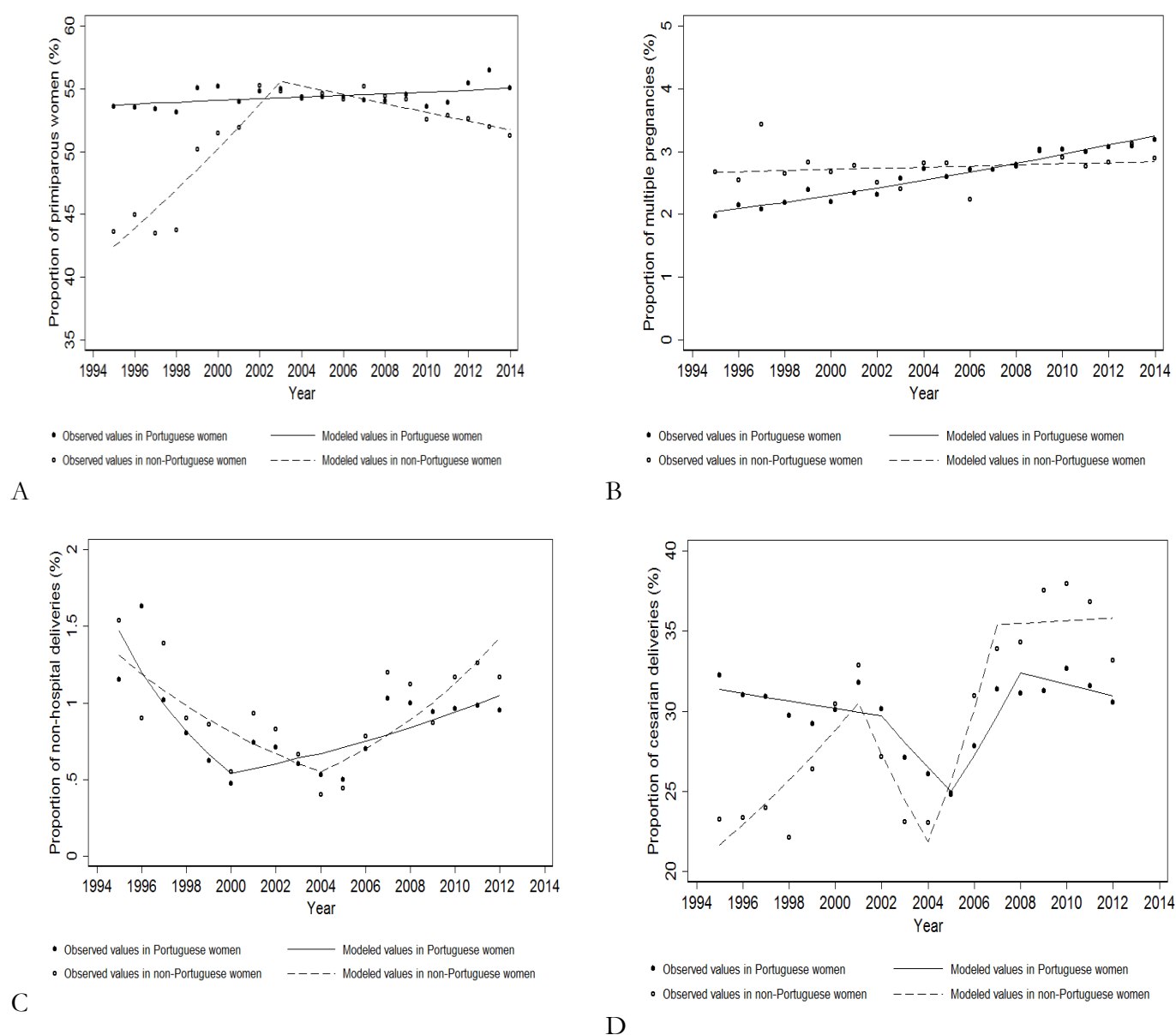


Figure 2. Trends in prevalence of obstetric risk factors for adverse pregnancy outcomes among Portuguese and non-Portuguese mothers in Portugal, 1995-2014: [A] Primiparous women [B] Multiple pregnancy [C] Non-hospital deliveries [D] Caesarean deliveries

3.3 Paper III

Kana MA, Correia S, Peleteiro B, Severo M, Barros H. The impact of the global financial crisis on low birthweight in Portugal: a time trend analysis *BMJ Glob Health*. 2017; 2(2): e000147.

Impact of the global financial crisis on low birth weight in Portugal: a time-trend analysis

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ABSTRACT

Background: The 2007–2008 global financial crisis had adverse consequences on population health of affected European countries. Few contemporary studies have studied its effect on perinatal indicators with long-lasting influence on adult health. Therefore, in this study, we investigated the impact of the 2007–2008 global financial crisis on low birth weight (LBW) in Portugal.

Methods: Data on 2 045 155 singleton births of 1995–2014 were obtained from Statistics Portugal. Joinpoint regression analysis was performed to identify the years in which changes in LBW trends occurred, and to estimate the annual per cent changes (APC). LBW risk by time period expressed as prevalence ratios were computed using the Poisson regression. Contextual changes in sociodemographic and economic factors were provided by their trends.

Results: The joinpoint analysis identified 3 distinct periods (2 jointpoints) with different APC in LBW, corresponding to 1995–1999 (APC=4.4; 95% CI 3.2 to 5.6), 2000–2006 (APC=0.1; 95% CI –0.50 to 0.7) and 2007–2014 (APC=1.6; 95% CI 1.2 to 2.0). For non-Portuguese, it was, respectively, 1995–1999 (APC=1.4; 95% CI –3.9 to 7.0%), 2000–2007 (APC=–4.2; 95% CI –6.4 to –2.0) and 2008–2014 (APC=3.1; 95% CI 0.8 to 5.5). Compared with 1995–1999, all specific maternal characteristics had a 10–15% increase in LBW risk in 2000–2006 and a 20–25% increase in 2007–2014, except among migrants, for which LBW risk remained lower than in 1995–1999 but increased after the crisis. The increasing LBW risk coincides with a deceleration in gross domestic product growth rate, reduction in health expenditure, social protection allocation on family/children support and sickness.

Conclusions: The 2007–2008 global financial crisis was associated with a significant increase in LBW, particularly among infants of non-Portuguese mothers. We recommend strengthening social policies aimed at maternity protection for vulnerable mothers and health system maintenance of social equity in perinatal healthcare.

BACKGROUND

The 2007–2008 global financial crisis and sequel of economic recessions have resulted

Key questions

What is already known about this topic?

- The 2007–2008 global financial crisis and sequel of economic recessions have resulted in adverse consequences on population health of affected European countries.
- Perinatal health outcomes are among the exacerbated indicators during previous economic depressions.
- During economic crisis, there are changes in low birth weight risk factors like childbearing practices (eg, fertility postponement), nutrition, substance use patterns and access to healthcare.

What are the new findings?

- Portugal has been experiencing an upward but unequal trend in singleton low birth weight (LBW), described by three distinct periods that escalated after 2007–2008.
- The general increase in LBW risk during the past two decades in Portugal affects the different strata of the population variables, with the exception of nationality, with non-Portuguese women experiencing a decrease in LBW risk before the financial crisis.
- The increasing risk in LBW was concomitant with declining birth rates and with worst macroeconomic indicators, such as an increased unemployment and a deceleration in gross domestic product (GDP) growth rate. There was a reduction in government expenditure on health as a proportion of GDP, percentage expenditure of social protection on family/children support and for sickness or healthcare.

in adverse consequences on population health of affected European countries.¹ The economic downturn and its health impact has intensified the vulnerability of children as detected in Greece, where stillbirths and infant deaths increased from 2008 to 2010, and in Iceland, where the proportion of children born small-for-gestational age increased from 2.0% to 3.4% 6 years after the banking collapse of October 2008.^{2 3}

Key questions

Recommendations for policy

- ▶ The continuous monitoring of relevant risk factors, the quality assurance of the process and information on further indicators, as part of data routinely collected by the national birth registration system, are essential.
- ▶ There should be strengthening of social policies aimed at maternity protection for non-Portuguese, working and other vulnerable mothers.
- ▶ The health system should sustain its capacity to effectively maintain social equity in perinatal healthcare access, utilisation and quality

Birth weight is a major determinant of infant health and welfare that persists into later life.⁴ Taking as example cognitive outcomes, so intensively valued in our societies, and considering individual and contextual changes, low birth weight (LBW) long-term effects seem more marked when birth weight reflects mainly the contribution of socioeconomic pathways than where pathways relate mostly to biological risk factors.^{5–6} Hence, fetal growth and birth weight have been employed to evaluate social policies as indicators of social inequalities sensitive to macroeconomic choices.⁷

LBW is among the adverse health outcomes exacerbated during previous economic depressions.^{8–10} Contextually, the heightening of LBW susceptibility during economic crisis denotes mediation through changes in the social profile of childbearing women and alterations in health behaviours.^{11–12} Additionally, there may be environmental mediation, as health system responses are sensitive to reductions in funding of programmes or to general cost containment measures, which may constitute a constraint to healthcare access.^{8–10} Economic recession affects differently those at the top or at the bottom of the social hierarchy, emphasising the importance of individual protection in promoting health.¹² Studies have recognised that during economic crisis, there are changes in childbearing practices, worsening nutrition, adoption of unhealthy coping strategies, modification of substance use patterns, decreased access to care and attention to health issues, as well as direct increases on stress.^{11–12} All these aspects can influence pregnancy outcomes, although the consequences pointing into different directions. Evidence about the impact of the current economic recession on health equity is still inconsistent and there is no such information available for the perinatal period.¹³

Although several contemporary studies have examined the impact of the recent financial crisis on specific health outcomes, less often they looked at perinatal indicators such as LBW that might have a long-lasting influence on adult health.¹⁴ There is paucity of research studies that consistently covered the link between health and key Portuguese socioeconomic problems.¹⁵ Considering that the establishment of the universal

healthcare and perinatal health services over the last 30 years has improved maternal and child health indicators in Portugal.^{16–17} It is appropriate to investigate the impact of adverse social and macroeconomic conditions on birth weight by monitoring time-based and social patterns of LBW.^{9–10} Therefore, we examined time trends in LBW during the past two decades in Portugal, researching the impact of the 2007–2008 global financial crisis and taking into consideration individual and contextual changes.

METHODS

Data source

Annual individual data concerning births and birth characteristics were obtained from Statistics Portugal—*Instituto Nacional de Estatística* (INE)—for the period 1995–2014. Online supplementary data on migrations, crude birth rate, gross domestic product (GDP), unemployment and social security expenditure covering the period 1995–2014 were obtained from Statistics Portugal as well as the Ministry of Solidarity and Social Security.

Study population

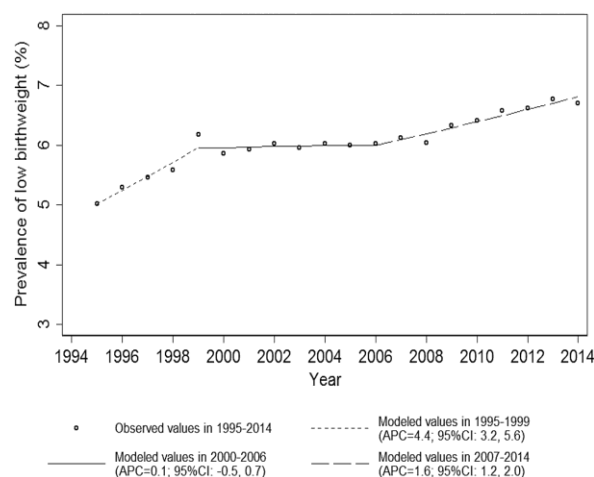
The study population consisted of 2 045 155 singleton live births (mother–infant pairs) as recorded in the national birth registry. We excluded records for which birth weight ($n=2976$) and maternal nationality ($n=109$) were missing and those that, because of the possibility of error in data entry, were registered as <500 or >6000 g ($n=3007$).

Measures

Birth weight is recorded in grams and corresponds to the first measure of weight obtained after birth, preferably during the first hour. In the national statistics, birth weight is also classified in 500 g categories, but for our analysis, we used only four: <1500 , $1500–2499$, $2500–3999$ and >3999 . Specifically, the main outcome variable considered in our analysis was the prevalence of LBW, defined as the proportion of singleton babies with birth weight <2500 g.

The duration of gestation, which is expressed in completed weeks, is calculated from the first day of the last normal menstrual period or based on ultrasound data. During the study period, there have been changes in the national policy regarding the record of gestational age, so for analysis, we considered the categories 22–31, 32–36, 37–41 and >41 and classified as preterm babies those with <37 completed weeks. The infant sex is recorded as male or female and the male to female ratio was calculated. The maternal age at birth was registered as a continuous variable, but for the purpose of this study was categorised as ≤ 19 , $20–34$ and ≥ 35 years; maternal nationality referred to nationality at the moment of birth and, although recorded according to each individual country, was considered as Portuguese

Figure 1 Trend in low birth weight rates among singleton births in Portugal 1995–2014.



or other. Maternal or paternal employment status was recorded in 10 categories but for analysis classified as employed, unemployed or others (housewife, student, retired, incapacitated), and maternal education stratified as primary, secondary and tertiary.

Statistical analysis

To study trends in LBW and to estimate the annual percentage change, we employed a Poisson joinpoint regression model.¹⁸ The procedure models the counts in the numerator and denominator for each time period rather than the precalculated rates. In essence, this approach is equivalent to having data at the individual level with sample size equalling the number of individuals in the denominators of the rates instead of the number of time periods for which rates are available. A joinpoint represents a knot at which an important change in the temporal trend occurs; joinpoints are estimated iteratively and do not require the specification of an a priori hypothesis about the location of the knots to be tested. Weighted least squares to account for heteroscedasticity was included to fit a loglinear Poisson joinpoint regression model that was used. We also allowed for autocorrelation of the residuals to account for the fact that the observed rates are not independent.¹⁹

The Poisson regression analysis was performed using the Joinpoint Regression Program, V.4.2.0.²⁰ The software fits the simplest joinpoint model that the data will allow using a series of permutation test. The estimated annual per cent change (APC) and their 95% CIs were computed by fitting a regression line to the natural logarithm of the rates using calendar year as a regressor variable (ie, given $y = \ln(\text{number of LBW})$ and $y = \ln(\text{total of birth}) + a + bx$ and $x = \text{calendar year}$, the APC is estimated as $100 \times (e^b - 1)$).²⁰ The final number of joinpoints was determined by comparing the best model with each number of change points using permutation tests, with a

Bonferroni correction to account for multiple hypothesis testing.¹⁹ The resulting graph for the best model had two joinpoints and it is a scatter plot of LBW rate from 1995 to 2014 (figure 1).

Additionally, χ^2 test was used to compare maternal and infant characteristics at the three periods (1995–1999—reference period, 2000–2006 and 2007–2014). Considering that we are working with large samples, measures of effect size were preferred over significance tests to remove the dependence on sample size and the associated high probability of significant differences. We used Cohen's d effect sizes, which indicate the magnitude of differences between groups independent of sample size were values of 0.10, 0.30 and 0.50 or greater, which were considered small, moderate and large effect sizes, respectively.²¹

Log-binomial regression or log-Poisson regression was used to estimate the magnitude of the association between LBW and each variable considered (maternal nationality, age, education, employment status and infant sex), and expressed as prevalence ratio (PR) with corresponding 95% CIs.

The information on the contextual changes in sociodemographic and economic factors was provided by the trends in the net migration rate (difference of immigrants and emigrants in a period of time; a positive value represents more people entering the country than leaving it), crude birth rate (annual number of live births per 1000 population), GDP (monetary value of all the finished goods and services produced within a country's borders in a specific time period, measured in euros) and social security expenditure (comprises of budgetary allocation for social security with social purposes) from 1995 to 2014. The proportion of government expenditure on health over the study period was reported as budget execution per capita (euro—ratio) and budget execution as a percentage of GDP. The GDP is expressed

as growth rate (%) and per capita based on purchasing power standards (PPS). When the comparison of GDPs in PPS is repeated for at least two periods, it is possible to infer the relative growth rates between the two periods. The unemployment rate represents unemployed persons (persons aged between 15 and 74 who during the reference period neither had a job nor were at work; were available for paid employment or self-employment; or had actively sought work) as a percentage of the civilian labour force, defined as the proportion of all persons aged 15 or over (14 or over until 1997) who, during the reference period, made up the available labour force for the production of economic goods and services.

Two approaches were used to study the relationship between maternal or infant characteristics and LBW time changes. First, the effect of each characteristic on LBW in time was assessed, fitting several models stratified by the characteristic of interest (adjusted for all the other variables) taking time as independent variable. Subsequently, we tested the effect of each characteristic on LBW taking into consideration that this effect can change in time. So, we fitted each model including the interaction between time and the characteristic under study (adjusted for the other variables). We used the likelihood ratio test to assess any significant interaction between the period and the characteristic (p-interaction).

SPSS V.21 (SPSS, Chicago, Illinois, USA) was used to calculate descriptive statistics and to perform the regression analyses.

RESULTS

Trends in LBW in Portugal 1995–2014

During the study period, the prevalence of LBW increased in singleton births from 5.0% in 1995 to 6.6% in 2014. The joinpoint analysis (figure 1) identified three distinct periods (2 jointpoints) corresponding to 1995–1999 (APC=4.4; 95% CI 3.2 to 5.6), 2000–2006 (APC=0.1; 95% CI -0.5, 0.7) and 2007–2014 (APC=1.6; 95% CI 1.2 to 2.0). A distinct pattern was observed when looking separately to Portuguese born (figure 2) and migrant mothers (figure 3): for the babies of Portuguese mothers, the annual changes were positive though with only two different periods: 1995–1999 (APC=3.6; 95% CI 2.1, 5.0) and 2000–2014 (APC=1.0; 95% CI 0.8 to 1.2) while that in babies of mothers of other nationalities were three: 1995–1999 (APC=1.4; 95% CI -3.9 to 7.0%), 2000–2007 (APC=-4.2; 95% CI -6.4 to -2.0) and 2008–2014 (APC=3.1; 95% CI 0.8 to 5.5), with a significant increase after the crisis.

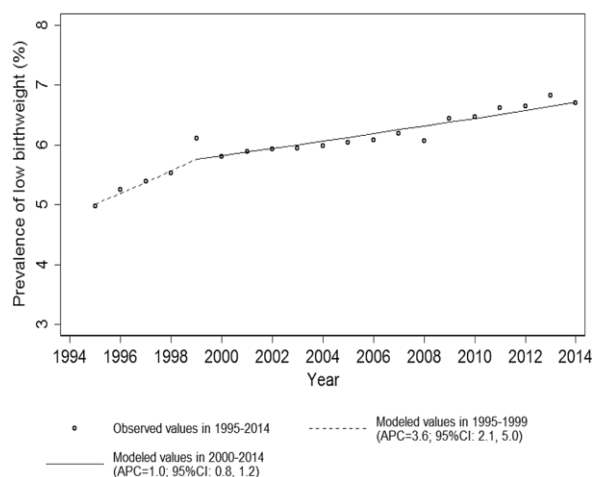
The annual number of singleton live births declined from 104 636 in 1995 to 79 918 in 2014. Table 1 presents the maternal and infant characteristics of the participants according to the three periods observed in the general sample. It is observed that the proportion of babies of native Portuguese mothers decreased from 97.8% (1995–1999) to 91.1% (2007–2014).

Furthermore, the mean maternal age increased from 27.6±5.49 years (1995–1999) to 30.1±5.63 years (2007–2014). This followed a reduction in the proportion of teenage mothers from 6.9% (1995–1999) to 4.0% (2007–2014). Women with tertiary-level education increased from 13.0% to 32.0% between 1995–1999 and 2007–2014, while the proportion of unemployed mothers varied from 4.4% (1995–1999) to 13.0% (2007–2014). The effect size of the change by the Cohen criteria was small (<0.10) for all characteristics except for maternal education that presented a moderate effect (0.21). However, all the comparisons of proportions and mean values were statistically significant at $p<0.001$.

Contextual changes of sociodemographic and economic indicators in Portugal 1995–2014

In table 2, we present values for some relevant social, demographic and economic indices in Portugal, according to the three periods considered from 1995 to 2014. In 1995–1999, there was a positive net migration, but in subsequent years, a negative net migration was recorded particularly from 2008 onward, reflecting the large emigration of young Portuguese adults. On the contrary, the foreign population in the country has been on a steady rise with a remarkable increase in the period between 2008 and 2012, but began to reduce afterwards. The crude birth rate has been declining over the years with an important reduction, especially in the post-2008 period. The GDP growth rate (%) has been sliding during the observation period; 1995–1999 (4.2), 2000–2006 (1.5) and 2007–2014 (-1.0). The average GDP per capita (PPS) increased from 12 872 in 1995–1999, to 17 513 in 2000–2006 and to 20 485 in 2007–2014. The unemployment rate increased in women from a maximum of 6.4 in the first period or 6.7 in the second to 16.0% after the financial crisis; a similar trend was seen for men among whom unemployment reached 16.4%. The relative increase in GDP was higher between the first and second periods than between the second and third. Precisely, the proportion of government expenditure on health (budget execution as a percentage of GDP) increased between the initial (1995–1999; 3.9%) and intermediate (2000–2006; 5.0%) periods but declined afterwards (2007–2014; 4.7%). It was observed that the social security expenditure as percentage of GDP has steadily been increasing, especially in the period 2007–2014. This is reflected in the rise of the percentage expenditure of social benefit on unemployment. However, there was a reduction in the percentage expenditure of social benefit on family and children support and in sickness/maternity. During the study period, the crude death rate had a maximum of 106 per 10 000 inhabitants from 1995 to 1999, 104 in 2000 to 2006 and 102 in the period 2007 to 2014. During the same periods, infant death steadily decreased from 7.4 per 1000 live births in 1995 to reach 2.5 in 2010, then increasing to 3.4 in 2012 and reaching 2.9 in 2014.

