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Work and health in mothers of a Portuguese birth cohort

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TESE DE DOUTORAMENTO EM SAÚDE PÚBLICA GLOBAL

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“A prime way of giving children a good start in life is to help their parents.”

Michael Marmot, The Status Syndrome

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ABBREVIATIONS

CHICOS: Developing a Child Cohort Research Strategy for Europe

COST: European Cooperation in Science and Technology

ENRIECO: Environmental Health Risks in European Birth Cohorts

EUCCONET: European Child Cohort Network

EU: European Union

GIS: Geographical information system

ICOH: International Commission on Occupational Health and Safety

ILO: International Labour Organization

ISCO-88: International Standard Classification of Occupations, 1988 version

ISCO-08: International Standard Classification of Occupations, 2008 version

OMEGA-NET: Network on the Coordination and Harmonisation of European Occupational Cohorts

UK: United Kingdom

UN Women: United Nations Entity for Gender Equality and the Empowerment of Women

WHO: World Health Organization

ABSTRACT

Background

Work may have several health enhancing effects as a source of paid income and financial security, as well as social integration. However, it also shapes individuals' exposure to physical environmental conditions, including trauma, chemicals, biologic agents and physical hazards, which may negatively influence health. And its most salient consequences are occupational injuries and diseases.

National data on occupational injuries and diseases is scarce and it either follows a more traditional occupational epidemiology approach by restricting research to a particular sector of activity, occupational group or type of injury/disease, or it relies on routine government statistics.

Also, over the past three decades, the presence of women in the workforce has increased substantially and the share of employed women in the European Union stands among the highest in the world. However, female labour force participation rates vary considerably according to the type of household. While the presence of children reduces women's labour force participation, it increases men's.

Thus, using large population-based prospective studies constitutes a unique opportunity to address the bidirectional relationship and complex interactions among parenthood, work and health in parents.

Objectives

In the present work our objectives were:

1. To estimate the work-life burden of occupational injuries (Paper I);

2. To identify clusters of co-occurring work-related health problems (Paper II);
3. To assess the association between work situation at the beginning of pregnancy and sick leave during pregnancy (Paper III);
4. To estimate the association between child neurodevelopmental and behavioural problems and maternal unemployment (Paper IV).

Methods

The objectives of this thesis were accomplished through the analysis of data obtained from Generation XXI, a prospective population-based birth cohort study, from the recruitment at birth and follow-up evaluation waves at 7 and 10 years of age. Specifically, data on the history of work-related health problems and occupational injuries was collected at the 10-year-old follow-up, while data on maternal work participation was retrieved from baseline (pregnancy-related sick leave) and the 7- and 10-year-old assessment waves (unemployment).

All women who delivered live-born children with gestational age above 23 weeks in one of the five public units in the metropolitan area of Porto between April 2005 and August 2006, and whose residence was in the units' catchment area were eligible for recruitment. Seventy percent of eligible mothers were invited and, of these, 91.4% accepted to participate. All 8647 children enrolled at birth were invited to attend follow-up assessments at ages four (2009-2011), seven (2012-2014) and ten (2015-2017) years (86.3%, 79.7% and 76.0% participation, respectively).

In face-to-face interviews at baseline and follow-up evaluations, information was collected using structured questionnaires concerning sociodemographic characteristics, child and family medical history, and parental work-related characteristics. A physical examination including anthropometric assessment was performed to children and mothers.

Results

Paper I

In 4338 women, over a fifth (21.8%) of working-age mothers reported having had at least one occupational injury throughout their working life. Wounds and superficial injuries were the most frequently reported types of occupational injuries (11.0%), followed by dislocated bones and joints, sprains and strains (10.7%). Women reporting any occupational injury had higher odds of having a blue-collar job, namely skilled agricultural, forestry and fishery workers and craft and related trades workers (adjusted OR=1.78, 95% CI [1.21-2.61]), plant and machine operators and assemblers (adjusted OR=1.82, 95% CI [1.20-2.74]), and elementary occupations (adjusted OR=1.56, 95% CI [1.08-2.25]), or of working in services and sales (adjusted OR=1.69, 95% CI [1.28-2.24]). Women who reported a history of occupational injuries also had a higher likelihood of reporting a work-related health problem (adjusted OR=2.64, 95% CI [2.27-3.07]) and of having a partner who also reported an occupational injury throughout their working life (adjusted OR=1.86, 95% CI [1.33-2.62]).