Figure 2 Trend in low birth weight rates among Portuguese singleton births in Portugal 1995–2014.



Trend of LBW risk according to maternal and infant characteristics

In a multivariate regression model, and considering 1995–1999 as the reference period, LBW risk increased, even after adjustment for maternal characteristics (table 3). It significantly increased in 2000–2006 (PR=1.119; 95% CI 1.103 to 1.135) and again in 2007–2014 (PR=1.229; 95% CI 1.103 to 1.235). We found a significant interaction with all characteristics except with infant sex. However, the change in risk was different across strata of some infant and maternal characteristics. It increased with time in Portuguese women, while in the non-Portuguese, the risk decreased and was still lower after the crisis although less than in the intermediate period. While in women with a maternal age higher than 20, the LBW risk increased, in the younger group, there was a decrease during the observation period. The increase in LBW risk in primiparous women was similar to the multiparous. For the other characteristics, when compared with 1995–1999, LBW risk

increased in 2000–2006 of about 10–15% and a more pronounced increase was observed in 2007–2014 (20–25%).

DISCUSSION

Our findings indicate that between 1995 and 2014, Portugal has been experiencing an upward but unequal trend in singleton LBW, described by three distinct periods that escalated after 2007–2008. This development is concurrent with macroeconomic and sociodemographic transformations in the country. The broad interval of observation (1995–2014) enabled the detection of the transformation of LBW rate in babies of non-Portuguese mothers, which indicated a period of decline (2000–2006) and an upsurge (2007–2014). There was an overall increase in the proportion of LBW births, but its time-based distribution in babies of non-Portuguese mothers showed a gradient different from their Portuguese peers.

Figure 3 Low birth weight rates among non-Portuguese singleton births in Portugal 1995–2014.

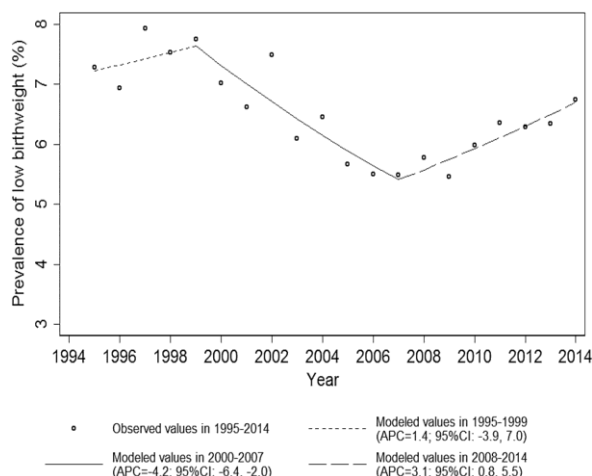


Table 1 Maternal and infant characteristics of singleton live births in Portugal, 1995–2014

Variable	1995–1999 n (%)	2000–2006 n (%)	2007–2014 n (%)	Effect size (Cohen's d)*
Total live births	546 032 (26.7)	762 325 (37.3)	736 798 (36.0)	
Maternal nationality				
Portugal	530 430 (97.1)	709 199 (93.0)	663 963 (90.1)	0.11
Other country	15 602 (2.9)	53 126 (7.0)	72 835 (9.9)	
Paternal age, mean (±) years	30.4 (6.14)	31.5 (6.24)	32.6 (6.33)	
Maternal age (years)				
Mean (±)	27.6 (5.49)	28.7 (5.57)	30.1 (5.63)	
≤19	37 710 (6.9)	42 906 (5.6)	29 734 (4.0)	0.13
20–34	447 384 (81.9)	605 099 (79.4)	541 738 (73.5)	
≥35	60 938 (11.2)	114 320 (15.5)	165 326 (22.4)	
Parity				
Primiparae	292 274 (53.5)	415 066 (54.5)	399 175 (54.3)	0.01
Multiparae	253 756 (46.5)	347 038 (45.5)	336 564 (45.7)	
Maternal education				
Primary	375 555 (68.8)	420 124 (55.1)	284 270 (39.2)	0.24
Secondary	99 277 (18.2)	179 741 (23.6)	209 131 (28.8)	
Tertiary	71 200 (13.0)	162 220 (21.3)	232 626 (32.0)	
Maternal employment status				
Employed	342 306 (62.7)	544 958 (71.5)	511 140 (70.8)	0.18
Unemployed	24 088 (4.4)	47 093 (6.2)	93 950 (13.0)	
Others	179 638 (32.9)	169 635 (22.3)	116 416 (16.1)	
Paternal employment status				
Employed	509 082 (96.5)	707 149 (94.8)	634 764 (89.2)	0.13
Unemployed	9973 (1.9)	17 802 (2.4)	45 488 (6.4)	
Others	8655 (1.6)	20 652 (2.8)	31 723 (4.5)	
Infant sex				
Male	282 468 (51.7)	394 313 (51.7)	378 057 (51.3)	0.004
Female	263 564 (48.3)	368 012 (48.3)	358 741 (48.7)	
Male/female ratio	1.07	1.07	1.05	
Gestational age at birth (weeks)				
<32 (very preterm)	4013 (0.7)	4871 (0.6)	5637 (0.8)	0.08
32–36 (moderate–late preterm)	26 860 (5.0)	35 716 (4.7)	42 049 (5.7)	
37–41 (term)	497 387 (92.3)	691 779 (90.9)	679 439 (92.4)	
>41 (post-term)	10 685 (2.0)	28 743 (3.8)	8583 (0.9)	
Birth weight (g)				
Mean (±)	3262.7 (506.56)	3229.3 (498.66)	3197.3 (491.23)	
<1500	3722 (0.7)	5150 (0.7)	5073 (0.7)	0.04
1500–2499	26 366 (4.8)	40 346 (5.3)	42 268 (5.7)	
2500–3999	482 616 (88.4)	678 757 (89.0)	658 970 (89.4)	
>4000	33 328 (6.1)	38 072 (5.0)	30 487 (4.1)	

*The p value for the comparison of the three periods using the χ^2 test or analysis of variance, as appropriate, is <0.001 for all variables.

Generally, comparing with 1995–1999, a 10–15% increase in LBW risk was observed in 2000–2006 for most maternal characteristics and a 20–25% increase was observed in 2007–2014. This argues in favour of a general increase in risk observed in the 21st century and

not in specific groups of the population.²² Except the non-Portuguese women who experienced decreasing LBW risk that reversed after the crisis. For these women, the decreased risk reflects the overall decline in LBW prevalence in 2000–2006, although it increased again

Table 2 Sociodemographic and economic indices in Portugal, 1995–2014

Indicator	1995–1999	2000–2006	2007–2014
Net migration rate	42 000	32 300	–14 200
Proportion of females in foreign population (%)	41.8	44.8	49.8
Crude birth rate (per 1000 population)	11.1	10.6	8.9
Crude death rate (per 1000 population)	10.6	10.4	10.2
Infant death rate (per 1000 live births)	7.4	5.5	3.6
GDP per capita (PPS millions, Euros)	12 872	17 513	20 485
GDP growth rate (%)	4.2	1.5	–1.0
Government expenditure on health: budget execution per capita (Euro—ratio)*	396.3	714.6	783.8
Government expenditure on health: budget execution as a % of GDP*	3.9	5.0	4.7
Unemployment rate (%; highest value in the period)			
Men	6.4	6.7	16.0
Women	8.2	8.9	16.4
Total social security expenditure as % of GDP	9.4	11.6	18.5
Total social security benefit (Euros, 1000s)	8 002 079.0	13 468 539.0	20 487 826.3
% of total social security benefit for sickness/maternity	6.9	5.1	4.1
Social security payment for sickness/maternity (1000s, Euros)	549 839.9	688 814.0	830 629.9
% of total social benefit for family/children (%)	5.5	4.8	4.4
Social security payment on family/children (1000s, Euros)	439 383.1	640 032.3	895 293.9
% of total social benefit for unemployment (%)	8.6	10.1	10.5
Social security payment for unemployment (1000s, Euros)	691 724.0	1 364 001.7	2 148 857.4

Figures presented describe the mean value for the period except for crude and infant deaths as well as unemployment where the highest values were depicted.

Sources: Statistics Portugal (INE) and Instituto de Gestão Financeira da Segurança Social (IGFSS).

*Only data for 1995–2013 were officially documented.

†Social benefits/social security payments are transfers to households, in cash or in kind, intended to relieve them from the financial burden of a number of risks or needs, including: (a) sickness; (b) invalidity, disability; (c) occupational accident or disease; (d) old age; (e) survivors; (f) maternity; (g) family; (h) promotion of employment; (i) unemployment; (j) housing (k) education; (l) general neediness.

after the economic crisis (but not reaching the 1995–1999 levels). This pattern may represent differential selection to pregnancy, but also the heterogeneity within the group of migrant women and different migration flows over time, namely regarding the country of origin and women's social characteristics. Future research is fundamental to disentangle differences within migrants as well as between migrants and natives, and the impact of these differences on societies' health indicators, especially LBW.

The 2007–2008 global financial crisis triggered a negative impact on European economies that led to the introduction of strict economic austerity measures, as happened in Portugal.^{23 24} In the Portuguese society, the impact of the crisis deepened after 2010, when a second phase of the financial and social crisis emerged, leading to more aggressive fiscal reforms that in turn worsened recession.²⁵ The health policy response included an increase in employer and employee contribution rates either across the board or for specific population subgroups, increased or introduced user charges for health services, and medicines were subjected to increased out-of-pocket user charges, although the prices tend to decrease, accompanying an increase in

the use of generics.²⁵ This development had a negative impact on hospital care utilisation and no clear effect was evident on mortality figures.²⁶ However, maternal and child health services remained free of charge even for non-documented migrants post-2008 when there was diminishing budgetary allocation for health.

Presently, our study has no documented precedence of demonstrating parallel LBW trends for migrant and native European women before and after the 2008 financial crisis.¹⁴ It is possible that the economic crisis affected them differently or they reacted differently to it. The plausible explanation for this variation may be in their contrasting LBW risk factors and the reactionary modification after recession. Possibly, there was a loss of the healthy immigrant effect in the context of a worse impact of the economic crisis on immigrants.²⁷ It has been proposed that the interaction of fiscal austerity with economic shocks and weak social protection is what ultimately seems to escalate health and social crises in Europe.²⁸ The vulnerable population including immigrants have been shown to bear greater burden of communicable diseases and there is disproportionate effect of austerity measures on migrant healthcare, even in countries that seem less affected by the economic

Table 3 Trend of low birth weight risk according to maternal and infant characteristics: results of multivariate regression analysis

	Prevalence ratio (PR) and 95% CIs			p interaction*
	1995–1999	2000–2006 PR (95% CI)	2007–2014 PR (95% CI)	
Crude	1	1.083 (1.068 to 1.098)	1.166 (1.150 to 1.182)	
Adjusted†	1	1.119 (1.103 to 1.135)	1.229 (1.103 to 1.235)	
Maternal‡				
Portuguese	1	1.128 (1.112 to 1.144)	1.256 (1.236 to 1.274)	<0.001
Non-Portuguese	1	0.863 (0.809 to 0.921)	0.833 (0.782 to 0.888)	
Maternal age (years)‡				
≤19	1	0.958 (0.914 to 1.003)	0.937 (0.889 to 0.989)	<0.001
20–34	1	1.151 (1.132 to 1.170)	1.269 (1.248 to 1.291)	
≥35	1	1.066 (1.026 to 1.106)	1.199 (1.156 to 1.244)	
Parity‡				
Primiparous	1	1.130 (1.110 to 1.151)	1.243 (1.219 to 1.267)	<0.001
Multiparous	1	1.098 (1.073 to 1.123)	1.200 (1.172 to 1.228)	
Maternal education (years)‡				
Primary	1	1.114 (1.094 to 1.133)	1.209 (1.186 to 1.232)	0.034
Secondary	1	1.142 (1.105 to 1.181)	1.230 (1.190 to 1.271)	
Tertiary	1	1.102 (1.058 to 1.147)	1.260 (1.213 to 1.310)	
Maternal employment status‡				
Employed	1	1.121 (1.100 to 1.141)	1.248 (1.225 to 1.272)	<0.001
Unemployed	1	1.131 (1.066 to 1.200)	1.209 (1.144 to 1.278)	
Others	1	1.122 (1.094 to 1.150)	1.190 (1.157 to 1.224)	
Infant sex‡				
Male	1	1.114 (1.091 to 1.138)	1.209 (1.183 to 1.236)	0.878
Female	1	1.122 (1.101 to 1.145)	1.245 (1.221 to 1.271)	

*p Value for the comparison of a model with and without the interaction term between the variable and time.

†Adjusted for maternal nationality, maternal age (years), parity, maternal education, maternal employment status and infant sex.

‡Adjusted for all other variables and an interaction term between the variable and time.

downturn.^{28 29} On a wider scale, the economic crisis has more effect on ‘crisis-sensitive’ measures of ill-health, particularly in the longer term. Mainly, it has been observed that the effects of this economic depression were more marked in nations with lower levels of social protection, compared with those with higher levels.¹ In Portugal, there has been an increase in the total expenditure for social protection as a response to the recession. But concomitant percentage expenditure of social protection on family and healthcare has been reduced over the crisis period.

Certainly, there are recognised sociodemographic and biological factors that mediate variations in LBW.⁷ We observed an increasing maternal age and LBW risk among older mothers in Portugal during the economic recession (2007–2014). Although there is controversy as to whether age is an independent determinant of intra-uterine growth or gestational duration, LBW and preterm births are generally more common after 35 years of age.^{7 30} Assisted reproductive technologies are also more frequently present among older women, particularly primiparae, as it were the case in Portugal,

and it is also more frequently associated with twins and adverse pregnancy outcomes.^{7 31 32} We partially avoided such effect by limiting our study to singleton births.

Since the 1970s, fertility trends in developed countries have been dominated by the shift in childbearing to ever-later ages.³³ This shift, often described as fertility postponement, may be partly or largely driven by period factors, such as economic ups and downs or sudden changes in the labour market and government policies.³³ The economic uncertainty coupled with waning social support for families during the recession can contribute to magnifying childbirth postponement.³⁴ Some recent studies expound that the association of economic decline (current and previous) and obstetric outcomes (eg, LBW) is intermediated by direct and indirect modification in fertility behaviour like childbearing postponement.^{31 34 35} Given the socioeconomic advantages (higher education, employed and higher income) of those who postpone having children, some authors have argued that the disadvantage experienced by certain groups in the context of a heterogeneous population, as in the USA, would be reduced if

they postponed their births to improve their education and income.³⁶ It is known that childbearing postponement and child outcome is a complex and varied relationship, especially in heterogeneous populations, but that is not the case in Portugal, where annual registry of births accounted by more than 90% native Portuguese mothers.^{35 36}

Fundamentally, socioeconomic circumstance of families provides an alternative causal approach for explaining the time-based variation of LBW. The proxy variables we used to tackle socioeconomic circumstances comprised maternal employment and education. Indeed, the economic crisis may result in adverse effect on population health consequent to heightened unemployment.³⁷ But the role of education and employment in the association between economic crisis and LBW is not fully understood. Nevertheless, it is known that increased total months worked during pregnancy, total daily working hours and time mothers spent standing up are significant aetiological factors of intrauterine growth retardation.³⁸ These are critical practices that are associated with an employed mother. In this study, we noted that a tertiary educated and employed mother had a greater LBW risk during the economic contraction. Contrary to our result, another study reports that women with higher education had lower risk of LBW after the onset of the economic crisis in Andalusia, Spain; an area accounting for 19% of births in the country.³⁹ The variation in maternal social characteristics, health behaviours and health system may explain the differences in maternal educational gradient and LBW relationship for Portugal and Spain during the recession.

The consequences of the economic crisis on population health occur suddenly or gradually.²³ This study showed that the alteration in LBW trend started even before the implementation of austerity measures later in the recession. This finding reaffirms that the impact of the economic crisis on LBW is mediated by the synergistic effect of multiple factors. A causal perspective that may explain the sudden change in the course of LBW trend infers that maternal exposure to stressful life events like economic crisis prior to conception or during pregnancy influences infant birth weight.^{40–44} During the recent economic crisis, high levels of antenatal stress, anxiety and depressive symptoms have been documented among low-risk pregnant women, in an economically impacted area of Ireland.⁴³ Tragic events are also known to trigger communal bereavement, which lead to perinatal health outcome changes as illustrated by the significant surge in very LBW the months following the Swedish Prime minister Olof Palme's murder in 1986 or the sinking of a ferry in Estonia in 1994.⁴⁵

The articulation of a comprehensive causal framework is important for a detailed investigation of the aetiological process of the impact of economic crisis on LBW. This would have augmented our explanation of LBW

trend and its intermediary factors. Unfortunately, the Portuguese birth registry system we based our analysis does not collect information on LBW risk factors, such as maternal substance abuse, prenatal care and morbidity.⁴⁶ Maternal smoking has been identified as the most important and modifiable risk factor for LBW in developed countries. But there is an indirect evidence of a rise in smoking among women of childbearing age in Portugal that preceded the economic crisis.⁴⁷ Thus, we expect that the independent role of this factor on LBW might add complexity to the estimated association during the study period.

The initiation year of this study was selected to cover a sufficiently long period so that sustainable trends could be accommodated. Hence, the major strengths of our study were the large sample size and extensive observation time that was sufficient to our hypothesis. The duration had allowed a satisfactorily lengthy interval that enabled simultaneous observation of time-based variation of LBW and part of its potential mediators (maternal characteristics). The Poisson regression analysis we employed has the advantage of accounting for the fluctuation across time and the variability at each time point. In addition, it is useful in detecting abrupt changes and describing shifting time trends that are applicable to our aim of detecting variation, particularly due to the economic recession without forcing any prejudgement.

The prolongation of the economic crisis portends a threat to perinatal healthcare, especially for non-Portuguese and vulnerable mothers with increased LBW risks; older (>35 years), tertiary educated and employed. Therefore, it is necessary to improve labour conditions of pregnant mothers and minimise other stressful circumstances.³⁸ It is discernible that in times of financial hardship, there is a temptation to revise the universal health policy and cut services for minority populations.²⁸ Accordingly, the health system should effectively maintain social equity in perinatal healthcare access and outcomes. It is noteworthy that in a developed country setting, non-resident women without healthcare coverage are more susceptible to adverse perinatal outcome than their native counterparts.⁴⁸ Even though, the universal healthcare and perinatal healthcare system instituted over three decades contributed to the mitigation of adverse perinatal outcomes for all categories of mothers in Portugal.^{16 17} The continuous reduction in public health expenditure constitute a detriment to assuring access, equity and quality of perinatal care because health systems require predictable sources of revenue to plan in a sustainable way.²⁵

CONCLUSIONS AND POLICY IMPLICATIONS

The 2007–2008 global financial crisis is associated with increased LBW occurrence in Portugal that is more evident in infants of non-Portuguese mothers. It is not possible to conclusively propose a mediatory mechanism

on how the financial crisis resulted in a higher rate of LBW and to what extent the resilience of available health and social responses buffered the effect of adverse individual or social level exposures. Further research will be required to improve the understanding of the role of particular factors, such as maternal nationality, fertility behaviour and the amplification of late maternity, substance abuse and mental stress, in the variation of LBW during periods of economic depression. The continuous monitoring of relevant risk factors, the quality assurance of the process and information on further indicators, as part of data routinely collected by the national birth registration system, are essential. Finally, there should be strengthening of social policies aimed at maternity protection for non-Portuguese, working and other vulnerable mothers. The health system should sustain its capacity to effectively maintain social equity in perinatal healthcare access, utilisation and quality.

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Contributors MAK and HB conceived and designed the study and analysis. SC, MAK and BP collected data and prepared the data sets. MAK, BP, MS and HB analysed the data. MAK drafted the manuscript. HB reviewed, edited and revised the manuscript as well as supervised all the processes. All authors interpreted data and revised the manuscript critically for intellectual content. Finally, all the authors read and approved the final version.

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3.4 Paper IV

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RESEARCH

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Effect of maternal country of birth on breastfeeding practices: results from Portuguese GXXI birth cohort

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Abstract

Background: Maternal country of birth has been associated with perinatal health outcomes but less is known regarding breastfeeding practices in contemporary European settings. This study investigated effect of maternal country of birth on breastfeeding initiation and duration by comparing native Portuguese and migrant mothers.

Methods: We analyzed data of 7065 children of the Generation XXI (GXXI) birth cohort recruited at birth (2005–06) and followed-up 4 years later. Logistic regression was used to assess the effect of maternal country of birth on breastfeeding initiation. Kaplan-Meier estimate was used to compare breastfeeding duration by maternal country of birth and length of residence by migrant mothers in Portugal.

Results: Breastfeeding initiation and the type of breastfeeding practice were similar for native Portuguese and migrant mothers. The migrants had significantly higher median duration in months of any breastfeeding (Odds Ratio [OR] 6.0, 95% Confidence Interval [CI] 5.4,6.6) and exclusive breastfeeding (OR 4.0, 95% CI 3.8,4.2) than native Portuguese mothers (OR 4.0, 95% CI 3.8,4.2 and OR 3.0, 95% CI 2.9,3.0). Migrant mothers who resided in Portugal for either ≤ 5 years (OR 5.0, 95% CI 3.9,6.1 and OR 4.0, 95% CI 3.8,4.2) or > 5 years (OR 6.0, 95% CI 5.5,6.5 and OR 4.0, 95% CI 3.7,4.3) years had similar duration of any breastfeeding or exclusive breastfeeding, in both cases higher than the native Portuguese mothers. No significant differences were found when world regions were compared.

Conclusions: Maternal country of birth does not influence breastfeeding initiation and type of feeding practice. However, migrant mothers have longer breastfeeding duration of either exclusive or any breastfeeding, which was not changed by length of residence in Portugal.

Keywords: Breastfeeding, Initiation, Duration, Maternal country of birth, Portugal

Background

Breastfeeding is a universally accepted means of optimal nutrition that promotes infant survival, growth and development [1, 2]. World Health Organization (WHO) recommends that infants be exclusively breastfed for the first 6 months of life with continued breastfeeding up to 2 years of age or beyond with adequate complementary feeds [3]. Breastfeeding is cost effective with life course benefits for mother and child [4]. Fundamentally, it has been established to have a positive effect on intelligence,

to be protective against childhood infections and obesity, as well as decreasing risk of some non-communicable diseases in adulthood [4, 5].

Infant feeding practices are determined by sociodemographic factors including maternal country of birth [1]. However, this association is typified by mixed findings [1, 6–9]. There are results indicating that immigrants with high income are more likely to initiate and breastfeed for longer duration than native born mothers [1, 8, 9]. While in other studies lesser or comparable initiation and duration rates were observed irrespective of maternal country of birth [6, 7]. Although the association is not homogenous for all settings, “healthy immigrant effect” could be considered the basis for the disparity of breastfeeding behaviour in migrant and native born mothers [10]. Comparing

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breastfeeding duration between emigrants and mothers in their home country also suggests a “healthy migrant effect” because of the better indicators in the emigrants [11].

“Healthy immigrant effect” describes immigrants as having better health outcomes compared with native-born and non-migrant populations in countries of origin [10]. The relationship between the maternal country of birth and perinatal outcomes has been well documented, but few regarding breastfeeding [4, 12, 13]. Even fewer studies addressed the effect of duration of residence by migrants in the host country on breastfeeding in European settings [14, 15]. In international terms, the share of immigrants particularly from contemporary conflict zones in total population in Portugal is relatively low. The national statistics shows that the immigration flows into the country, which accelerated in the last three decades is mainly linked with employment opportunities, and females constituted a slightly greater proportion of the immigrant population [16, 17]. Therefore, this study investigated breastfeeding initiation and duration in a birth cohort comparing Portuguese and migrant mothers. Additionally, we examined the effect of time since migration to Portugal on breastfeeding practices. We hypothesized that migrant mothers would have greater proportions of breastfeeding initiation and longer duration.

Methods

Study setting and context

Generation XXI (GXXI) is a population-based prospective birth cohort that initially enrolled a total of 8647 newborns between April 2005 and August 2006 from all five public maternity units of the metropolitan area of Porto, Portugal [18]. Information was collected on maternal demographic and obstetric characteristics, as well as parental lifestyle (e.g. diet, smoking, alcohol consumption, physical activity) during the pregnancy and in the early period of baby's life. Data on a wide range of pregnancy outcomes and information on child health were also obtained. Exposure and outcome data were collected directly from participants by questionnaires, interviews and clinical assessments [18]. Details of the methods including data collection tools and processes are also found in the project Generation XXI website [19].

In this study, we analyzed data from the Generation XXI obtained at birth and 4 years follow-up evaluation [20]. Four years after birth, the total cohort was invited for reevaluation between April 2009 and July 2011. Trained interviewers administered a structured questionnaire concerning maternal health, which included breastfeeding experience. In this study, only children with data on breastfeeding practices obtained at the 4 years evaluation and maternal country of birth (Portuguese, non-Portuguese Europeans, South Americans and

Africans) were included. We excluded migrants from any other regions ($n = 6$) and twins ($n = 296$). The final sample included 7065 participants (Additional file 1). Characteristics of participants and non-participants regarding maternal sociodemographic characteristics at birth are presented in Additional file 2.

Measurements

Outcome measures

Type of breastfeeding practices was defined in three categories: exclusive formula when the child never received breast milk; exclusive breastfeeding when the child was only fed with breast milk, and it was considered until formula or another type of foods and beverages were introduced and breastfeeding stopped; and mixed if combined breast milk with formula or other type of foods any time (i.e., concurrently since birth or when the child was exclusively breastfed for a period of time and then formula or another type of foods were introduced to supplement breastfeeding). Any breastfeeding was considered if the child ever received breast milk, regardless if it was exclusive or mixed, categorized as “Yes” (ever breastfed) or “No” (never breastfed). Breastfeeding duration indicated how long the child was exclusively breastfed and also for how long the child was breastfed in total (any type of breastfeeding). Duration of breastfeeding was recorded in weeks and categorized in months. The total duration of breastfeeding was categorized in six groups: never breastfed (0 months), breastfed during < 1 month, breastfed between 1.0 and 2.9 months, between 3.0 and 5.9 months, between 6.0 and 11.9 months, and breastfed for or more than 12 months. These cut-off points were based on WHO recommendations [3]. For exclusive breastfeeding duration we created 5 groups: never exclusively breastfed, breastfed during < 1, exclusively breastfed between 1.0 and 2.9 months, between 3.0 and 5.9 months, and those exclusively breastfed for ≥ 6.0 months.

Exposure measure

A woman was classified as migrant if (a) she was born abroad and both parents were foreign born or (b) she was born abroad and one or both parents were Portuguese born and she moved to Portugal at the age of 18 or later. Otherwise, the participant was considered Portuguese [21]. Time since migration to Portugal was used as a proxy for measuring acculturation and social integration into Portuguese society. We adopted and adapted published classification and assessed the level of acculturation by time since migration to Portugal measured as completed years from arrival to delivery. For analysis we classified duration as ≤ 5 or > 5 years duration groups as previously done [22].

Covariates

Potential confounders considered in analysis included maternal and child specific factors measured at birth: maternal age (< 20, 20–34 and ≥ 35 years), education (basic, secondary or tertiary), employment (employed or unemployed) and household income classified based on euros (€)/month as ≤ 1000 (low), 1001–1500 (medium) and > 1500 (high), parity (primiparae or multiparae), maternal pre-pregnancy body mass index (BMI < 25, underweight/normal weight or ≥ 25 kg/m², overweight/obese), smoking during pregnancy (smoking or not), number of prenatal visits (≤ 6 prenatal visits or > 6 prenatal visits), gestational age at birth (< 32, 32–36, 37–41 and ≥ 42 weeks), mode of delivery (vaginal or caesarian section). Infants were classified as preterm if delivered at < 37 completed weeks, and low birthweight was defined as babies with birthweight less than 2500 g. While small for gestational age (SGA) babies were classified as those with birthweight below the 10th percentile for the gestational age and sex.

Statistical analysis

Sociodemographic, obstetric and infant as well as breastfeeding characteristics were described by maternal country of birth (Portugal, other European countries, South American and African). Proportions were compared using the Pearson's chi-square or Fisher's exact test for categorical variables. For immigrant mothers, we also described their length of residence in Portugal (≤ 5 vs. > 5 years) and age on arrival (< 18 or ≥ 18 years). We compared breastfeeding practices for exclusive and any breastfeeding. Median duration of exclusive or any breastfeeding were compared using Kruskal-Wallis test. Analyses of any breastfeeding and exclusive breastfeeding duration (continuous variable) excluded never breastfed and outlier observations (exclusive breastfeeding > 36 weeks and for any breastfeeding > 180 weeks).

Logistic regression analysis was used to estimate the effect of maternal country of birth (Portuguese vs. migrants) on breastfeeding initiation (any or exclusive categorized as "Yes" or "No") expressed as OR (95% CI). Multiple regression analysis was performed to adjust for age, education, household income, parity, pre-pregnancy BMI, number of prenatal visits, smoking during pregnancy, mode of delivery, gestational age, birthweight and Neonatal Intensive Care Unit (NICU) admission. In all the models, native Portuguese was considered as reference category for comparison with other Europeans, South Americans and Africans. Kaplan-Meier estimate was used to compare breastfeeding duration by maternal country of birth and length of residence by migrant mothers in Portugal. The log-rank test was used to compare median breastfeeding duration (95% CI) of Portuguese and migrants mothers. A *p* - value < 0.05 was considered statistically significant. All

statistical analyses were performed using Statistical Package for Social Sciences (SPSS), version 23.0 (IBM Corp., New York, USA).

Results

Participants consisted of native Portuguese (6831, 96.7%), other Europeans (61, 0.9%), South Americans (106, 1.5%) and Africans (67, 0.9%) (Table 1). There is variation in some observed characteristics of foreign and native born mothers. The majority (80.2%) of South Americans had resided for ≤ 5 years in Portugal as compared to 39.3 and 29.9% of other Europeans and Africans. The proportion of migrants that arrived in Portugal after ≥ 18 years of age was: other Europeans (93.4%), South Americans (97.2%) and Africans (70.1%). Mothers aged ≥ 35 years were around one third among Africans (31.3%) but lower percentages for South Americans (14.2%), other Europeans (8.2%) and native Portuguese (17.1%). Only 21.4% of Portuguese mothers and from 17.9 to 39.3% of migrants were tertiary educated. The proportion of households earning 1000 euros or less per month were 38.4% for native Portuguese, 24.5% for other Europeans, 52.3% for South Americans and 42.1% for Africans. The proportion of primiparous mothers was 57.5% (native Portuguese), 73.8% (other Europeans), 62.5% (South Americans) and 48.8% (Africans). More than 80% of mothers attended > 6 prenatal visits irrespective of their country of birth. Caesarean section rates were 35.9% (native Portuguese), 33.3% (other Europeans), 51.9% (South Americans) and 37.9% (Africans). Low birthweight prevalence was 7.1% (native Portuguese), 3.3% (other Europeans), 3.8% (South Americans) and 4.5% (Africans). Preterm birth and NICU admission proportions were respectively 7.2 and 8.7% for native Portuguese, 6.6 and 19.3% for other Europeans, 4.7 and 4.0% for South Americans, 9.0 and 6.1% for Africans.

Prevalence of breastfeeding initiation and duration

Comparing mothers according to maternal country of birth we observed similarity in their breastfeeding options, considering exclusive formula, exclusive breastfeeding and mixed feeding (Table 1): native Portuguese (7.4, 22.4 and 70.2%), other Europeans (3.9, 23.5 and 72.5%), South Americans (6.4, 22.3 and 71.3%) and Africans (5.1, 16.9 and 78.0%) respectively.

The median duration of any breastfeeding and exclusive breastfeeding was significantly higher for migrant mothers compared to native Portuguese (24.0 and 12.0 weeks), other Europeans (34.0 and 16.0 weeks), South Americans (32.0 and 16.0 weeks) and Africans (50.6 and 16.0 weeks). The proportion of migrant mothers that exclusively breastfed for ≥ 6.0 months were significantly higher: 16.6% of native Portuguese, 18.8% of other Europeans, 27.4% of South Americans and 33.3% of Africans. Prevalence of any

Table 1 Sociodemographic, obstetric, infant and breastfeeding characteristics by maternal country of birth

Characteristic, n (%)	Portuguese	European	South American	African	p - value
Median length of maternal residence in Portugal (Years)		7.0	3.0	10.5	< 0.05
≤ 5 years		24 (39.3)	85 (80.2)	20 (29.9)	< 0.05
> 5 years		37 (60.7)	21 (19.8)	47 (70.1)	
Age at arrival in Portugal					
< 18 years		4 (6.6)	3 (2.8)	20 (29.9)	< 0.05
≥ 18 years		57 (93.4)	103 (97.2)	47 (70.1)	
Maternal age at birth (years)					
< 20	330 (4.8)	2 (3.3)	1 (1.0)	0 (0.0)	< 0.05
20–34	5330 (78.0)	54 (88.5)	90 (84.9)	46 (68.7)	
≥ 35	1171 (17.1)	5 (8.2)	15 (14.2)	21 (31.3)	
Marital status					
Married/committed	6418 (94.0)	59 (98.3)	100 (94.3)	60 (89.6)	0.428
Single	405 (6.0)	1 (1.7)	6 (5.7)	7 (10.4)	
Maternal education					
Basic	3287 (48.1)	6 (9.8)	16 (15.1)	18 (26.9)	< 0.05
Secondary	2081 (30.5)	31 (50.8)	71 (67.0)	29 (43.3)	
Tertiary	1463 (21.4)	24 (39.3)	19 (17.9)	20 (29.9)	
Maternal occupation					
Employed	5354 (79.1)	50 (82.0)	74 (69.8)	47 (71.2)	0.076
Unemployed	1413 (20.9)	11 (18.0)	30 (30.2)	19 (28.8)	
Household income (euros/month)					
≤ 1000	2289 (38.4)	13 (24.5)	46 (52.3)	24 (42.1)	< 0.05
1001–1500	1776 (29.9)	18 (34.0)	17 (19.3)	10 (17.5)	
> 1500	1894 (31.8)	22 (41.5)	25 (28.4)	23 (40.4)	
Primiparae	3866 (57.5)	45 (73.8)	65 (62.5)	30 (48.8)	< 0.05
Overweight/Obese	2042 (29.9)	10 (16.4)	27 (25.5)	14 (20.9)	
> 6 prenatal visits	5848 (89.8)	51 (86.4)	84 (84.0)	53 (84.1)	0.096
Maternal smoking during pregnancy	1512 (22.1)	17 (27.9)	16 (15.1)	8 (11.9)	< 0.05
Caesarean section delivery	2445 (35.9)	20 (33.3)	54 (51.9)	25 (37.9)	< 0.05
Infant's sex (male)	3346 (49.0)	26 (42.6)	55 (51.9)	34 (50.7)	0.702
Preterm infant	493 (7.2)	4 (6.6)	5 (4.7)	6 (9.0)	0.721
Low birthweight infant	484 (7.1)	2 (3.3)	4 (3.8)	3 (4.5)	0.242
Small for gestational age infant	1006 (14.7)	6 (9.8)	11 (10.4)	4 (6.0)	0.081
NICU Admission	442 (8.7)	9 (19.3)	3 (4.0)	3 (6.1)	< 0.05
Type of breastfeeding practices					
Exclusive formula	446 (7.4)	2 (3.9)	6 (6.4)	3 (5.1)	0.841
Exclusive breastfeeding	1353 (22.4)	12 (23.5)	21 (22.3)	10 (16.9)	
Mixed feeding	4232 (70.2)	37 (72.5)	67 (71.3)	46 (78.0)	
Duration of exclusive breastfeeding in months					
< 1 month	965 (17.6)	6 (12.5)	8 (9.6)	4 (7.5)	< 0.05
1.0–2.9 months	1354 (24.7)	8 (16.7)	16 (19.0)	11 (20.4)	< 0.05
3.0–5.9 months	2258 (41.2)	25 (52.1)	37 (44.0)	21 (38.9)	
≥ 6.0 months	902 (16.6)	9 (18.8)	23 (27.4)	18 (33.3)	

Table 1 Sociodemographic, obstetric, infant and breastfeeding characteristics by maternal country of birth (Continued)

Characteristic, n (%)	Portuguese	European	South American	African	p - value
Total duration of any breastfeeding in months					
< 1 month	497 (5.8)	3 (7.9)	4 (5.9)	2 (4.2)	< 0.05
1.0–2.9 months	740 (16.6)	2 (5.3)	6 (8.8)	3 (6.3)	
3.0–5.9 months	867 (19.4)	8 (21.1)	11 (16.4)	7 (14.6)	
6.0–11.9 months	1309 (29.3)	13 (34.2)	29 (42.6)	11 (22.9)	
≥ 12 months	1157 (25.9)	12 (31.6)	18 (26.5)	25 (52.1)	

P-values are for comparisons of all categories; Some variables contain missing values or excluded outliers (calculation of median duration of exclusive or any breastfeeding)

breastfeeding for ≥12 months was 25.9% for native Portuguese, 31.6% for other Europeans, 26.5% for South Americans and 52.1% for Africans.

Effect of maternal country of birth on breastfeeding initiation and duration

Maternal country of birth was not found to be associated with initiation of any breastfeeding and exclusive breastfeeding (Table 2). Using native Portuguese as the reference category, the adjusted odds ratio (AOR) and 95% Confidence Interval) for any breastfeeding and exclusive breastfeeding were as follows for the various categories of migrants: other Europeans (AOR 0.5, 95% CI 1.9;2.8 and AOR 1.1, 95% CI 0.5;2.2), South Americans (AOR 1.9 95% CI 0.5;7.9) and Africans (AOR 0.9, 95% CI 0.3;2.8 and AOR 1.1, 95% CI 0.5;2.2).

Migrant mothers have significantly higher duration in months of any breastfeeding and exclusive breastfeeding than the native Portuguese (Figs. 1 and 2). Portuguese (OR 4.0, 95% CI 3.8;4.2 and OR 3.0, 95% CI 2.9;3.0), migrants (OR 6.0, 95% CI 5.4;6.6 and OR 4.0, 95% CI 3.8;4.2). Migrant mothers who resided in Portugal for either ≤5 or > 5 years were also observed to have greater duration of any

breastfeeding or exclusive breastfeeding compared with native Portuguese mothers (Figs. 3 and 4); migrants who resided ≤5 years (OR 5.0, 95% CI 3.9;6.1 and OR 4.0, 95% CI 3.8;4.2), and migrants who resided >5 years (OR 6.0, 95% CI 5.5;6.5 and OR 4.0, 95% CI 3.7;4.3).

Discussion

This study assessed the effect of maternal country of birth on breastfeeding practices among mothers of a birth cohort recruited in Portugal. We observed that the native Portuguese and migrant mothers were similar in their marital status, occupation, number of prenatal visits and birth outcomes. However, there was variation in the distribution of maternal age, education, household income, parity and caesarean section. In our sampled population, the migrants had a higher proportion of tertiary educated mothers. A third of the African born mothers were ≥ 35 years, while the other migrant groups had a lower proportion of this age category compared with the Portuguese. Nevertheless, the proportion of those that initiated any and exclusive breastfeeding were similar for foreign and native born mothers. However, migrants have longer duration of any and exclusive breastfeeding. Furthermore, the length of residence in Portugal by migrant mothers does not negatively impact on the breastfeeding duration.

Breastfeeding could be dependent on the social context of study country or setting. In western developed societies there are evolving social and lifestyle factors that modify breastfeeding practices over time [23]. Substantial proportions of mothers participating in this study were employed and discontinue exclusive breastfeeding before the recommended 6 months duration. This is because maternal employment is known to significantly affect breastfeeding duration [24]. We observed a decline of exclusive breastfeeding at 4 months for both maternal categories, which coincides with the expiration of 4 months of full paid maternity leave according to Portuguese law. [25]

Our findings showed that migrant mothers irrespective of their length of residence in Portugal breastfed (any breastfeeding or exclusive breastfeeding) for longer periods than their native peers, which is contrary to the

Table 2 Effect of maternal country of birth on breastfeeding initiation

	Crude model	Adjusted model (95% CI)*
Any breastfeeding		
Portuguese	1	1
Non-Portuguese European	0.6 (0.2,1.8)	0.6 (0.2,2.9)
South American	2.2 (0.5,9.0)	1.9 (0.5,7.6)
African	0.9 (0.3,3.2)	0.9 (0.3,2.9)
Exclusive breastfeeding		
Portuguese	1	1
Non-Portuguese European	1.2 (0.6,2.4)	1.1 (0.5,2.3)
South American	1.0 (0.6,1.8)	0.9 (0.5,1.7)
African	1.2 (0.6,2.4)	1.1 (0.6,2.2)

Any breastfeeding is mixed feeding or exclusive breastfeeding

*Adjusted for age, education, household income, parity, BMI, number of prenatal visits, smoking in pregnancy, mode of delivery, gestational age, birthweight, and NICU admission

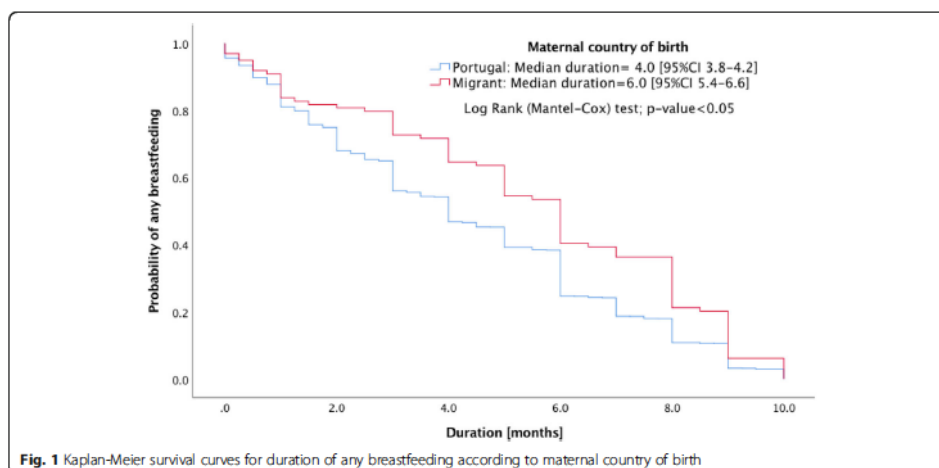


Fig. 1 Kaplan-Meier survival curves for duration of any breastfeeding according to maternal country of birth

observation of some studies [15, 26, 27]. Specifically, the African-born women averagely had lengthier period of residence in Portugal but breastfeed for longer duration compared with other migrant mothers. This negates the notion that acculturating to host country could negatively influence migrant mother's breastfeeding practices, especially those coming from settings with higher breastfeeding rates than Western nations [26]. Our observation is not unusual because acculturation has been reported as not having an influence on breastfeeding for particular migrant groups [7, 28]. Basically, certain traditional beliefs facilitate

positive breastfeeding practices that persist for longer period especially in migrants from cultural backgrounds, which western breastfeeding practices was unknown or perceived as unacceptable [29]. On the contrary, it has been shown that post migration, immigrant breastfeeding rates tends to converge towards native born rates of breastfeeding as length of residence in host country increases [15].