Paper II

In 4330 women, the overall prevalence of reporting at least one work-related health problem since the beginning of working life was 31.5% (n=1366). Mental disorders were the most prevalent (21.3%), followed by those related to the neck/upper limbs (17.0%), and headache and/or eyestrain (16.9%). Five groups were identified using exploratory factor analysis. Factor 1 gathered all items on musculoskeletal disorders. Participants with lower socioeconomic position, higher BMI, smokers, and with history of occupational accidents scored higher in this factor. Factor 2 gathered mental disorders together with headache and/or eyestrain, and showed higher scores among women with a higher socioeconomic position. Factor 3 included the item on other disorders with some loading from digestive disorders, and showed higher scores in older and public sector workers. Factor 4 encompassed respiratory disorders, and it

associated with lower socioeconomic position and occupational accident history. Factor 5 was composed by hearing and ear problems and associated with blue-collar workers.

Paper III

In 5638 mothers, nearly two thirds had been on sick leave by the third trimester (62.2%) and 4.3% had been on sick leave throughout all three trimesters. Compared to managers/professionals, mothers in blue-collar jobs were more likely to be on sick leave, even at an earlier stage of their gestation – OR[adjusted]=1.72, 95% CI [1.14-2.60] for skilled agricultural and fishery workers and craft and related trades workers and OR[adjusted]=2.03, 95% CI [1.28-3.20] for plant and machine operators and assemblers. Being an own-account worker (OR[adjusted]=0.56, 95%CI [0.33-0.93]) and having low job autonomy (OR[adjusted]=1.80, 95%CI [1.29-2.49]) and low decision authority (OR[adjusted]=1.45, 95%CI [1.14-1.84]) held as main determinants of earlier sick leave during pregnancy, even after excluding high-risk pregnancies.

Paper IV

Of the 5754 mothers assessed in our study and their children, the prevalence of maternal unemployment was 18.5% at the 7-year-old follow-up, 16.7% when the child was 10 years of age, and 8.7% at both assessment waves. Women were more likely to be unemployed when their child was ten if the child had, up to age seven, any of the following suspected problems: an autism spectrum disorder (adjusted PR=1.69, 95%CI [1.04-2.74]), developmental delay (adjusted PR=1.54, 95%CI [1.18-2.02]), externalizing behaviours (adjusted PR=1.27, 95%CI [1.09-1.47]) or learning problems (adjusted PR=1.24, 95%CI [1.05-1.45]). When the exposure was restricted to clinically diagnosed disorders, the magnitude of associations remained similar even though estimates were less precise. Associations with unemployment were stronger at child age ten (longitudinal analyses), than at child age seven (cross-sectional).

Conclusion

By using a population-based sample, this thesis provided a working women's perspective on both occupational injuries and non-traumatic work-related health problems, including the identification of groups of health problems with specific characteristics. Also, there was a clear association between mothers' and partners' history of occupational injuries and work-related health problems, which may pose a double challenge for family and child well-being. Regarding maternal work participation, we found that, independently of occupational group, employment status, job autonomy and decision authority at work were major determinants in the decision to work during pregnancy, even in healthier pregnancies. Moreover, our findings suggested that having a child with a learning, developmental or behavioural problem, or an autism spectrum disorder up to age seven was associated with maternal unemployment three years later. These findings point towards a broadened understanding of work-related outcome consequences and research focusing on family-level factors that account for the embeddedness of workers in households.

RESUMO

Introdução

O trabalho engloba vários benefícios para a saúde, seja como fonte de rendimento, de segurança financeira ou de integração social. No entanto, o trabalho também molda a exposição dos indivíduos ao ambiente que o rodeia, incluindo trauma, exposição a produtos químicos, agentes biológicos e riscos físicos, que podem por sua vez influenciar negativamente a saúde. E as suas consequências mais proeminentes são as lesões e as doenças ocupacionais.