An important public health implication of this study is that the duration of any breastfeeding and exclusive breastfeeding were below the WHO recommendations in native Portuguese and migrant mothers. Thus, we

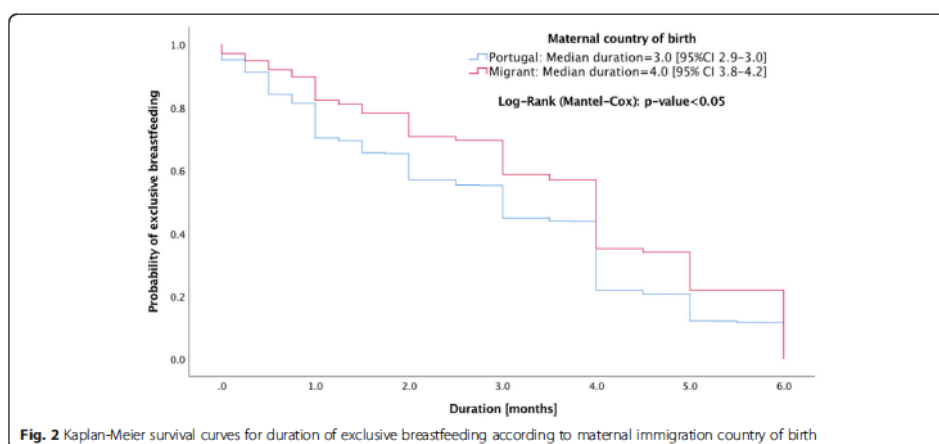
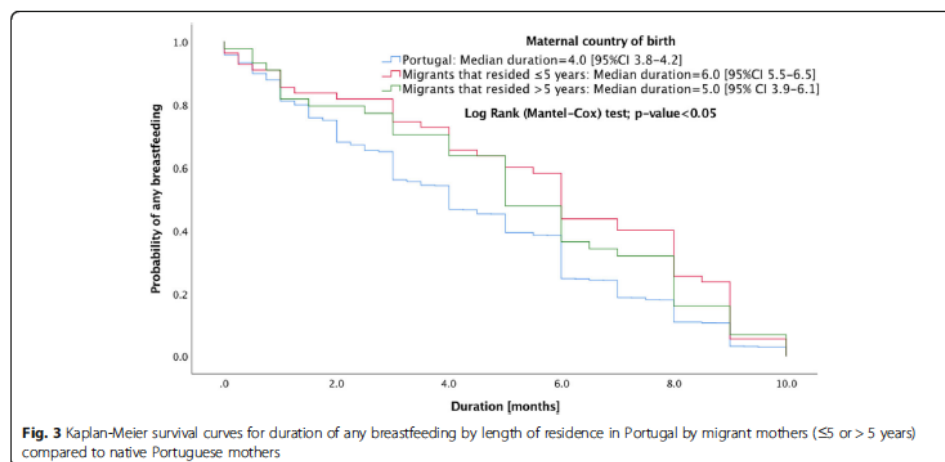
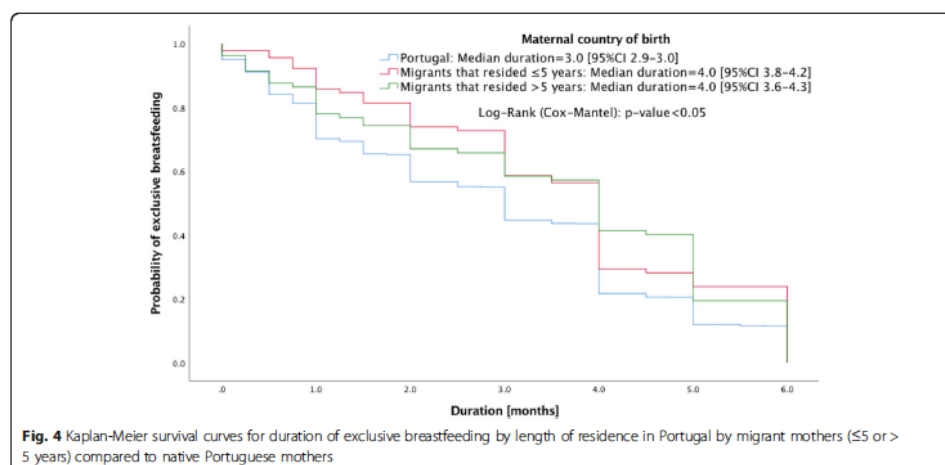


Fig. 2 Kaplan-Meier survival curves for duration of exclusive breastfeeding according to maternal immigration country of birth



recommend intensive breastfeeding promotion for all maternal categories especially for the employed to whom adequate conditions to continue breastfeeding should be provided. Breastfeeding education during prenatal and postnatal care should be emphasized because of its effectiveness at enhancing breastfeeding initiation and duration [30]. In Portugal, there is universal healthcare for women irrespective of immigration status. This is relevant for immigrants because migration isolates women but health professionals could serve as a major

source of information on breastfeeding [31]. More so for recently arrived migrant mothers arriving at a time characterized by multiple challenges to breastfeeding practices in contemporary European context. Finally, future research can improve the understanding of the exact role of maternal country of birth in breastfeeding. It is fundamental to explore acculturation pathway to explain healthy migrant effects by comparing breastfeeding practices in source countries with that of first and second generation migrant as well as native-born mothers.



Strengths and limitations

A major strength of the study is the comprehensive birth cohort data derived for the same mothers at birth and at 4 years evaluation. Even though, recall bias is a potential limitation, it has been reported that maternal recall of infant feeding practices is reliable even after 10 years [32]. The total sample size of this study is large but the proportion of migrants is comparably smaller, which we recognized as a limitation. This poses a challenge for external validity and generalization of findings. However, this was our finding in the study setting, regarding the proportion of migrants, as it was comparable to migrant categories in the contemporary national Portuguese birth registry at inception of the birth cohort. Contextually, the GXXI birth cohort represents 54.6% of all recorded births in greater Porto metropolitan area during recruitment period.

Even though we are unable to study the breastfeeding experience of migrants from some regions like Asia and North America, which were not represented in the study population, we explored migrant diversity by categorizing migrant mothers into three groups based on geographical regions that are predominantly represented in the north of Portugal (other Europeans, South Americans and Africans). We also categorized migrant mothers according to length of residence in Portugal, which is identified as proxy of acculturation in characterizing healthy migrant effect [15].

The data we used for this study has been previously validated. Information about feeding practices was collected from a sub sample of the study population at 6, 15 and 24 months, which was found to be reliable [33]. The analytical approach we employed was also robust in addressing the research question. We evaluated the effect of maternal country of birth on breastfeeding duration by Kaplan Meier survival analysis. This method is effective in estimating time to event (e.g. cessation of breastfeeding) and measuring the fraction of subjects breastfed for a certain amount of time after the initiation of breastfeeding [34]. Kaplan-Meier analysis allows estimation of survival over time, even when participants drop out or are studied for different lengths of time.

Conclusions

The study has shown that maternal country of birth influences breastfeeding duration but not its initiation among mothers of Generation XXI birth cohort. Migrant mothers have longer duration of exclusive or any breastfeeding, which was not changed by length of residence in Portugal. The duration of breastfeeding is below recommended duration in both native and foreign-born mothers. We recommend intensive promotion of breastfeeding for all categories of mothers especially the employed to whom adequate condition to continue breastfeeding should be provided.

Additional files

Additional file 1 Participant selection flowchart. (DOC 79 kb)

Additional file 2 Comparison between participants and non-participants regarding children and maternal characteristics at birth. (DOC 46 kb)

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Availability of data and materials

Please contact author for data request.

Authors' contributions

MK and HB conceived and designed the study and analysis. MK and HB collected data and prepared the datasets. MK, CR, MJF, ACS and HB analysed the data. MK drafted the manuscript. HB reviewed, edited and revised the manuscript as well as supervised all the processes. All authors interpreted data and revised the manuscript critically for intellectual content. Finally, all the authors read and approved the final version.

Ethics approval and consent to participate

The project Generation XXI received ethical approval by the Ethical Committee of São João Hospital/ University of Porto Medical School and complies with the Helsinki Declaration and the current national legislation. The Portuguese Data Protection Authority also approved the study [20]. Written informed consent was obtained from all participants during baseline and subsequent follow up re-evaluations.

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests.

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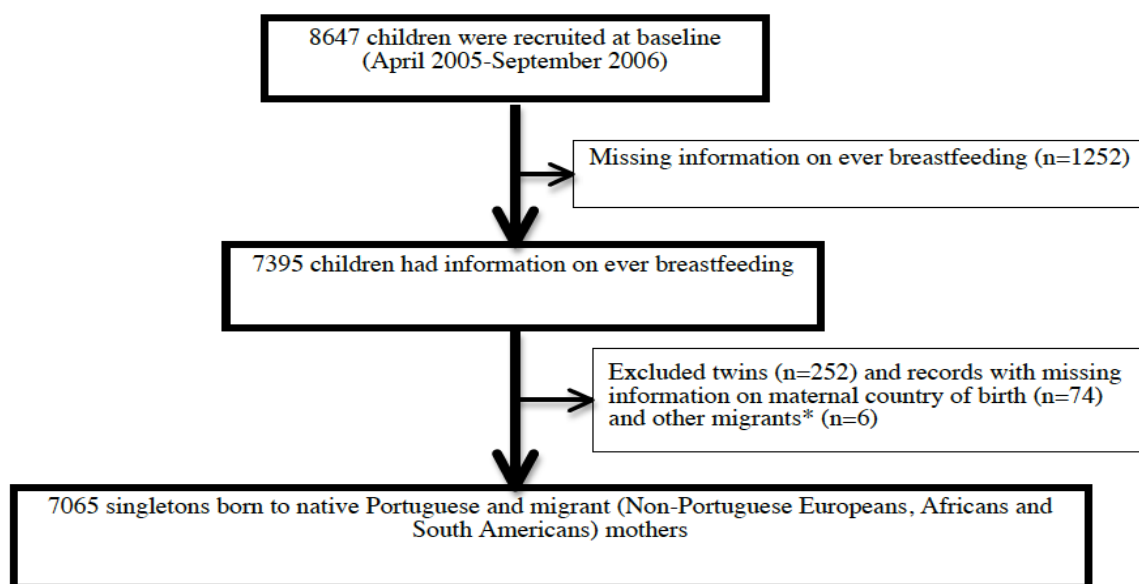
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Supplementary files



Participant selection flowchart

*Other than Non-Portuguese Europeans, South Americans and Africans

Supplementary figure: Participant selection flow chart

Supplementary table Comparison between participants and non-participants regarding children and maternal characteristics at birth

Characteristic, n (%)	Participants, 7065 (85.6)	Non-Participants, 1192 (14.4)	P-value
Maternal country of birth			
Portuguese	6831 (96.7)	1077 (90.4)	<0.0005
Non-Portuguese Europeans	61 (0.9)	23 (1.9)	
South American	106 (1.5)	71 (6.0)	
African	67 (0.9)	21 (1.8)	
Maternal duration of residence in Portugal			
≤5 years	129 (55.1)	89 (77.4)	<0.0005
>5 years	105 (44.9)	26 (22.6)	
Maternal age at birth (years)			
<20	333 (4.7)	132 (11.1)	<0.0005
20-34	5520 (78.1)	919 (77.1)	
≥35	1212 (17.2)	141 (11.8)	
Maternal education			
Basic	3327 (47.1)	750 (62.9)	<0.0005
Secondary	2212 (31.3)	305 (25.6)	
Tertiary	1526 (21.6)	137 (11.5)	
Family income (euros/month)			
≤1000	2372 (38.5)	527 (53.8)	<0.0005
1001-1500	1821 (29.6)	226 (23.1)	
>1500	1964 (31.9)	226 (23.1)	
Type of delivery			
Vaginal	4499 (63.9)	819 (68.9)	0.001
Caesarean section	2544 (36.1)	370 (31.1)	
Infant's sex			
Male	3604 (51.0)	615 (51.6)	0.710
Female	3461 (49.0)	577 (48.4)	
Preterm birth	508 (7.2)	110 (9.2)	0.013
Low birthweight	493 (7.0)	99 (8.3)	0.100

3.5 Paper V

Kana MA, Costa-Correia L, Azevedo A, Barros H. Blood pressure tracking and predictors of hypertension at 4 and 7 years in children of Generation XXI birth cohort

Blood pressure tracking and predictors of hypertension at 4 and 7 years in children of Generation XXI birth cohort

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Abstract

Background

Early prevention of hypertension is reliant on the understanding of timing of its multifactorial interactions. But few studies concurrently tracked blood pressure with prenatal and postnatal predictors of hypertension in childhood. Therefore, in this study we investigated blood pressure changes during middle childhood, taking into consideration several potential determinants of hypertension at 4 and 7 years of age. We also determined the prevalence of hypertension at 4 and 7 years.

Methods

Generation XXI is a prospective and closed birth cohort of mother-child pair assembled at birth in Porto, North of Portugal. Our analyses included 3803 children with blood pressure measurements for both four years and seven years follow-up evaluation.

Results

Prevalence of obesity at 4 years was greater in males (18.5%) than females (14.7%). At 7 years, proportion of male (16.2%) and female (15.6%) obese children was similar. Systolic and diastolic blood pressure variation between 4 and 7 years were similar for males (7.3 ± 9.87 and 12.6 ± 10.25 mmHg) and females (7.0 ± 9.79 and 12.1 ± 10.03 mmHg). Proportion of children classified, as either systolic or diastolic hypertension in both evaluations was less for males (23, 1.2%) than females (65, 3.3%). Obesity at 4 or 7 years is the only factor that significantly predicts hypertension at either four (13.4, 95% CI=6.8-26.6) or seven years (9.3, 95% CI=4.7-18.4).

Conclusion

Females had greater prevalence of elevated systolic blood pressure at 4 and 7 years. In both evaluations obesity is the only significant predictor of hypertension.

Keywords: Blood pressure tracking; longitudinal; Childhood; Portuguese

Background

Globally, cardiovascular disease is among the leading causes of death.[1] An increased prevalence of risk factors in the past two decades predicts a potential epidemic of cardiovascular disease in the future among younger segment of the population of developed nations.[2] From a life course perspective, the underlying pathological process of cardiovascular disease starts shortly after birth.[3] Thus, studying the early natural history of heart disease and tracking of recognized risk factors during childhood could help in developing preventive paediatric strategies.[3, 4] Hypertension is the key modifiable risk factor for cardiovascular disease, which offers an effective means of predicting risk and preventing morbidity and mortality.[5, 6] Fundamentally, strategies to reduce the burden of hypertension require knowledge of blood pressure changes across ages and its determinants.[7]

Blood pressure tracking enables longitudinal monitoring of same individuals at defined intervals taking into account other variables. This continuous monitoring enables early detection and intervention targeting amendable risk factors at the appropriate time. Evidence synthesis from studies tracking blood pressure in diverse populations indicates that children with elevated blood pressure had higher blood pressure in adolescence and adulthood.[8-11] Nevertheless, the development of hypertension is based on more than one parameter and this understanding is paramount for early intervention.[12] Prenatal and postnatal factors have been established to predict later blood pressure in children.[13] Presently, the knowledge of the critical period, accumulation of risk and pathway of how these factors exert their effect on blood pressure is inconclusive.

Causation of hypertension involves multifactorial interaction between parameters during the life course. The contribution of genetic and environmental factors into phenotypic variability of blood pressure has been defined.[14] Multiple interactions between hemodynamic and metabolic parameters have been shown to foreshadow the clustering of cardiometabolic risk factors in the course of life.[15] Understanding the interaction timing will enable appropriate application of interventions. Many longitudinal studies have tracked blood pressure from childhood but few concurrently tracked blood pressure with prenatal and postnatal predictors of hypertension in childhood.[8, 16-28] Therefore, in this study we investigated blood pressure changes during middle childhood, taking into consideration several potential determinants of hypertension at 4 and 7 years of age. We also determined the prevalence of hypertension at 4 and 7 years.

Methods

Study design and population

Generation XXI is a prospective and closed birth cohort that consists of children assembled at birth in Porto (North of Portugal) between April 2005 and August 2006.[29] During the recruitment period, all mothers resident in the catchment area who delivered a live-born child in one of the five public maternity units were eligible and invited to join the study 24 to 72 hours after delivery. A total of 8495 mothers (91.4% of those invited) and 8647 children were enrolled at baseline. Trained interviewers using structured questionnaires collected data on demographic and socioeconomic characteristics, lifestyles, obstetric history, and anthropometrics, within 72 hours of delivery, during the hospital stay, by face-to-face interview. Clinical records were also reviewed at birth.

At four and seven years after delivery, all the children and their mothers were invited to a follow-up evaluation. For families that were not able to participate in a face-to-face evaluation, a telephone interview was offered but blood pressure was not recorded. The present study included only children with blood pressure measurements at four years (April 2009 and April 2011) and seven years (April 2012-March 2014) follow-up evaluation. Thus, the present analysis was based on the information of 3803 children (Figure 1) who have Z scores for both systolic and diastolic blood pressure in both 4 and 7 years evaluations.

Details of the methods including data collection tools and processes are also found in <http://www.geracao21.com>. Ethical approval was obtained from Ethics Committee of São João Hospital/University of Porto Medical School, which complies with Helsinki Declaration and national legislation. Portuguese Data Protection Authority also approved the study.[29] Written informed consent was obtained from all participants during baseline and subsequent follow-up re-evaluations.

Exposure and outcome measurements

Exposure and outcome measures were derived from questionnaire interviews, maternal medical records and child physical examination at birth, 4 and 7 years evaluations.

1. Exposure measurements: We selected exposure variables that were included in the analyses based on documented prenatal and postnatal factors that will predict later blood pressure among children.[13, 30] We classified factors were classified according to life course perspective.

a. Maternal factors: These included maternal socio-demographic characteristics, personal history of hypertension, obstetric and pregnancy history of index child. Selected variables included age at birth (categorized as <20, 20-34 or ≥ 35 years), maternal education corresponding to the number of completed schooling years at delivery (classified as basic, secondary or higher/tertiary) and maternal country of birth categorized as native Portuguese, non-Portuguese Europeans, Brazilians, or Africans. Parity was recorded as the number of deliveries, including the index classified as primiparae or multiparae.

b. Prenatal/pregnancy related factors: Prepregnancy weight was self-reported after delivery and recorded to the nearest 0.1 kg. Height was measured in centimeters, to the nearest tenth, using a portable stadiometer. The calculated BMI was categorized as underweight, normal weight, overweight and obese. Gestational weight gain was measured and excessive weight gain was defined as ≥ 9 kg. Personal history of hypertension was considered present when participants recalled a medical diagnosis of this condition before the current pregnancy, while gestational hypertension was considered only when explicitly recorded on obstetrical records as a diagnosis during the current pregnancy. Cigarette smoking during pregnancy any trimester of pregnancy (Yes or No).

c. Infant and childhood factors: In this study we considered pregnancy outcome parameters that influence blood pressure; gestational age and birth weight. Duration of gestation was expressed in completed weeks. Gestational age was derived by ultrasound measurements (if performed up to the 20th gestational week) and, if no such data was available it was based on last menstrual period. Infants were classified as preterm if delivered at <37 completed weeks. Small for gestational age (SGA) and large for gestational age (LGA) were used to assess, respectively, fetal growth restriction and high fetal growth and were defined as the sex-specific birth weight <10th or > 90th percentile for each gestational age.[31] The birth weight is recorded in grams and corresponds to the first measure of weight obtained after birth, preferably during the first hour. Duration of exclusive breastfeeding was recorded in weeks and categorized in months with optimal defined as ≥ 6 months. The infant gender was classified as male or female.

During follow-up at 4 and 7 years, the child's age in months, height and weight were recorded. Trained examiners performed anthropometric measurements. Weight was measured in light clothing to the nearest 0.1 kg using a digital scale, and height was measured to the nearest centimeter with a wall standiometer. BMI was calculated as weight in kg divided by height in squared meters. BMI, age-, and sex-specific standard deviation scores (BMI z-scores) were computed according to the World Health Organization.[32] Children who had BMI for age percentile 5th to < 85th were regarded as of healthy weight, 85th to < 95th as of overweight and ≥ 95 th as obese. Children with BMI for age percentile < 5th were regarded as underweight.

2. Outcome measurement:

Blood pressure was measured two times with a 5-min interval between measurements for each child during follow-up visits at 4 and 7 years. Blood pressure was recorded in sitting position with child's back supported, feet on the floor, the right arm supported and antecubital fossa at the heart level. Blood pressure was measured with an aneroid sphygmomanometer (Erka® Vario DeskModel) with an appropriately sized cuff, by a trained examiner. When the difference between the two determinations was larger than 5 mm Hg for systolic blood pressure (SBP) or diastolic blood pressure (DBP), a third measurement was taken, and the mean of the 2 closest values was considered. No significant differences were found between the average BP of the group with two measurements and the average of the second and third measurement in the group with three measurements (SBP: 106.8 vs. 106.7, $p = .934$; DBP: 73.5 vs. 74.0, $p = .617$, respectively).[30] Blood pressure standard deviation score values were calculated, following the recommendations of the American Academy of Pediatrics, and children were classified as having high blood pressure levels (hypertension) if SBP or DBP were above the 90th percentile for age, gender, and height.[33]

Statistical analysis

Descriptive analysis of exposure variables and comparison of all blood pressure measurements were done according to gender of the child. Continuous variables were presented as mean (SD), and Student t test or ANOVA were used for 2-or >2 groups comparisons. Proportions were compared using chi-square tests. Mean blood pressure was calculated and classified at 4 and 7 years by gender. Blood pressure classification was reported as normal, prehypertension, stage 1 and 2 hypertension for males and females. We reported children classified as systolic or diastolic HTN (stage 1 & 2) at 4, 7 or both 4 and 7 years and have mothers with prepregnancy hypertension. The BP percentiles were used to categorize blood pressure in the following manners²: (i) Normal: SBP and DBP < 90th percentile; (ii) Prehypertension: SBP or DBP ≥ 90 th percentile to <95th percentile or BP >120/80 mmHg to <95th percentile; (iii) Stage I hypertension: SBP and or DBP $\geq$

95th percentile to < 99th percentile plus 5 mmHg; (iv) Stage II hypertension: SBP and or DBP $\geq$ 99th percentile plus 5 mmHg. We also calculated the systolic and diastolic blood pressure variation between 4 and 7 years; $\Delta = 7$ years observation – 4 years observation e.g. Δ SBP (mmHg) = SBP (mmHg, 7 years observation) – SBP (mmHg, 4 years observation) or Z-score Δ SBP = Z-score SBP (7 years observation) - Z-score SBP (4 years observation).

The association between predictor (exposure) variables and children's blood pressure (Hypertensive vs. Normotensive) at 4 and 7 years were estimated with logistic regression analyses expressed as crude and adjusted odds ratio (OR) and 95 % confidence intervals (95% CI). The level of statistical significance was set at a p-value of 0.05. Univariable (crude) models were used to determine the association between individual predictor variable and children's blood pressure (Hypertensive vs. Normotensive). Based on previous literature, we tested potential confounders and verified that maternal educational level, gestational hypertension, and child's BMI were associated with both exposure and outcome. Hence, we adjusted for age, sex and these confounders; a multivariate logistic regression model using forward selection was built using variables with p-values below 0.25 on univariate analysis. In all the models, native Portuguese was considered as reference category for comparison with other Europeans, South Americans and Africans.

Statistical analyses were performed using the Statistical Package for the Social Sciences (IBM® SPSS® Statistics), version 23.0. Statistical significance was considered with a α critical value of 0.05.

Results

Socio-demographic characteristics

The study consisted of 1854 (48.8%) males and 1949 (51.2%) females. The maternal characteristics at prenatal or birth of index child were comparable for both gender categories except for education. The distribution by maternal country of birth for male and female respectively was Portuguese (1805, 97.4% and 1886, 96.8%), non-Portuguese Europeans (12, 0.6% and 23, 1.2%), Brazilians (22, 1.2% and 23, 1.2%) and Africans (15, 0.8% and 17, 0.9%). Mean maternal age was 29.8 ± 5.48 years (males) and 29.6 ± 5.33 years (females). Proportion of mothers aged greater or equal to 35 years for male and female participants was 16.5% and 17.5%. Mothers with higher education (≥ 12 schooling years) were 17.5% and 20.1% for male and female participants respectively. Primiparous mothers among males and females were 55.4% and 56.6%.

Overweight/obese mothers consisted of almost a third among males (32.5%) and females (31.8%). Excessive weight gain in pregnancy ($\geq 9\text{kg}$) was recorded in 75% and 74.5% of mothers of male and female participants. Prevalence of maternal pre-pregnancy diagnosed or gestational hypertension was low in both gender categories, males (2.0 and 1.2%) and females (1.9 and 1.3%). About a quarter of mothers smoked cigarettes during pregnancy, males (23.8%) and females (23.1%).

The reported characteristics for male and female children were comparable in majority of variables at birth, during infancy, four and seven years evaluation. The mean (SD) gestational age at birth was 38.7 ± 1.78 and 38.6 ± 1.67 weeks for male and female participants. Prevalence of preterm births in males and females was 8.0% and 8.7%. Mean (SD) birth weight was $3586.9 \pm 268.54\text{g}$ and $3582.7 \pm 270.54\text{g}$ for males and females. Proportion of small or large for gestational aged babies was similar among males (13.6 and 3.0%) and females (15.9 and 2.7%). More than a quarter of males (27.6%) and females (29.0%) were exclusively breastfed.

Mean (SD) follow-up period between the 4 and 7 years evaluations was 2.7 ± 0.41 and 2.7 ± 0.41 years in males and females respectively. Averagely, during the 4 years evaluation, male and female children were aged 53.2 ± 4.78 and 53.4 ± 4.89 months. Prevalence of obesity was greater for males (343, 18.5%) than females (14.7%). At the 7 years evaluation, the mean age for males and females was 84.9 ± 2.58 and 84.9 ± 2.58 months. Prevalence of obesity was similar in male (301, 16.2%) and female (304, 15.6%) children.

Mean blood pressure and hypertension classification at 4 and 7 years

During the 4 years evaluation, the mean (SD) systolic blood pressure for males ($97.8 \pm 8.2\text{ mmHg}$) was less than that of females ($98.4 \pm 8.3\text{ mmHg}$). The diastolic blood pressure was similar for males ($57.7 \pm 7.96\text{ mmHg}$) and females ($57.6 \pm 8.08\text{ mmHg}$). Prevalence of systolic pre-hypertension and hypertension (stage 1 and 2) was greater for females (4.3 and 8.0%) compared to males (3.0 and 5.0%). While prevalence of diastolic pre-hypertension and hypertension (stage 1 and 2) was lesser for females (4.4 and 4.0%) than males (5.9 and 6.8%). Only few male (5, 0.3%) and female (5, 0.3%) participants were classified as having systolic or diastolic hypertension (stage 1 or 2) and had mothers with pre-pregnancy hypertension.

At the 7 years evaluation, the mean (SD) systolic blood pressure was similar for male ($105.1 \pm 9.07\text{ mmHg}$) and female ($105.5 \pm 8.92\text{ mmHg}$). Mean diastolic blood pressure was greater for male ($70.4 \pm 7.88\text{ mmHg}$)

than female (69.7 ± 7.78 mmHg) children. Prevalence of systolic pre-hypertension and hypertension (stage 1 and 2) was similar in male (3.9 and 5.3%) and female (4.5 and 6.7%). Prevalence of diastolic pre-hypertension and hypertension (stage 1 and 2) was higher in males (5.4 and 7.5%) compared with females (4.8 and 4.3%). Children categorized with systolic or diastolic hypertension (stage 1 and 2) and having a pre-pregnancy hypertensive mother was comparable for male (4, 0.2%) and female (6, 0.3%).

The systolic and diastolic blood pressure variation between 4 and 7 years were similar for males (7.3 ± 9.87 and 12.6 ± 10.25 mmHg) and females (7.0 ± 9.79 and 12.1 ± 10.03 mmHg). Proportion of children classified, as either systolic or diastolic hypertension in both evaluations was less for male (23, 1.2%) than females (65, 3.3%). Proportion of females (54, 2.8%) classified with systolic hypertension in both evaluations was twice that for males (23, 1.2%). Proportion of the children classified with diastolic hypertension in both evaluations was similar in males (17, 0.9%) and females (10, 0.5%).

Predictors of hypertension at 4 and 7 years: Results of regression analyses

Obesity at 4 or 7 years is the only factor that is significantly associated with hypertension at either four (13.4, 95% CI=6.8-26.6) or seven years (9.3, 95% CI=4.7-18.4). Some factors have greater strength of association (OR, 95% CI) with hypertension at 4 years compared with the 7 years evaluation: Pre-gestational hypertension (2.5, 95% CI=0.5-11.7 vs. 0.9, 95% CI=0.2-4.9), maternal country of birth (1.5, 95% CI=0.5-4.0 vs. 0.6, 95% CI=0.2-2.2), smoking during pregnancy (1.7, 95% CI=0.9-2.9 vs. 1.0, 95% CI=0.6-1.8).

The strength of association for some factors and hypertension was greater at 7 years than the 4 years evaluation: Maternal age ≥ 35 years (1.6, 95% CI=0.9-2.8 vs. 1.3, 95% CI=0.7-2.3), higher education (1.0, 95% CI=0.6-1.7 vs. 0.6, 95% CI=0.3-1.1), pre-gestational overweight/obesity (1.0, 95% CI=0.5-1.9 vs. 0.8, 95% CI=0.4-1.6), excessive weight gain during pregnancy (1.5, 95% CI=0.8-2.8 vs. 0.8, 95% CI=0.5-1.5) and female child (1.5, 95% CI=0.9-2.3 vs. 1.3, 95% CI=0.8-2.1). Comparable estimates were observed for the strength of association between some factors and hypertension at 4 and 7 years: small for gestational age (1.1, 95% CI=0.6-1.9 vs. 1.1, 95% CI=0.6-2.0) and exclusive breastfeeding for ≥ 6 months (0.9, 95% CI=0.5-1.7 vs. 0.9, 95% CI=0.2-4.3)

Discussion

In this study we tracked blood pressure of children between 4 and 7 years. Variation in mean systolic and diastolic blood pressure between these two milestones during middle childhood was similar for male

and female children. Proportion of females having elevated systolic blood pressure in both evaluations was twice that for males. Compared with females, prevalence of diastolic pre-hypertension and hypertension was greater in males in both evaluations. Among the male participants, the prevalence of systolic and diastolic pre-hypertension and hypertension was greater in seven years than four years evaluation. It is only in the prevalence of diastolic pre-hypertension and hypertension that a similar observation was made among females. We did not observe a chronological order in the expression of the predictive role of prenatal and postnatal factors. Obesity is the only significant predictor of hypertension at 4 and 7 years. The association between other factors and hypertension is manifested differently at either 4 or 7 years.

The child's nurture and environmental factors have been known to influence blood pressure changes during childhood. Childhood obesity and other relevant risk factors as we have observed have been associated with the blood pressure changes.[23, 34, 35] Our finding of obesity being the most significant determinant of blood pressure during middle childhood is consistent with accruing evidence of worldwide "childhood obesity epidemic" as a plausible precursor of increasing rates of hypertension in adults.[36] BMI-related reduction in effect size reinforces the importance of BMI on the diet-BP relation, because a less-healthy transition diet by age 2 years is associated with higher blood pressure at 7.5 years. [37] But the correlation between blood pressure and body mass has been observed to lessen with age.[14] The contribution of genetic and environmental factors into phenotypic variability of blood pressure and body mass, as well as into phenotypic correlation between these traits is defined.[14] This could be the plausible explanation for differences we observed between males and females.

Existence of shared mother-offspring risk factors specific for higher blood pressure has also been described. Gestational hypertension has been found to be associated with higher offspring blood pressure in childhood, and this corresponds with our results.[38] Those common environmental factors are relevant but operate within the limits of one generation. Maternal effect of systolic and diastolic blood pressure variability is negligible. Among our study population, the exposure to maternal smoking before pregnancy, during pregnancy and 4 years after delivery has been documented to be associated with elevated systolic blood pressure at 4 years.[30] Nonetheless, our observation showed that predictive effect of maternal smoking during pregnancy on raised blood pressure is diminished at 7 years compared with 4 years.

Conclusion

Variation in mean blood pressure between 4 and 7 years was similar for male and female children. In both evaluations, the proportions of females with elevated systolic blood pressure were greater than for males. Males recorded a higher prevalence of diastolic pre-hypertension and hypertension in both evaluations. Among male participants, the prevalence of systolic and diastolic pre-hypertension and hypertension was greater in seven years than four years evaluation. Among females, we noted this observation for only diastolic pre-hypertension and hypertension. Obesity is the only significant predictor of hypertension at 4 and 7 years. The association between other factors and hypertension is manifested differently at either 4 or 7 years.

Declaration of interest

The authors declare that they have no competing interests.

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Author contribution

MK and HB conceived and designed the study. MK, AA and LC generated the dataset and performed the analyses. MK drafted the manuscript. HB reviewed, edited and revised the manuscript as well as supervised all the processes. All authors interpreted data and revised the manuscript critically for intellectual content. Finally, all the authors read and approved the final version.

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Table 1. Characteristics of the study population, by gender (n=3803)

Variable, n (%)	Male (n=1854)	Female (n=1949)	p-value
Maternal characteristics			
Country of birth			
Portuguese	1805 (97.4)	1886 (96.8)	0.390
European	12 (0.6)	23 (1.2)	
Brazilian	22 (1.2)	23 (1.2)	
African	15 (0.8)	17 (0.9)	
Maternal age at birth, years (mean $\pm$ SD)	29.8 $\pm$ 5.48	29.6 $\pm$ 5.33	0.174
Maternal age $\geq$ 35 years	306 (16.5)	341 (17.5)	0.416
Higher education ($\geq$ 12 schooling years)	324 (17.5)	391 (20.1)	0.041
Parity (Primiparae)	1011 (55.4)	1086 (56.6)	0.461
Prepregnancy BMI and weight changes			
Pre-pregnancy BMI class - Overweight/Obesity	557 (32.5)	578 (31.8)	0.655
Mean pregnancy weight gain (kg)	12.7 $\pm$ 5.72	12.7 $\pm$ 5.53	0.803
Excessive weight gain in pregnancy ($\geq$ 9kg)	1007 (75.0)	1054 (74.5)	0.764
Pre-pregnancy diagnosis of hypertension	35 (2.0)	35 (1.9)	0.235
Gestational hypertension	19 (1.2)	22 (1.3)	0.712
Smoking during pregnancy	442 (23.8)	450 (23.1)	0.603
Birth and infant characteristics			
Gestational age (weeks) (mean $\pm$ SD)	38.7 $\pm$ 1.78	38.6 $\pm$ 1.67	0.920
Preterm birth	148 (8.0)	170 (8.7)	0.410
Birth weight (g) (mean $\pm$ SD)	3586.9 $\pm$ 268.54	3582.7 $\pm$ 270.54	0.630
Small for gestational age	244 (13.6)	299 (15.9)	0.049
Large for gestational age	53 (3.0)	52 (2.7)	0.660

Exclusively breastfed for at least 6 months	512 (27.6)	565 (29.0)	0.343
Follow-up period between 4 and 7 years, mean $\pm$ SD)	2.7 $\pm$ 0.41	2.7 $\pm$ 0.41	0.278
Children's characteristics at 4 years follow-up			
Age in months (mean $\pm$ SD)	53.2 $\pm$ 4.78	53.4 $\pm$ 4.89	0.313
Obesity	343 (18.5)	287 (14.7)	0.002
Children's characteristics at 7 years follow-up			
Age in months (mean $\pm$ SD)	84.9 $\pm$ 2.58	84.9 $\pm$ 2.58	0.914
Obesity	301 (16.2)	304 (15.6)	0.591

*The following variables have missing cases: Parity; maternal smoking; hypertension in pregnancy; breastfeeding duration. **Maternal prepregnancy BMI was categorized according to the standard World Health Organization definition (REF); ** Pregnancy weight gain is classified according to the Institute of Medicine recommendation.

Table 2: Mean blood pressure and hypertension classification at 4 and 7 years, by gender

Variable, n (%)	Male	Female	p-value
4 years evaluation			
SBP, mmHg (mean±SD)	97.8±8.2	98.4±8.3	0.012
zSBP (mean±SD)	-1.3±0.87	-1.0±0.87	<0.001
Prehypertension*	56 (3.0)	84 (4.3)	<0.001
Stage 1 HTN*	55 (3.0)	104 (5.3)	
Stage 2 HTN*	37 (2.0)	52 (2.7)	
DBP, mmHg (mean±sd)	57.7±7.96	57.6±8.08	0.466
zDBP, (mean±sd)	-0.9±0.75	-1.1±0.73	<0.001
Prehypertension*	109 (5.9)	86 (4.4)	<0.001
Stage 1 HTN*	105 (5.7)	64 (3.3)	
Stage 2 HTN*	21 (1.1)	12 (0.6)	
Children classified as systolic or diastolic HTN (stage 1 & 2) at 4 years and have mothers with prepregnancy hypertension	5 (0.3)	5 (0.3)	1.000
7 years evaluation			
SBP, mmHg (mean±sd)	105.1±9.07	105.5±8.92	0.171
zSBP, (mean±sd)	-0.2±0.75	0.1±1.92	<0.001
Prehypertension*	73 (3.9)	88 (4.5)	0.241
Stage 1 HTN*	65 (3.5)	86 (4.4)	
Stage 2 HTN*	33 (1.8)	44 (2.3)	
DBP, mmHg (mean±sd)	70.4±7.88	69.7±7.78	0.007
zDBP, mmHg (mean±sd)	0.6±0.74	0.5±0.70	<0.001
Prehypertension*	101 (5.4)	93 (4.8)	<0.001
Stage 1 HTN*	83 (4.5)	52 (2.7)	
Stage 2 HTN*	56 (3.0)	31 (1.6)	

Children classified as systolic or diastolic HTN (stage 1 & 2) at 7 years and have mothers with prepregnancy hypertension	4 (0.2)	6 (0.3)	0.754
BP variation between 4 and 7 years			
SBP, mmHg (mean $\pm$ sd)	7.3 $\pm$ 9.87	7.0 $\pm$ 9.79	0.325
zSBP, (mean $\pm$ sd)	0.4 $\pm$ 0.36	0.4 $\pm$ 0.36	0.002
DBP, mmHg (mean $\pm$ sd)	12.6 $\pm$ 10.25	12.1 $\pm$ 10.03	0.125
zDBP, (mean $\pm$ sd)	0.6 $\pm$ 0.38	0.6 $\pm$ 0.35	0.239
Proportion of children classified as either systolic or diastolic HTN in both evaluations	46 (2.5)	65 (3.3)	0.118
Proportion of children classified with systolic hypertension in both evaluations	23 (1.2)	54 (2.8)	0.001
Proportion of children classified with diastolic hypertension in both evaluations	17 (0.9)	10 (0.5)	0.138

SBP= Systolic blood pressure; DBP= Diastolic blood pressure; HTN=Hypertension; Hypertension classification in percentiles; Pre-hypertension= ≥ 90 - $<95^{th}$ percentile, Stage 1 HTN= >95 - $\leq 99^{th}$ percentile and Stage 2 HTN= $>99^{th}$ percentile.