Dados nacionais sobre lesões e doenças ocupacionais são escassos e, ou seguem uma abordagem à epidemiologia ocupacional mais clássica, restringindo-se a um determinado sector de actividade, grupo profissional ou tipo de lesão/doença, ou dependem de estatísticas governamentais.

Além disso, ao longo das últimas três décadas, a presença das mulheres no mercado de trabalho aumentou substancialmente e a proporção de mulheres empregadas na União Europeia situa-se entre as mais altas do mundo. No entanto, as taxas de participação das mulheres no trabalho variam consideravelmente de acordo com o tipo de agregado familiar. Enquanto, por um lado, a presença de crianças no agregado familiar diminui a participação das mulheres no trabalho, por outro, aumenta a dos homens.

Assim, o uso de estudos prospectivos de base populacional de grande dimensão constitui uma oportunidade única para abordar a relação bidireccional e as complexas interacções entre parentalidade, trabalho e saúde dos pais.

Objectivos

Os objectivos do presente trabalho consistiram em:

1. Estimar a carga de lesões por acidente de trabalho ao longo da vida profissional (Artigo I);
2. Identificar a agregação de problemas de saúde relacionados com o trabalho (Artigo II);
3. Avaliar a associação entre o contexto de trabalho no início da gravidez e a incapacidade temporária para o trabalho durante a gravidez (Artigo III);
4. Estimar a associação entre problemas de neurodesenvolvimento e de comportamento da criança e o desemprego materno (Artigo IV).

Métodos

Por forma a alcançar os objetivos desta tese foram analisados dados da Geração XXI, uma coorte de nascimentos prospectiva de base populacional, recolhidos durante o recrutamento ao nascimento e nas reavaliações dos sete e dez anos de idade. Concretamente, foi recolhida informação sobre a história de problemas de saúde relacionados com o trabalho e de lesões por acidente de trabalho na reavaliação dos dez anos de idade, enquanto informação sobre a participação no trabalho das mães foi recolhida durante o recrutamento ao nascimento (incapacidade temporária para o trabalho durante a gravidez), e nas reavaliações dos sete e dez anos de idade (desemprego).

Foram consideradas elegíveis para o estudo todas as mulheres com partos que originaram nados-vivos com idade gestacional superior a 23 semanas numa das cinco maternidades de nível III do Porto, entre Abril de 2005 e Agosto de 2006, e que residiam na área de referência das maternidades. Setenta por cento das mães elegíveis foram convidadas e destas, 91,4% aceitaram participar. Todas as 8647 crianças incluídas no estudo ao nascimento foram convidadas a participar em reavaliações da coorte aos quatro (2009-2011), sete (2012-2014) e dez (2015-17) anos de idade (86,3%, 79,7% e 76,0% de participação, respectivamente).

Ao nascimento e nas reavaliações subsequentes foram realizadas entrevistas presenciais, utilizando questionários estruturados, com o objetivo de recolher informação sobre

características sociodemográficas, história de saúde da criança e da família, e características relacionadas com o trabalho dos pais. Foi também realizado um exame físico que incluiu uma avaliação antropométrica da criança e da mãe.