Table 3: Predictors of hypertension at 4 and 7 years: Univariate and multivariate regression analysis

Predictor variable	Hypertensive vs. Normotensive, OR (95% CI)			
	4 years evaluation		7 years evaluation	
	Univariate	Multivariate	Univariate	Multivariate
Non-Portuguese (Ref: Portuguese)	1.5 (0.6-3.8)	1.5 (0.5-4.0)	0.7 (0.2-2.5)	0.6 (0.2-2.2)
Maternal age ≥ 35 years	1.3 (0.8-2.3)	1.3 (0.7-2.3)	1.6 (0.9-2.7)	1.6 (0.9-2.8)
Tertiary educated	0.6 (0.3-1.1)		1.0 (0.6-1.7)	
Primiparae	0.7 (0.5-1.1)		0.7 (0.5-1.1)	
Pre-gestational overweight/obesity	0.8 (0.4-1.6)		1.0 (0.5-1.9)	
Excessive weight gain in pregnancy	0.8 (0.5-1.5)		1.5 (0.8-2.6)	1.5 (0.8-2.8)
Pre-gestational hypertension	3.6 (0.9-13.9)	2.5 (0.5-11.7)	1.6 (0.4-7.4)	0.9 (0.2-4.9)
Smoking during pregnancy	1.5 (0.9-2.5)	1.7 (0.9-2.9)*	0.9 (0.6-1.6)	1.0 (0.6-1.8)
Female child	1.1 (0.7-1.9)	1.3 (0.8-2.1)	1.5 (0.9-2.4)	1.5 (0.9-2.3)
Preterm birth	0.7 (0.3-1.7)		0.4 (0.1-1.6)	
Small for gestational age	1.1 (0.6-2.0)		1.1 (0.6-1.9)	
Exclusively breastfed for ≥ 6 months	0.9 (0.2-4.3)		0.9 (0.5-1.7)	
Obesity at 4 or 7 years	12.9 (6.6-25.2)*	13.4 (6.8-26.6)*	11.7 (6.1-22.5)*	9.3 (4.7-18.4)*

*p-value<0.05; Obesity is recorded at 4 and years evaluation;

Supplementary files

Supplementary figure 1: Participant selection pathway

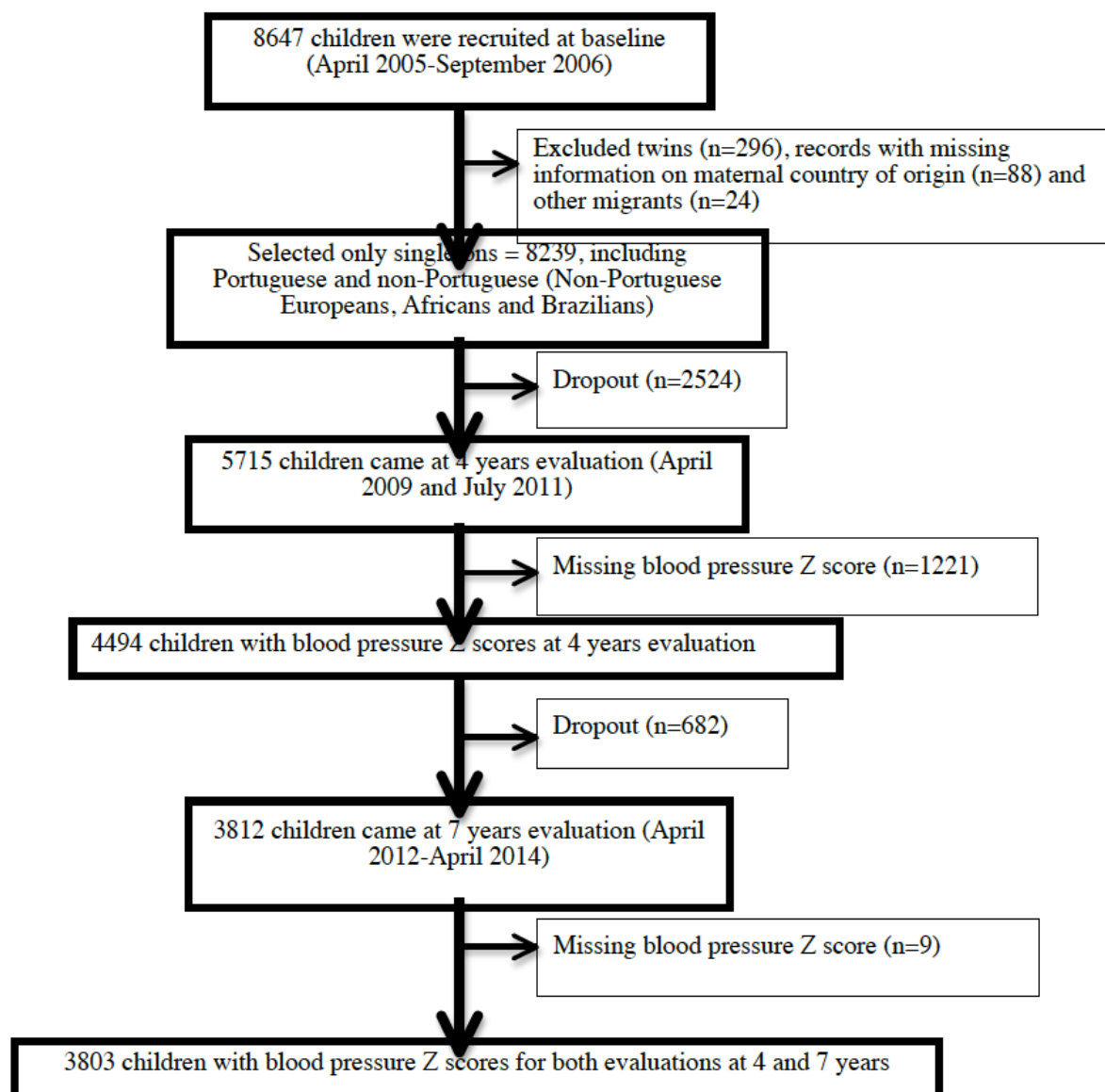


Figure 1. Participant selection flowchart, Generation XXI birth cohort

Supplementary Table 1: Characteristics of study population (n=3803) by maternal country of birth

Variable, n (%)	Portuguese (n=3691)	European (n=35)	Brazilian (n=45)	African (n=32)	p-value
Prenatal characteristics					
Maternal age at birth, years (mean $\pm$ sd)	29.7 $\pm$ 5.41	29.7 $\pm$ 3.42	31.4 $\pm$ 5.14	29.7 $\pm$ 5.86	0.325
Parity					
Primiparae	2107 (58.0)	26 (74.3)	27 (61.4)	13 (40.3)	0.045
Multiparae	1527 (42.0)	9 (25.7)	17 (38.6)	19 (38.6)	
Pre-pregnancy diagnosed hypertension	68 (1.9)	0 (0.0)	0 (0)	2 (6.3)	0.105**
Hypertension in pregnancy					
Smoking during pregnancy	865 (23.5)	8 (22.9)	13 (28.9)	6 (18.8)	0.767
>9kg weight gain during pregnancy	2002 (74.9)	15 (68.2)	27 (77.1)	17 (68.0)	0.750
Characteristics at birth and 1st year of life	31 (1.3)	0 (0.0)	0 (0.0)	0 (0.0)	0.829
Infant sex					
Male	1805 (48.9)	12 (34.3)	22 (48.9)	15 (46.9)	0.390
Female	1886 (51.1)	23 (65.7)	23 (51.1)	17 (53.1)	
Preterm birth	312 (8.5)	2 (5.7)	2 (4.4)	2 (6.3)	0.695
Low birth weight	326 (8.8)	0 (0.0)	2 (4.4)	3 (9.4)	0.081
Small for gestational age	528 (14.8)	5 (14.7)	4 (9.1)	6 (18.8)	0.643
Ever breastfed	3447 (94.4)	33 (94.3)	42 (95.5)	31 (96.9)	0.962
Exclusive breastfeeding duration (weeks)	13.1 $\pm$ 7.89	15.1 $\pm$ 7.25	14.3 $\pm$ 8.37	15.6 $\pm$ 7.55	0.154
Total breastfeeding duration (weeks)	36.3 $\pm$ 33.81	39.4 $\pm$ 27.26	35.5 $\pm$ 31.61	50.3 $\pm$ 30.94	0.234
Follow-up period between 4 and 7 years	2.7 $\pm$ 0.41	2.8 $\pm$ 0.32	2.7 $\pm$ 0.42	2.6 $\pm$ 0.47	0.138
Characteristics at 4 years follow-up					
Age in months (mean $\pm$ sd)	53.3 $\pm$ 4.84	51.5 $\pm$ 3.45	52.6 $\pm$ 4.73	54.5 $\pm$ 5.62	0.046
BMI >85th percentile (Overweight/ Obese)	612 (16.6)	3 (8.6)	10 (22.2)	5 (15.6)	0.422
Characteristics at 7 years follow-up					
Age in months (mean $\pm$ sd)	84.9 $\pm$ 2.59	84.4 $\pm$ 1.83	84.7 $\pm$ 2.23	84.8 $\pm$ 2.26	0.713
BMI >85th percentile (Overweight/Obese)	591 (16.0)	2 (5.7)	8 (17.8)	4 (12.5)	0.287

Supplementary Table 2: Mean blood pressure and classification of hypertension in males and females by maternal country of origin at 4 and 7 years evaluation

Variable	Males					Females				
	Portuguese (n=1805)	European (n=12)	Brazilian (n=22)	African (n=15)	p-value	Portuguese (n=1886)	European (n=23)	Brazilian (n=23)	African (n=17)	p-value
4 years evaluation										
SBP, mmHg (mean±sd)	97.7±8.2	99.7±7.9	98.6±8.85	100.9±10.77	0.398	98.5±8.27	96.5±7.87	97.4±10.44	97.4±9.05	0.591
zSBP, mmHg (mean±sd)	-1.3±0.86	-1.1±0.89	-1.2±0.91	-0.9±1.13	0.364	-1.0±0.87	-1.26±0.84	-1.13±1.09	-1.0±0.93	0.656
<90 th percentile (Normal)	1664 (92.2)	10 (83.3)	19 (86.4)	13 (86.7)	0.058**	1655 (87.8)	21 (91.3)	18 (78.3)	15 (88.2)	0.454
≥90-<95 th percentile (Prehypertension)	54 (3.0)	1 (8.3)	1 (4.5)	0 (0.0)		81 (4.3)	1 (4.3)	1 (4.3)	1 (5.9)	
>95-≤99 th percentile (Stage 1 HTN)	53 (2.9)	0 (0.0)	2 (9.1)	0 (0.0)		101 (5.4)	1 (4.3)	2 (8.7)	0 (0.0)	
>99 th percentile (Stage 2 HTN)	34 (1.9)	1 (8.3)	0 (0.0)	2 (13.3)		49 (2.6)	0 (0.0)	2 (8.7)	1 (5.9)	
DBP, mmHg (mean±sd)	57.7±7.99	59.1±5.11	57.4±7.22	58.5±7.42	0.914	57.6±8.02	54.6±8.83	58.3±10.92	54.6±8.88	0.134
zDBP, mmHg (mean±sd)	-0.9±0.76	-0.8±0.56	-0.9±0.64	-0.8±0.67	0.900	-1.1±0.73	-1.4±0.77	-1.0±0.98	-1.3±0.81	0.182
<90 th percentile (Normal)	1573 (87.1)	12 (100.0)	21 (95.5)	13 (86.7)	0.823**	1729 (91.7)	22 (95.7)	20 (87.0)	16 (94.1)	0.142
≥90-<95 th percentile (Prehypertension)	107 (5.9)	0 (0.0)	0 (0.0)	2 (13.3)		84 (4.5)	1 (4.3)	1 (4.3)	0 (0.0)	
>95-≤99 th percentile (Stage 1 HTN)	104 (5.8)	0 (0.0)	1 (4.5)	0 (0.0)		63 (3.3)	0 (0.0)	0 (0.0)	1 (5.9)	
>99 th percentile (Stage 2 HTN)	21 (1.2)	0 (0.0)	0 (0.0)	0 (0.0)		10 (0.5)	0 (0.0)	2 (8.7)	0 (0.0)	
7 years evaluation										
SBP, mmHg (mean±sd)	105.0±9.04	109.3±11.72	104.7±8.16	106.6±11.39	0.386	105.5±8.89	102.9±10.91	102.3±8.97	107.8±8.00	0.113
zSBP, mmHg (mean±sd)	-0.2±0.93	0.2±1.22	-0.2±0.82	-0.2±1.14	0.408	-0.1±0.91	-0.3±1.18	-0.3±0.87	0.2±0.79	0.131
<90 th percentile (Normal)	1640 (90.9)	10 (83.3)	20 (90.9)	13 (86.7)	0.180**	1673 (88.7)	22 (95.7)	21 (91.3)	15 (88.2)	0.873**
≥90-<95 th percentile (Prehypertension)	72 (4.0)	1 (8.3)	0 (0.0)	0 (0.0)		85 (4.5)	0 (0.0)	2 (8.7)	1 (5.9)	
>95-≤99 th percentile (Stage 1 HTN)	62 (3.4)	0 (0.0)	2 (9.1)	1 (6.7)		84 (4.5)	1 (4.3)	0 (0.0)	1 (5.9)	
>99 th percentile (Stage 2 HTN)	31 (1.7)	1 (8.3)	0 (0.0)	1 (6.7)		44 (2.3)	0 (0.0)	0 (0.0)	0 (0.0)	
DBP, mmHg (mean±sd)	70.4±7.8	71.3±11.47	66.4±9.44	71.0±9.16	0.120	69.7±7.78	68.1±7.54	68.5±8.61	70.3±6.73	0.669
zDBP, mmHg (mean±sd)	0.6±0.73	0.7±1.07	0.3±0.86	0.7±0.88	0.137	0.5±0.70	0.3±0.70	0.39±0.74	0.6±0.66	0.562
<90 th percentile (Normal)	1570 (87.0)	10 (83.3)	22 (100.0)	12 (80.0)	0.452**	1715 (90.9)	22 (95.7)	21 (91.3)	15 (88.2)	0.466
≥90-<95 th percentile (Prehypertension)	99 (5.5)	1 (8.3)	0 (0.0)	1 (6.7)		92 (4.9)	0 (0.0)	1 (4.3)	0 (0.0)	

>95-≤99 th percentile (Stage 1 HTN)	81 (4.5)	0 (0.0)	0 (0.0)	2 (13.3)		48 (2.5)	1 (4.3)	1 (4.3)	2 (11.8)	
>99 th percentile (Stage 2 HTN)	55 (3.0)	1 (8.3)	0 (0.0)	0 (0.0)		31 (1.6)	0 (0.0)	0 (0.0)	0 (0.0)	
BP variation between 4 and 7 years										
SBP, mmHg (mean ± sd)	7.4±9.85	9.6±8.17	6.1±10.35	6.8±13.75	0.791	7.0±9.78	6.4±9.61	4.9±9.74	10.4±10.43	0.370
zSBP, mmHg (mean ± sd)	0.4±0.36	0.5±0.32	0.3±0.35	0.4±0.49	0.728	0.4±0.36	0.3±0.32	0.3±0.37	0.5±0.49	0.158
DBP, mmHg (mean ± sd)	12.7±10.2	12.3±10.39	9.1±12.45	12.9±10.94	0.436	12.1±9.95	13.5±12.69	10.2±12.3	15.7±11.69	0.325
zDBP, mmHg (mean ± sd)	0.6±0.38	0.5±0.37	0.5±0.47	0.6±0.39	0.419	0.6±0.34	0.6±0.38	0.5±0.44	0.8±0.54	0.124

SBP= Systolic blood pressure; DBP= Diastolic blood pressure; HTN=Hypertension; Fisher's exact**; BP Classification in percentiles (n, %

3.6 Paper VI

Kana MA, Fraga S, Santos AC, Barros H. Comparison of parental disciplinary practices in Portuguese and first-generation immigrant mothers of Generation XXI birth cohort

Comparison of parental disciplinary practices in Portuguese and first generation immigrant mothers of Generation XXI birth cohort

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Abstract

Background

Parental disciplinary practices have a major role in determining the long-term health of children but disciplinary strategies employed by parents and their consequences vary with social and cultural backgrounds, particularly among migrant families. Therefore, we used a population birth cohort to compare disciplinary practices of migrant and Portuguese born mothers.

Methods

Parental disciplinary strategies were assessed for 5277 children and their mothers using the Portuguese version of the Parent-Child Conflict Tactics Scales questionnaire completed at the seven years follow-up evaluation of Generation XXI birth cohort (Porto, Portugal). Past year prevalence and chronicity scores of parental disciplinary practices were compared between children of migrant and Portuguese native mothers.

Results

Both maternal and child responses disclosed a high prevalence of non-violent discipline (>85.0%), but also of psychological aggression (>75.0%) and corporal punishment (>70.0%) use by mothers. As by maternal self-report the prevalence of severe (6.2% vs. 7.6%) and extreme (3.5% vs. 6.7%) physical assault acts was similar although lower in native than migrant mother. A higher proportion of children born to migrant mothers reported (9.9%) severe physical assault (9.9% vs. 8.2%). According to children's answers migrant mothers seem to use of extreme physical assault more frequently (25.9% vs. 19.8%). The disciplinary scale with the highest past year chronicity was maternal response for non-violent discipline in Portuguese (35.4 ± 23.52 times/year) and non-Portuguese (32.6 ± 22.64 times/year).

Conclusion

There was a high prevalence of past year prevalence of corporal punishment. Children of migrant mothers reported higher prevalence of maternal use of extreme physical assault.

Keywords: Parental discipline; Prevalence; Migrant; Portugal

Background

Discipline is the process of teaching children cultural values and normative behaviours of their society.(Wissow, 2002) Parents being primarily responsible for socializing their children usually employ a variety of disciplinary strategies to enforce conformity to societal norms.(Baumrind) Fundamentally, parental disciplinary practices have a role in the determination of behaviour, health and cognitive ability of children and adolescents.(Lipps et al., 2012; Raudino, Woodward, Fergusson, & Horwood, 2012; Stalmach, Jodkowska, Tabak, & Oblacinska, 2013; White, Widom, & Chen, 2007; Zottis, Salum, Isolan, Manfro, & Heldt, 2014) Positive parenting practices and good level of parental control confers a substantial impact on balanced mental health of children(Stalmach et al., 2013) while sterner forms of discipline, such as harsh physical punishment, have been identified as adverse social determinants of health, associated with depressive symptoms and inappropriate adolescent behaviours. (Lipps et al., 2012; Zottis et al., 2014) Parenting experienced during childhood and early adolescence is related to the degree and direction that adolescents resembled their parents later in life.(Herrenkohl, Klika, Brown, Herrenkohl, & Leeb, 2013; Langenhof, Komdeur, & Oldehinkel, 2016)

The significance and concepts of parenting philosophies are shared among culturally and socially diverse families (McEvoy et al., 2005) but variation in parenting practices have been observed across diverse cultural backgrounds.(Byford et al., 2014; Runyan et al., 2010; Theunissen, Vogels, & Reijneveld, 2015) Parenting is a great challenge and is made more complex when it is combined with migration, as recognized in first-generation migrant parents (Liamputtong & Naksook, 2003) that often lack the supportive social structure of a network of kith and kin, and may struggle with adaptation to a new culture.(Bradley, Pennar, & Glick, 2014) Though, the immigrant families gradually experience a cultural transition that manifests more in children born and raised in the host country.(Kim & Hong, 2007) These migrant children have to adapt both to the culture of their parents and host country, while their parents might be conflicted between the desire for cultural preservation and assimilation.(Hassan, Rousseau, Measham, & Lashley, 2008; Kim & Hong, 2007; McEvoy et al., 2005)

The escalating wave of international migration during the early 21st century has affected many European countries including Portugal as receiver nation.(Maurizio Ambrosini, 2016) The physical relocation of

immigrant families to another country, with a different socio-cultural setting and parenting statutes may have profound implication for their parental disciplinary practices. This is at a time that European families' are experiencing intensifying pressure regarding negotiating parental role due to the expansion of legislation regulating parental discipline, which adds parenting challenges for migrant families.(Daly, 2004) However, few studies explored the disciplinary practices of migrant parents using standard questionnaires whose importance increases once results on child maltreatment based on native population samples cannot be extrapolated to immigrant families because of their specific characteristics and needs.(Bjorknes & Manger, 2013; LeBrun et al., 2016; Theunissen et al., 2015) Therefore, we compared disciplinary practices of Portuguese and first-generation immigrant parents of a population-based Portuguese birth cohort based on children and mother reports.

Methods

Study participants

Generation XXI birth cohort recruited children at birth in metropolitan area of Porto (North of Portugal) between April 2005 and August 2006.(Alves, Correia, Barros, & Azevedo, 2012) During that period, all mothers resident in the catchment area who delivered a live-born child in one of the five public maternity units serving the region were eligible and invited to join the study 24 to 72 hours after delivery. A total of 8495 mothers (91.4% of those invited) and 8647 children were enrolled at baseline. The present study included 5277 children and their mothers (Figure 1) who answered the Portuguese version of the Parent-Child Conflict Tactics Scales at the seven years old follow-up evaluation (April 2012-March 2014). Ethical approval was obtained from Ethics Committee of São João Hospital/ University of Porto Medical School. The study complies with Helsinki Declaration, national legislation and recommendations for proper conduct on studies about violence (Resnik & Randall). The Portuguese Data Protection Authority also approved the study.(Alves et al., 2012) Written informed consent was obtained from all participants' parents or legal tutors at baseline and subsequent follow-up re-evaluations.

Exposure and outcome measurements

Migrant classification: Migrant status was classified based on maternal country of birth as Portuguese native or migrant. A mother was defined as a migrant if (a) she was born abroad and both parents were

foreign-born or (b) if she was born abroad and one or both parents were Portuguese-born but she moved to Portugal at the age of 18 or later, otherwise the mother was considered as native.(Teixeira, Correia, Victora, & Barros, 2013) Length of residence in Portugal by migrant mothers was used as a proxy for measuring acculturation and social integration into Portuguese society.

Parental disciplinary practices: The disciplinary practices adopted by parents were assessed using Portuguese version of the Parent-Child Conflict Tactics Scale (CTSPC) questionnaire.(Straus, Hamby, Finkelhor, Moore, & Runyan, 1998) This assessment tool evaluates three principal scales (forms) of parental discipline employed in past year: non-violent discipline characterized by practices widely used as alternatives to corporal punishment (namely, explanation, time out, substitute activity and deprivation of privileges – 4 items); psychological aggression which enclose verbal and symbolic acts used in order to cause psychological pain or fear to the child (5 items); and physical assault which, according to severity, may range from corporal punishment (acts that have traditionally been expected responses of parents to persistent child's misbehavior – 6 items), severe physical assault (3 items) and very severe or extreme physical assault (4 items).

It has been documented that parents were consistent and reliable in their reports of parent to child violence using CTSPC.(Straus et al., 1998) Additionally, assessment of the psychometric properties of the Portuguese version of the CTSPC questionnaire was tested and found to be valid within the context of the study setting.(Isabel Moreira et al, unpublished data)

Mothers reported the variety of disciplinary practices through a self-administered questionnaire and children were evaluated by face to face interview.

Mothers and their children independently completed the 22-item CTSPC questionnaire and based on their reports separate annual prevalence and annual frequency (to estimate chronicity) were used to score scales of parental disciplinary practices. Hence, each item of a particular disciplinary scale was transformed into the annual prevalence and annual frequency score.