Resultados

Artigo I

Em 4338 mulheres, mais de um quinto (21,8%) relatou ter sofrido pelo menos uma lesão por acidente de trabalho durante a sua vida profissional. Feridas e lesões superficiais foram os tipos de lesões ocupacionais reportados mais frequentemente (11,0%), seguidos de luxações, entorses e distensões (10,7%). As mulheres que reportaram pelo menos uma lesão por acidente de trabalho tinham maior probabilidade de ter um trabalho mais manual, ou seja, trabalhadoras qualificadas da agricultura, da pesca, da floresta, da indústria e da construção, e artífices (OR ajustado=1,78; IC 95% [1,21-2,61]), operadoras de instalações e máquinas, e trabalhadoras de montagem (OR ajustado=1,82; IC 95% [1,20-2,74]), e trabalhadoras não qualificadas (OR ajustado=1,56; IC 95% [1,08-2,25]), ou trabalhadoras dos serviços pessoais, de protecção e segurança e vendedoras (OR ajustado=1,69; IC 95% [1,28-2,24]). Mulheres que reportaram história de lesão por acidente de trabalho tinham também maior probabilidade de reportar um problema de saúde relacionado com o trabalho (OR ajustado=2,64; IC 95% [2,27-3,07]) e de ter um companheiro que também reportou lesão por acidente de trabalho (OR ajustado=1,86; IC 95% [1,33-2,62]).

Artigo II

Em 4330 mulheres, a prevalência de ter tido pelo menos um problema de saúde relacionado com o trabalho desde o início da vida ativa foi de 31,5% (n=1366). Os problemas mentais foram os mais frequentemente reportados (21,3%), seguidos dos relacionados com o pescoço/membros superiores (17,0%) e cefaleias e/ou fadiga visual (16,9%). Foram identificados cinco grupos de problemas de saúde relacionados com o trabalho através de uma

análise factorial exploratória. O factor 1 reuniu todos os itens sobre problemas músculo-esqueléticos. Participantes com uma posição socioeconómica mais baixa, com um maior índice de massa corporal, fumadoras e com história de lesão por acidente de trabalho pontuaram mais alto neste fator. O factor 2 reuniu problemas mentais com cefaleias e/ou fadiga visual e apresentou scores mais elevados entre as mulheres com maior posição socioeconómica. O factor 3 incluiu o item sobre outros problemas com alguma carga de problemas digestivos, e mostrou pontuações mais elevadas em trabalhadoras mais velhas e do sector público. O factor 4 englobou problemas respiratórios, e estava associado a uma posição socioeconómica mais baixa e a uma história de lesão por acidente de trabalho. O fator 5 foi composto por problemas auditivos e do ouvido e estava associado às trabalhadoras manuais.

Artigo III

Em 5638 mães, quase dois terços tiveram uma incapacidade temporária para o trabalho no terceiro trimestre de gravidez (62,2%) e 4,3% durante os três trimestres. Mães com trabalhos mais manuais tinham maior probabilidade de ter uma incapacidade temporária para o trabalho, mesmo em fases mais iniciais da gestação – OR[ajustado]=1,72; IC 95% [1,14-2,60] em trabalhadoras qualificadas da agricultura, da pesca, da floresta, da indústria e da construção e artífices, e OR[ajustado]=2,03; IC 95% [1,28-3,20] em trabalhadoras não qualificadas. Após a exclusão de gestações de risco, ser uma trabalhadora independente (OR[ajustado]=0,56; IC 95% [0,33-0,93]) e ter baixa autonomia (OR[ajustado]=1,80; IC 95% [1,29-2,49]) e baixa autoridade no trabalho (OR[ajustado]=1,45; IC 95% [1,14-1,84]) constituíram os principais determinantes de incapacidade temporária para o trabalho durante a gravidez.

Artigo IV

Das 5754 mães avaliadas neste estudo e respectivos filhos, a prevalência de dese3mprego nas mães era de 18,5% na avaliação dos 7 anos, 16,7% quando as crianças tinham 10 anos, e 8,7%

em ambas as avaliações. As mães tinham uma maior probabilidade de estarem desempregadas aos dez anos de idade se a criança tivesse, até aos sete anos, a suspeita de qualquer um dos seguintes problemas: uma perturbação do espectro do autismo (PR ajustado=1,69; IC 95% [1,04-2,74]), atraso no desenvolvimento (PR ajustado=1,54; IC 95% [1,18-2,02]), comportamentos de externalização (PR ajustado=1,27; IC 95% [1,09-1,47]), ou problemas de aprendizagem (PR ajustado=1,24; IC 95% [1,05-1,45]). Quando a exposição foi restringida a problemas com um diagnóstico clínico, a magnitude das associações permaneceu semelhante, embora as estimativas fossem menos precisas. As associações com o desemprego foram mais fortes aos dez anos de idade da criança (análise longitudinal), do que aos sete (transversal).