For the maternal questionnaire, the CTSPC scoring technique adopted is in accordance with principles described and explained in the manual for the conflict tactic scale 1 (CTS1).(Straus et al., 1998) Annual prevalence of various scales of disciplinary practices was defined as “prevalence in past-year”, which had a dichotomous scoring code of 1, when the act occurred once or more in the past year or 0, when the act did not occur in past year. Response category 0, 1, 2, 3, 4, 5, 6 and 9 were recoded into 0=0, 1-6=1 and 9=missing respectively. If mother reported that it happened before but not in the past year, this was recoded

as did not occur in the past year. Annual frequency was designated as “frequency in past year score”, which was defined as the number of times an act of discipline in a particular scale was performed during past year. Derivation of frequency score involved recoding the response categories of each parental disciplinary scale into estimated midpoints of every response category to indicate the number of times in past year. Midpoints were the same as the response category numbers for categories 0, 1, and 2. For category 3 (3-5 times) the midpoint is 4, for category 4 (6-10 times) it is 8, for category 5 (11-20 times) it is 15, and for category 6 (>20 times in past year) it is 25.

The child version of CTSPC, suitable for children of 7 years and older was administered by a trained interviewer in a private setting. As each item was presented in the form of pictures depicting acts of maltreatment or non-violent discipline practices, the interviewer read a description such as “This child’s mother shook her when she did something wrong. When you do something wrong, does your mother shake you?” If the response was positive, the interviewer presented a second card that showed the response categories in the form of stacked circles that the child could point to. Answers to the child-report form items were rated using a 5-point Likert-type scale, ranging from “Never” to “Always”, with higher scores indicating higher occurrence of the parental act. To calculate an estimate of prevalence, reports for each item were recoded in never vs. it happened at least once. Additionally, to estimate chronicity from children’s reports we have assumed a similar procedure to the scales administered to mothers. Thus, each item in the 5-point Likert scale assumed an estimated frequency (1=1; 2=2; 3=4; 4=8; 5=15). The mean ($\pm$ standard deviation) was then presented for each item and for each sub-scale.

Covariates: Social and-demographic characteristics of participants were considered, such as parent’s immigration status (classified as both parents migrants, both parents Portuguese born, a parent migrant and the other Portuguese born), age, marital status (married/committed relationship or separated/divorced), education (less vs. equal and greater than 9 years), employment status (employed vs. unemployed), household income categorized based on euros/month as low (≤ 1000), medium (1001-2500) or high income (>2500). Family structure was classified as nuclear (i.e., two-parent families) and non-nuclear (e.g. single-parent family, extended family or stepfamily). Other covariates included child’s sex and age at the time of evaluation.

Statistical analysis

Descriptive analysis of socio-demographic characteristics and comparison of all CTSPC responses were done according to the maternal country of birth (Portuguese and non-Portuguese). Proportions were compared using Pearson's chi-square or Fisher's exact test for categorical variables, as appropriate. Continuous variables are presented as means ($\pm$ standard deviation) and compared with one-way Analysis of Variance (ANOVA) or the Mann Whitney test. Data were analyzed using Statistical Package for Social Sciences (SPSS), version 23.0 (IBM® SPSS®, Armonk, NY, USA).

Results

Socio-demographic characteristics

A total of 5277 child-mother pairs (Table 1) were evaluated consisting of 5122 Portuguese born (97.1%) and 155 migrant (2.9%) mothers. Mean age at arrival in Portugal of migrant mothers was 22.2 ± 6.75 years. Both parents were migrant in 67.1% of the families with a migrant mother and at seven years follow-up, their median length of residence in Portugal was 13.0 years. At evaluation the children averaged 85 months for both maternal categories. Distribution of household income was similar with 30.8% of Portuguese and 38.5% of migrants having low income (≤ 1000 Euros/month). Irrespective of maternal country of birth, the mothers and fathers were the primary and secondary caregivers for $>95\%$ and $>85\%$ of children. Mean maternal and paternal age were respectively 36.8 ± 5.29 and 38.9 ± 5.64 years for Portuguese parents and 37.3 ± 4.98 years and 40.3 ± 5.98 years for migrants.

Most ($>85\%$) primary caregivers were married or in a committed relationship. Prevalence of current smoking among primary caregivers was 20.6% for migrants and 24.3% for Portuguese. The proportion of Portuguese primary caregivers that had >9 years education was 59.7% while it was 85.2% for migrants; 77.4% and 71.0% of Portuguese and migrant primary caregivers, respectively, were employed. Current smoking prevalence was 39.3% among the Portuguese and 34.0% in migrants.

Past year prevalence of disciplinary practices scale and items

Portuguese and migrant mothers similarly reported more of non-physical discipline practices (Table 2) while children's report of physical disciplinary strategies was greater than for their mothers. Almost all mothers reported at least one form of disciplinary act on their children during the preceding year. Both maternal and

child responses showed a high prevalence of non-violent discipline (>85.0%), psychological aggression (>75.0%) and corporal punishment (>70.0%) by Portuguese or migrant mothers. The migrant mothers (33.1%) reported more acts of hitting the child on the bottom with something like a belt, hairbrush, stick, or some other hard object, as compared with Portuguese mothers (18.9%). There is a significant difference between Portuguese (73.7%) and migrant (50.3%) mothers who threatened to spank or hit the child but did not actually do it. Differences in the proportions of slapping the child on the hand, arm, or leg (63.5 and 49.0%), pinched the child (11.1 and 16.9%) and slapped the child on the face or head or ears (36.8 and 26.7%) were also observed between Portuguese and migrant mothers.

Prevalence of severe and extreme physical assault was generally low according to maternal self-reporting for Portuguese (6.2 and 3.5%) and migrant (7.6 and 6.7%). The migrant children reported greater proportions (9.9%) for severe physical assault compared to the Portuguese (8.2%). But the response of Portuguese children (19.8%) significantly differs from that of migrant (25.9%) regarding maternal application of extreme physical assault.

Past year chronicity for disciplinary practices scale and items

Maternal and child reports of past year chronicity varied for different forms of parental disciplinary scales (Table 3). Disciplinary scale with highest chronicity item is the maternal response about child's non-violent form of discipline in Portuguese (35.4 ± 23.52 times/year) and migrant mothers (32.6 ± 22.64 times/year). Spanking of child on the bottom with a bare hand is physical assault with the highest chronicity score based on maternal and children's responses. Maternal responses about severe and extreme physical assault were averagely less than one occurrence in past year, while children reported mean of ≥ 3 times/ year. This was significantly different for children's response about the maternal use of severe physical assault among Portuguese (3.4 ± 1.86 times/year) and migrants (3.5 ± 2.12 times/year). There was also a difference between Portuguese (4.8 ± 2.53 times/year) and migrant (5.1 ± 2.37 times/year) children's response about the maternal use of extreme physical assault. Specifically, children reported an average of 2 times/ year of being beaten up, hit over and over as hard as they could by their mothers.

Discussion

This study compared parental disciplinary practices of Portuguese and migrant mothers from both the maternal and the child perspectives. Portuguese and migrant families differ in the expression of severe and

extreme physical assault. Maternal responses were characterized by high past year prevalence of non-violent discipline, psychological aggression and corporal punishment. Migrant children compared to their Portuguese peers reported higher prevalence of maternal use of extreme physical assault.

Physical and verbal punishments of children are common in high-, middle, and low-income communities across the world.(Hillis, Mercy, Amobi, & Kress, 2016; Runyan et al., 2010) Hence, promoting the global aim of decreasing parental violence against children requires legal reforms and institution of primary prevention methods.(Peltonen, Ellonen, Poso, & Lucas, 2014) As of 2012, twenty-three of the forty-seven Council of Europe countries have passed laws prohibiting the use of corporal punishment within the home with Estonia, Malta, Ireland, Macedonia, Lithuania and Slovenia joining later.(General, 2013) Although, a similar law prohibiting the use of any form of corporal punishment against children was enacted in Portugal since 2007.(Portuguesa, 2007) Our study showed a prevalence of corporal punishment by mothers similar to that observed in other jurisdictions that indicate the limited effect of legislation on changing public views regarding corporal punishment.(Roberts, 2000; Ryan, Kalil, Ziol-Guest, & Padilla, 2016) Nevertheless, it is noteworthy that odds of having parents who occasionally or frequently used corporal punishment were 1.7 times higher in countries where its use is unbanned, after controlling for socio-demographic factors.(duRivage et al., 2015) This reinforces the significance of having a legal framework and identification of risk factors associated with violent behaviour among parents so as to facilitate targeted population approaches for prevention.(Peltonen et al., 2014)

Parental immigration status has been recognized as a risk factor for child abuse among immigrant and refugee families.(LeBrun et al., 2016) In this study, we observed similarities in non-physical forms and variation in some physical modes of disciplinary practices between migrant and native Portuguese families. Portugal is not racially and ethnically diverse country, but our findings on physical forms of discipline does not fully align with a European country like Netherlands or socially assorted country like the United States, which showed higher rates of severe physical assaults for migrants and minority groups.(Straus, 1994; Theunissen et al., 2015) It has been recognized that work or family-related stress and lack of help in dealing with parenting problems have been detected as risk factors for severe violent acts toward one's own child.(Peltonen et al., 2014)

There is “generational consonance” within the family when the level of acculturation is consonant for parents and children whereas children of generationally dissonant families have increased likelihood of poor parental outcomes because of parental inclination for unsupportive parenting techniques.(Weaver & Kim, 2008) Participant migrant mothers averagely arrived when they were over 18 years and have resided for over a decade in the country. We expected that the period of residence would have intensified assimilation and adaptation to Portuguese cultural milieu. But from a developmental perspective, it has been shown that maternal age at arrival impacted on parenting styles of immigrants.(Glick, Hanish, Yabiku, & Bradley, 2012) Mothers arriving in adulthood reflect greater exposure to parenting styles of their country of birth, which enabled them to better differentiate the nuances in parenting that vary from culture to culture.(Glick et al., 2012) Our results showed a higher rate of parental physical abuse among the immigrant group, which may be attributed to cultural differences. Acculturation gap between children and their parents could lead to parents losing control over their children, which may put some parents at increased risk of using more rigid discipline strategies.(Dettlaff, Earner, & Phillips, 2009) Yet again it has to be recognized that the disciplinary approaches used by migrant parents could express a common feature in their country of birth.

We observed a disparity between children and maternal reports on the occurrence of severe and extreme physical assault. Irrespective of maternal country of birth children tended to report higher prevalence than their parents on these disciplinary acts, an observation that is in consonance with previous studies.(Ashton, 2001; Fuhua & Qin, 2009; Mackenbach et al., 2014) However, it may not entirely apply to our setting as it has been earlier documented that parents that approved of physical forms of discipline were less likely to report maltreatment.(Ashton, 2001) Additionally, children’s obedience to parents and families’ invisibility to authorities has been thought to be coexisting factors that might prohibit child maltreatment from being disclosed to authorities.(Fuhua & Qin, 2009)

Participants of this study are members of a birth cohort assessed for discipline practices during mid-childhood. It will be remarkable that future evaluations investigate their mental health as well as disciplinary practices towards their offspring and also compare with that of their parents. Indeed, there is international variation in harsh child discipline between and within countries, and the cardinal role of difference in family child-rearing practices has been identified.(Runyan et al., 2010) Our findings have important lessons and implications towards creating awareness for halting unwholesome parental disciplinary practices. This raises concerns of negative parental disciplinary approaches and accentuating role of health system in helping

families develop effective disciplinary practices tailored to their context and needs.(Barkin, Scheindlin, Ip, Richardson, & Finch, 2007)

Strength and limitation of the study

The major strength of this study is the multiple and simultaneous informant measurement of parental discipline by mothers and children. Especially, the inclusion of child reports that estimate physical forms of parental discipline more accurately.(Mackenbach et al., 2014) Although, the total sample size is large, the proportion of foreign-born mothers was comparably small. Considering that migrant families were dissimilar from Portuguese for certain aspects of disciplinary scales, the small sample size of the migrant population could be a limitation for generalization of our findings and did not allow a detailed assessment of variables such as country of origin. Nonetheless, the findings are relevant for inference within the context of Portugal since the national population distribution of migrants in the country at the time of the study is analogous to that of our study sample. Precisely, Generation XXI birth cohort represents 54.6% of all births during participant recruitment (2005-2006) in the Porto metropolitan area, which contributed to 10% of all deliveries in Portugal for the same period.

Conclusions

Majority of mothers used at least one form of disciplinary acts on their children during the preceding year. Past year prevalence of corporal punishment by all maternal categories is high. Mothers reported a low prevalence of severe and extreme physical assault. But migrant and Portuguese children reported greater proportions of severe and extreme physical assault. Migrant compared to Portuguese children reported higher prevalence and chronicity of maternal application of extreme physical assault.

Keypoints

- Almost all mothers performed at least a form of disciplinary act on their children during the preceding year.
- Past year prevalence of corporal punishment by all maternal categories is high
- Portuguese and migrant mothers similarly reported more of non-physical disciplinary practices. While the children's record about prevalence and chronicity of physical disciplinary practices were greater than maternal responses

- Migrant compared to Portuguese children reported higher prevalence of maternal application of extreme physical assault. This reinforces the significance of identifying risk factors associated with violent behaviour among parents so as to facilitate targeted population approaches for prevention.

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Declaration of interest

The authors declare that they have no competing interests.

Author contribution

MK and HB conceived and designed the study and analysis. MK and AC generated the dataset. MK and SF performed the analyses and drafted the manuscript. HB reviewed, edited and revised the manuscript as well as supervised all the processes. All authors interpreted the data and revised the manuscript critically for intellectual content. Finally, all the authors read and approved the final version.

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Table 1. Socio-demographic characteristics of index child and family by maternal country of birth

	Portuguese	Migrant	p-value
Immigration status of parents, n (%)			
Both parents are migrants	0 (0.0)	104 (67.1)	<0.05
Both parents are Portuguese	2727 (53.2)	0 (0.0)	
A parent Is migrant and the other is Portuguese	2329 (46.8)	51 (32.9)	
Child's age in months (mean $\pm$ sd) at 7 years evaluation	85.1 $\pm$ 2.80	85.1 $\pm$ 3.22	0.881
Sex, n (%)			
Female	2485 (48.5)	79 (51.0)	0.569
Male	2637 (51.5)	76 (49.0)	
Family structure (Nuclear)	3081 (82.8)	93 (77.5)	0.142
Household income (euros/month)			
Low ($\leq$ 1000)	1051 (30.5)	39 (37.5)	0.127
Medium (1001-2500)	2155 (62.5)	55 (52.9)	
High (>2500)	240 (7.0)	10 (9.6)	
Primary caregiver (Biological mother)	5089 (99.5)	155 (100.0)	1.000
Maternal age (mean$\pm$sd years) at seven years evaluation	36.8 (5.29)	37.3 (4.98)	0.199
Marital status of primary caregiver (Married/committed)	4457 (87.1)	132 (85.2)	0.147
Educational level of primary caregiver (>9 years)	3055 (59.7)	132 (85.2)	<0.05
Employment status of primary caregiver (Employed)	3959 (77.4)	110 (71.0)	0.079
Smoking status of primary caregiver			
Current smoker	1239 (24.3)	32 (20.6)	0.152
Former smoker	723 (14.2)	16 (10.3)	
Never smoked	3143 (61.6)	107 (69.0)	
Secondary caregiver (Father)	4453 (87.0)	136 (87.7)	
Paternal age (mean $\pm$) at seven years evaluation	38.9 (5.64)	40.3 (5.98)	<0.05
Educational level of secondary caregiver (>9 years)	2540 (49.6)	113 (72.9)	<0.05
Employment status of secondary caregiver (Employed)	4196 (84.0)	130 (87.8)	0.406
Smoking status of secondary caregiver			
Current smoker	1955 (39.3)	50 (33.6)	0.222
Former smoker	862 (17.3)	24 (16.1)	
Never smoked	2155 (43.3)	75 (50.3)	

NA=Not applicable; Some variables have missing cases

Table 2. Prevalence rate in past year for disciplinary practices scale and item according to maternal country of birth

Scale and item, n (%)	Maternal response about child		Child response about mother	
	Portuguese	Migrant	Portuguese	Migrant
Non-violent discipline	5064 (99.2)	154 (99.4)	4668 (88.8)	144 (88.9)
Explained why something was wrong	4946 (97.3)	148 (96.7)	3838 (74.2)	120 (75.0)
Put the child in time out (or sent to child's room)	4116 (81.0)	131 (86.2)	2761 (53.0)	89 (54.9)
Gave the child something else to do instead of what the child was doing wrong	3529 (72.3)	100 (70.4)	1840 (35.6)	57 (35.6)
Took away privileges or grounded the child	3744 (75.1)	112 (74.7)	1109 (21.3)	42 (25.9)
Psychological aggression	4932 (97.0)	145 (95.4)	4024 (76.6)	126 (77.8)
Shouted, yelled, or screamed at the child	4749 (93.9)	140 (92.7)	3384 (65.0)	113 (69.8)
Swore or cursed at the child	262 (5.3)	13 (8.8)	810 (15.5)	24 (14.9)
Said you would send the child away or kick the child out of the house	275 (5.5)	10 (6.7)	90 (1.7)	3 (1.9)
Threatened to spank or hit the child but did not actually do it	3672 (73.7)	76 (50.3)**	2333 (44.9)	68 (42.5)
Called the child stupid or lazy or some other name like that	2085 (41.8)	62 (41.9)	386 (7.4)	13 (8.0)
Corporal punishment	4741 (93.5)	141 (91.6)	3969 (75.5)	116 (71.6)
Shook the child	1683 (33.4)	52 (34.2)	265 (5.1)	9 (5.6)
Hit the child on the bottom with something like a belt, hairbrush, stick, or some other hard object	956 (18.9)	50 (33.1)**	695 (13.3)	20 (12.3)
Spanked the child on the bottom with your bare hand	4493 (89.3)	134 (87.6)	3143 (60.3)	92 (56.8)
Slapped the child on the hand, arm, or leg	3150 (63.5)	71 (49.0)**	1606 (30.9)	52 (32.3)
Pinched the child	554 (11.1)	25 (16.9)*	326 (6.2)	11 (6.8)
Slapped the child on the face or head or ears	1843 (36.8)	40 (26.7)*	2059 (39.6)	63 (39.1)

Physical assault-Severe	307 (6.2)	11 (7.6)	430 (8.2)	16 (9.9)
Hit the child with a fist or kicked him/her hard	161 (3.2)	6 (4.0)	112 (2.1)	5 (3.1)
Hit the child on some other part of the body besides the bottom with something like a belt, hairbrush, a stick, or some other hard object	176 (3.5)	6 (4.0)	306 (5.9)	14 (8.6)
Threw or knocked him/her down	40 (0.8)	1 (0.7)	60 (1.1)	2 (1.2)
Physical assault-Extreme	177 (3.5)	10 (6.7)	1039 (19.8)	42 (25.9)*
Grabbed him/her around the neck and choked him/her	83 (1.7)	3 (2.0)	79 (1.5)	1 (0.6)
Beat him/her up, that is you hit him/her over and over as hard as you could	63 (1.3)	5 (3.3)	971 (18.6)	42 (26.1)*
Burned or scalded child on purpose	30 (0.6)	1 (0.7)	15 (0.3)	0
Threatened the child with a knife or gun	28 (0.6)	1 (0.7)	6 (0.1)	0

**P-value<0.01; *P-value<0.05

Table 3. Past year chronicity for disciplinary practices scale and item according to maternal country of birth

Scale and item, mean ($\pm$ sd)	Maternal response about child		Child response about mother	
	Portuguese	Migrant	Portuguese	Migrant
Non-violent discipline	35.4 (23.52)	32.6 (22.64)	12.7 (8.39)	13.5 (9.90)
Explained why something was wrong	16.6 (9.03)	15.8 (9.48)	5.2 (4.85)	5.4 (5.02)
Put child in time out (or sent to child's room)	6.7 (7.66)	6.2 (7.25)	3.2 (3.28)	3.3 (3.53)
Gave child something else to do instead of what child was doing wrong	6.8 (8.08)	6.5 (8.41)	2.6 (3.17)	2.8 (3.55)
Took away privileges or grounded child	6.0 (7.47)	5.2 (7.24)	1.8 (2.15)	1.9 (2.48)
Psychological aggression	20.5 (16.94)	17.4 (15.97)	10.8 (6.94)	10.7 (6.24)
Shouted, yelled, or screamed at child	12.4 (9.32)	11.5 (9.19) **	4.0 (3.82)	4.1 (3.40)
Swore or cursed at child	0.2 (1.22)	0.4 (1.65)	1.6 (2.04)	1.7 (2.41)
Said you would send child away or kick child out of the house	0.1 (0.84)	0.2 (0.83) **	1.1 (0.67)	1.0 (0.34)
Threatened to spank or hit child but did not actually do it	6.3 (8.28)	4.0 (7.35)	2.8 (2.98)	2.6 (2.66)
Called child stupid or lazy or some other name like that	1.9 (4.08)	1.8 (3.73)	1.3 (1.28)	1.3 (1.29)
Corporal punishment	14.5 (15.93)	13.4 (16.48)	12.2 (7.56)	12.0 (7.96)
Shook child	1.5 (3.80)	1.6 (3.98)	1.2 (1.29)	1.3 (1.41)
Hit child on the bottom with something like a belt, hairbrush, stick, or some other hard object	0.7 (2.51)	1.2 (2.97) **	1.6 (1.92)	1.5 (1.92)
Spanked child on the bottom with your bare hand	7.6 (7.67)	6.8 (7.55)	3.7 (3.63)	3.4 (3.41)
Slapped child on the hand, arm, or leg	3.4 (5.34)	2.8 (5.94)	2.1 (2.28)	2.3 (2.90) *
Pinched child	0.4 (2.00)	0.6 (1.58)	1.2 (1.04)	1.2 (0.66)
Slapped child on the face or head or ears	1.2 (2.95)	0.8 (2.10)	2.5 (2.71)	2.4 (2.46)
Physical assault-Severe	0.3 (1.82)	0.4 (2.70)	3.4 (1.86)	3.5 (2.12) *

Hit child with a fist or kicked him/her hard	0.1 (1.29)	0.1 (0.44)	1.1 (0.85)	1.2 (1.19) *
Hit child on some other part of the body besides the bottom with something like a belt, hairbrush, a stick, or some other hard object	0.1 (1.15)	0.1 (1.25)	1.2 (1.29)	1.3 (1.48)
Threw or knocked him/her down	0.01 (0.27)	0.2 (2.04) **	1.0 (0.54)	1.0 (0.33)
Physical assault-Extreme	0.1 (1.20)	0.2 (1.39)	4.8 (2.53)	5.1 (2.37)
Grabbed him/her around the neck and choked him/her	0.05 (0.75)	0.04 (0.34)	1.1 (0.67)	1.1 (0.24)
Beat him/her up, that is you hit him/her over and over as hard as you could	0.03 (0.43)	0.1 (1.27) **	1.8 (2.19)	2.0 (2.34) *
Burned or scalded child on purpose	0.02 (0.53)	0.01 (0.08)	1.0 (0.33)	1.0 (0.00)
Threatened child with a knife or gun	0.01 (0.39)	0.01 (0.08)	1.0 (0.37)	1.0 (0.00)

**P-value<0.01; *P-value<0.05

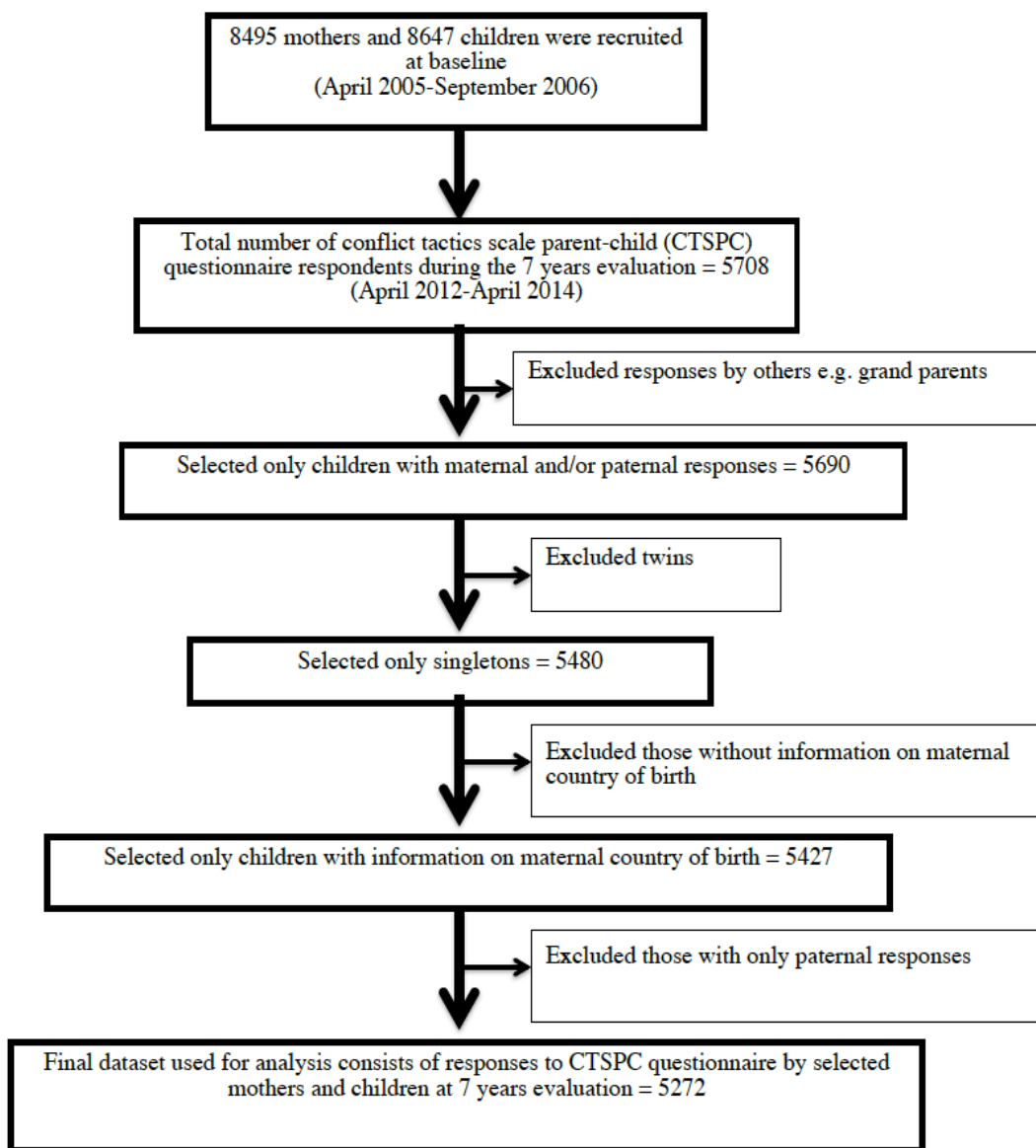


Figure 1. Participant selection flowchart, Generation XXI birth cohort

Supplementary figure: Participant selection flow chart



4. Discussion

This study comprehensively investigated person, place and time contexts in the growth and development of second-generation migrant children in Portugal. In the migration timeline second-generation migrant children are born to foreign-born mothers, subsequently they grow in an environment different from that of their ‘parents upbringing’. In the present study we hypothesized that there was no difference in growth and development of migrant and native children. Using cross-sectional and longitudinal observations we explored influences and interactions of socio-demographic characteristics and behaviour (person), intra-uterine and external environment (place and time) concurrently during pregnancy, birth and follow-up until seven years.

Firstly, we used a Portuguese population birth cohort to compare risk factors and prevalence of adverse pregnancy outcomes in native Portuguese and migrants. Additionally, we determined the association between maternal country of birth and adverse pregnancy outcomes. Our findings indicate similarity in most biological, obstetric and socio-demographic factors between native Portuguese and migrants. There were also differences in the distribution of certain categories of key risk factors like maternal age, education, employment, parity, pre-gestational body mass index and pregnancy weight changes, smoking during pregnancy, prenatal care (timing of first visit and frequency of visits) and caesarean section delivery. These risk factors can, independently or interacting with others, influence adverse pregnancy outcomes. Indeed, the results of this study showed that migrants presented a lower risk of some adverse pregnancy outcomes (low birthweight and small for gestational age), even after adjustment for those important covariates. Thus, suggesting a “healthy migrant effect” because of better indicators in the migrants.

We noted that migrant mothers presented a relatively low median residency time in Portugal but those that recently arrived were similar to those with lengthier stay regarding well recognized risk factors of adverse pregnancy outcomes. It is plausible that relevant exposures of host country have not become sufficiently exertive. Although, the native Portuguese mothers had greater risk of LBW and SGA than the migrants. The risk factors for adverse pregnancy outcomes were not uniformly higher for native Portuguese mothers. A higher caesarean section rate was observed among the migrants of the GXXI birth cohort, which is accounted by the preference for this delivery method in Brazilian mothers as documented.[159] In the context of the study setting and time of the study, the Brazilians constituted half of migrant population in

the GXXI birth cohort. Their predominant representation in the migrant population is mainly due to historical, linguistic and cultural ties of their country with Portugal, which facilitated migratory movements.

Our second study investigated the 20 years trend of risk factors for adverse pregnancy outcomes in Portuguese and non-Portuguese mothers using the national birth registry data of Portugal. The primary objective was to compare the mediators of differences in adverse pregnancy outcomes in Portuguese and non-Portuguese. Additionally, we examined time trends of risk factors for public health surveillance and programming. We found that over the last two decades the proportion of live births by non-Portuguese especially Brazilians has increased but the constitution of the modal immigrant nationalities has remained stable. We observed divergent trends and rate of change in the evolution of the selected socio-demographic and obstetric factors in Portuguese and non-Portuguese. There were no similarities in the trends of preterm birth and low birthweight prevalence among Portuguese and non-Portuguese in this study. The average age of Portuguese mothers significantly changed with concurrently appreciation in the proportion of mothers that were aged ≥ 35 years. The caesarean section rate among non-Portuguese significantly increased and this has been associated with Brazilian preference for this mode of delivery.[22]

In the 20 years period we observed an increase in proportion of live births by non-Portuguese. Even though we did not detect any significant change in source countries. There could have been a cohort or period effect on the risk factors of adverse pregnancy outcome in migrants. The different wave of immigrants is indicative that new immigrants and those with lengthier duration of residence could differ in maternal risk profile. Typically, those with longer duration of residence in host country are associated with social integration and adoption of similar lifestyle choices (e.g. smoking) as the natives.[160] Nevertheless, foreign-born status being associated with adverse birth outcomes could be observed in better-educated mothers, which is the opposite of healthy immigrant effect and known as epidemiological paradox.[161] The results of this study have shown that in 2000-2014 there is an increase rate of the prevalence of tertiary educated and ≥ 35 years mothers among the non-Portuguese.

In our third study we investigated the impact of the 2007-2008 global financial crisis on low birthweight (LBW) in Portugal. Our results showed that between 1995 and 2014 Portugal has been experiencing an upward but unequal trend in singleton low birthweight, described by three distinct periods that escalated

after 2007-2008. This development is concurrent with macro-economic and socio-demographic transformations in the country. The broad interval of observation (1995-2014) enabled the detection of the transformation of low birthweight rate in babies of non-Portuguese mothers, which indicated a period of decline (2000-2006) and an upsurge (2007-2014). There was an overall increase in the proportion of low birthweight births but its time-based distribution in babies of non-Portuguese mothers showed a gradient different from their Portuguese peers.

At the time of publication, our third study has no documented precedence of demonstrating parallel LBW trends for migrant and native European women before and after the 2008 global financial crisis. It is possible that the economic crisis affected them differently or they reacted differently to it. The plausible explanation for this variation may be in their contrasting LBW risk factors and the reactionary modification after recession. Possibly, there was a loss of the healthy immigrant effect in the context of a worse impact of the economic crisis on immigrants. It has been proposed that the interaction of fiscal austerity with economic shocks and weak social protection is what ultimately seems to escalate health and social crises in Europe

Our fourth objective was to assess the effect of maternal country of birth on breastfeeding practices among mothers of the Portuguese population birth cohort we studied in objective one. We observed that proportion of those that initiated any and exclusive breastfeeding were similar for foreign and native-born mothers. However, migrant mothers had longer duration of any and exclusive breastfeeding. Furthermore, the length of residence in Portugal by migrant mothers does not negatively impact on the breastfeeding duration.

Our findings showed that migrant mothers irrespective of their length of residence in Portugal breastfed (any breastfeeding or exclusive breastfeeding) for longer periods than their native peers, which is contrary to the observation of some studies [162-164]. Specifically, the African-born women averagely had lengthier period of residence in Portugal but breastfeed for longer duration compared with other migrant mothers. This negates the notion that acculturating to host country could negatively influence migrant mother's breastfeeding practices, especially those coming from settings with higher breastfeeding rates than Western nations [163]. Our observation is not unusual because acculturation has been reported as not having an

influence on breastfeeding for particular migrant groups [165, 166]. Basically, certain traditional beliefs facilitate positive breastfeeding practices that persist for longer period especially in migrants from cultural backgrounds, which western breastfeeding practices was unknown or perceived as unacceptable[167]. On the contrary, it has been shown that post-migration, immigrant breastfeeding rates tends to converge towards native-born rates of breastfeeding as length of residence in host country increases [162].

In the fifth study, we tracked blood pressure of children of the GXXI birth cohort between 4 and 7 years. Additionally, we determined prevalence of hypertension and its predictors at 4 and 7 years. Our results showed that variation in mean systolic and diastolic blood pressure between these two milestones during middle childhood was similar for male and female children. Proportion of females having elevated systolic blood pressure in both evaluations was twice that for males. Compared with females, prevalence of diastolic pre-hypertension and hypertension was greater in males in both evaluations. Among male participants, prevalence of systolic and diastolic pre-hypertension and hypertension was greater in seven years than four years evaluation. It is only in the prevalence of diastolic pre-hypertension and hypertension that a similar observation was made among females. We did not observe a chronological order in the expression of the predictive role of prenatal and postnatal factors. Obesity is the only significant predictor of hypertension at 4 and 7 years. The association between other factors and hypertension is manifested differently at either 4 or 7 years. Although insignificant, the risk of hypertension was greater in non-Portuguese children at 4 years. The association between maternal country of birth and hypertension is diminished at 7 years.

Acculturation has been known to affect migrants in their attitudes and behaviour. In the sixth objective study we compared parental disciplinary practices of Portuguese and migrants from the maternal and child perspectives. Apart from differences in specific subscales, the similarity in socio-demographic characteristics of migrant and native Portuguese families could partly account for the results observed in most of the parental disciplinary scales. Portuguese and migrant families differ in the expression of severe and extreme physical assault. Maternal responses about were characterized by high past year prevalence of non-violent discipline, psychological aggression and corporal punishment. Migrant children compared to their Portuguese peers reported higher prevalence of maternal application of extreme physical assault.

Parental immigration status has been recognized as a risk factor for child abuse among immigrant and refugee families.[168] In this study, we observed similarities in non-physical forms and variation in some physical modes of disciplinary practices between migrant and native Portuguese families. Portugal is not racially and ethnically diverse country, but our findings on physical forms of discipline does not fully align with a European country like Netherlands or socially assorted country like the United States, which showed higher rates of severe physical assaults for migrants and minority groups.[169, 170] It has been recognized that work or family-related stress and lack of help in dealing with parenting problems have been detected as risk factors for severe violent acts toward one's own child.[171]

Public health implications and future direction of research

Our study has recognized the predictive role of maternal country of birth not currently included in the national birth register of Portugal. The articulation of a comprehensive causal framework is important for a detailed investigation of the aetiological process of the impact of contextual occurrences like the economic crisis on perinatal health indicators. This would have augmented our explanation of LBW trend and its intermediary factors. Our finding underscores the limitation in sufficiency for some other important indicators not in the current birth register. Availability of the factors is required to exhaustively explain causal mechanisms for temporal changes in adverse pregnancy outcomes. Monitoring of these relevant risk factors will require inclusion in routine perinatal health surveillance system or innovative approaches involving clinical data linkage with the birth registration system. Consequently, future studies can be designed to examine feasibility of routine monitoring of additional aetiological factors for adverse pregnancy outcomes.

Immigrants being a heterogeneous group represent different cultures and risk factor profile.[61] The association between migration and adverse birth outcomes varies by immigrant subgroup and it is sensitive to the definition of the migrant and reference groups.[61] Hence, specific studies will be needed on immigration status (documented, non-documented immigrant, refugees, asylum seekers), language fluency and ethnicity as defined by maternal place of birth and duration of residence.[172] There is evidence consistent about differential access to and utilisation of health services among ethnic minority mothers, regardless of migrant status, in particular recently arrived migrants, refugees and asylum seekers.[173] Hence, attention should be given to the specific mechanisms linking maternal risk factors to poor pregnancy

outcomes for specific racial/ethnic groups.[174] Awareness of differing risks and health needs would assist provision of appropriate pregnancy care to improve the health of women with greater risk and their babies [175]

An important public health implication of our study is that the duration of any breastfeeding and exclusive breastfeeding were below WHO recommendations in native Portuguese and migrant mothers. Thus, we recommend intensive breastfeeding promotion for all maternal categories especially for the employed to whom adequate condition to continue breastfeeding should be provided. Breastfeeding education during prenatal and post-natal care should be emphasized because of its effectiveness at enhancing breastfeeding initiation and duration [176]. In Portugal, there is universal healthcare for women irrespective of immigration status. This is relevant for immigrants because migration isolates women but health professionals could serve as a major source of information on breastfeeding [177]. More so for recently arrived migrant mothers arriving at a time characterized by multiple challenges to breastfeeding practices in contemporary European context. Finally, future research can improve understanding of the exact role of maternal country of birth in breastfeeding. It is fundamental to explore acculturation pathway to explain healthy migrant effects by comparing breastfeeding practices in source countries with that of first and second-generation migrant as well as native-born mothers.

Participants of this study are members of a birth cohort assessed during mid-childhood. It will be remarkable that future evaluations investigate their mental health as well as disciplinary practices towards their offspring and also compare with that of their parents. Indeed, there is international variation in harsh child discipline between and within countries, and the cardinal role of difference in family child-rearing practices has been identified.[178] Our findings have important lessons and implications towards creating awareness for halting unwholesome parental disciplinary practices. This raises concerns of negative parental disciplinary approaches and accentuating role of health system in helping families develop effective disciplinary practices tailored to their context and needs[179]

5. Conclusions

In conclusion, there is difference between migrants and native Portuguese depending on specific factors as well as their stage of growth and development. Comparison of prenatal and intra-uterine factors showed that native Portuguese and migrants have variations in distribution of categories of maternal age, education, and employment, parity, and smoking during pregnancy, prenatal care (timing of first and frequency of consultations) and type of delivery. We observed an association between maternal country of birth and adverse pregnancy outcomes. Migrant mothers had a lesser risk of low birthweight and small for gestation, which suggests a healthy immigrant effect. This association is not significantly affected by other risk factors of adverse pregnancy outcomes.

Time change evaluation of the last two decades indicated that proportion of live births by non-Portuguese especially Brazilians has increased in Portugal. Time changes in selected socio-demographic and obstetric factors were characterized by divergent trends and rate of change for Portuguese and non-Portuguese mothers between 1995-2014. There was a significant increase in the proportion of mothers that were aged ≥ 35 years and tertiary educated. Among non-Portuguese multiparity became less frequent, while caesarean section rates appreciated. The sufficiency of the birth registry for perinatal surveillance is limited because some individual-level risk factors, which could assume aetiological relevance as time changed, are not currently measured.

A remarkable contextual occurrence we observed is that the 2007–2008 global financial crisis is associated with increased LBW occurrence in Portugal, which was more evident in infants of non-Portuguese mothers. It is not possible to conclusively propose a mediatory mechanism on how the financial crisis resulted in a higher rate of LBW and to what extent the resilience of available health and social responses buffered the effect of adverse individual or social level exposures. Further research will be required to improve the understanding of the role of particular factors, such as maternal nationality, fertility behaviour and the amplification of late maternity, substance abuse and mental stress, in the variation of LBW during periods of economic depression. The continuous monitoring of relevant risk factors, the quality assurance of the process and information on further indicators, as part of data routinely collected by the national birth registration system, are essential. We recommend strengthening of social policies aimed at maternity protection for non-Portuguese, working and other vulnerable mothers. The health system should sustain its capacity to effectively maintain social equity in perinatal healthcare access, utilization and quality.

We noted that maternal country of birth influences breastfeeding duration but not its initiation among mothers of Generation XXI birth cohort. Migrant mothers have longer duration of exclusive or any breastfeeding, which was not changed by length of residence in Portugal. However, the duration of breastfeeding is below recommended duration in both native and foreign-born mothers. We recommend intensive promotion of breastfeeding for all categories of mothers especially the employed to whom adequate condition to continue breastfeeding should be provided.

Variation in mean blood pressure between 4 and 7 years was similar for male and female children. In both evaluations, proportion of females with hypertension was greater than for males. Among male participants, prevalence of systolic and diastolic pre-hypertension and hypertension was greater in seven years than four years evaluation. Among females, we noted this observation for only diastolic pre-hypertension and hypertension. Obesity is the only significant predictor of hypertension at 4 and 7 years. At both milestones, maternal country of birth is not associated with hypertension.

At seven years, majority of mothers performed at least a form of disciplinary acts on their children during the preceding year. Past year prevalence of corporal punishment by all maternal categories is high. Mothers reported a low prevalence of severe and extreme physical assault. But migrant and Portuguese children reported greater proportions of severe and extreme physical assault. Migrant compared to Portuguese children reported higher prevalence and chronicity of maternal application of extreme physical assault.

6. References

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7. Appendices

Exmo. Senhor
Mestre Musa Abubakar Kana
musakana77@yahoo.com

v.referência	v.comunicação	n.referência	data
		FOA.26. <u>4087</u> .2018	07 JUN 2018
assunto			
Provas de Doutoramento.			

Informo V. Ex^a. que, por meu despacho de 2018.06.05, proferido no âmbito de delegação reitoral, nomeei o júri das provas de doutoramento em Saúde Pública, requeridas por V. Ex^a., com a seguinte constituição:

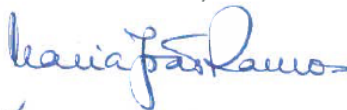
Presidente: Doutor José Carlos Neves Cunha Areias, Professor Catedrático da Faculdade de Medicina da Universidade do Porto (nomeado por despacho reitoral de 2018.06.04)

Vogais:

- Doutor Ronald LaPorte, Professor Emeritus da University of Pittsburgh, USA;
- Doutora Sónia Maria Ferreira Dias, Professora Associada com Agregação do Instituto de Higiene e Medicina Tropical da Universidade Nova de Lisboa;
- Doutora Sofia Gonçalves Correia, Investigadora Auxiliar do ISPUP - Instituto de Saúde Pública da Universidade do Porto;
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- Doutora Teresa Maria Alves Rodrigues, Professora Auxiliar Convidada da Faculdade de Medicina da Universidade do Porto.

Com os melhores cumprimentos,

A Vice-Reitora,



(Prof.ª. Doutora Maria João Ribeiro Nunes Ramos)

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