Conclusão

Ao utilizar uma amostra de base populacional, esta tese forneceu uma perspectiva das mulheres trabalhadoras sobre as lesões por acidente de trabalho e problemas de saúde não traumáticos relacionados com o trabalho, incluindo a identificação de grupos de problemas de saúde com características específicas. Além disso, houve uma clara associação entre o reporte de lesões por acidente de trabalho e de problemas de saúde relacionados com o trabalho nas mães e companheiros, o que poderá representar um duplo desafio para o bem-estar da família e da criança. Em relação à participação no trabalho das mães, verificamos que, independentemente do grupo profissional, a situação perante o emprego, a autonomia e a autoridade no trabalho constituíram importantes determinantes na decisão de trabalhar durante a gravidez, mesmo em gestações mais saudáveis. Além disso, os nossos resultados sugeriram que ter um filho com um problema de aprendizagem, desenvolvimento ou comportamental, ou uma perturbação do espectro do autismo aos sete anos de idade está associado com o desemprego materno três anos mais tarde. Estes resultados apontam para uma compreensão mais abrangente das consequências resultantes do trabalho e para uma

investigação dirigida a factores familiares que têm em conta a inserção dos trabalhadores nas famílias.

1. INTRODUCTION

1.1. A brief history of occupational health

Occupational risks associated with low technology and poor working and living conditions are known since the ancient Egypt. But it was in Europe, around 1700, where the first steps towards a deeper and formal knowledge on Occupational Health were taken. Georgius Agricola (1499-1555), a German mineralogist and scholar who became a physician in a mining town, published *De Re Metallica*, a 12-volume book on metallurgy. He ends his work with a description of the most frequent diseases and accidents among miners, as well as ways of preventing them. Although his description and explanation of lung diseases is not very rigorous, he has the merit of proposing the ventilation of mines and the use of a cloth over the face of miners. Agricola is also the author of a relevant social observation when he mentions that, in the Carpathian mountains, there are women that had been married seven times as a result of the premature death of their mining husbands, who died of the same disease (1). Paracelsus (1493-1541) is another important historical reference as he also described the hazards and diseases associated with metal mining. However, unlike Agricola, he did not value prevention, concluding that the diseases observed are the price to pay for progress (2).

The manufacturing development that accompanied the Italian Renaissance diversified and intensified production, thus worsening the working conditions of many workers and artisans. Bernardino Ramazzini (1633-1714), an Italian physician, wrote the first systematic study of occupational diseases *De Morbis Artificium Diatriba* (The diseases of workmen). He strongly advised doctors to question their patients about their occupations when making a diagnosis and he also noted that many workers were misdiagnosed when this was not considered. He became known as the father of occupational medicine due to his focus on the direct observation of the workplace, and his extensive interest and concern for the worker's health (1).

A key development occurred in 1775 when Percival Pott identified scrotal cancer in chimney sweeps, the first occupational cancer recorded in history. Nearly 130 years after Ramazzini's work and with the Industrial Revolution as a background, Charles Thackrah's work stands as one of the landmarks of occupational health. He added an epidemiologic dimension to occupational health. By studying the bills of mortality, Thackrah observed that death rates were higher in manufacturing towns when compared to agricultural areas. He also showed that manual workers lived shorter lives than the more affluent merchants, professionals, and employers (1).

Apart from the scientific aspects of occupational health, the implementation of interventions in order to protect workers' health dates back to early 19th century: in Great Britain, the first labour inspectors were appointed in 1802 and the "Althorp" Law led to the creation of an effective labour inspection service in 1833. In 1906, the first international scientific and professional association was established in Milan, *Commissione Internazionale per le Malattie Professionali*, and is still a key non-governmental organization worldwide – the International Commission on Occupational Health and Safety (ICOH) (3). In the wake of World War I, the International Labour Organization (ILO) was founded in 1919, a tripartite organization that included representatives of governments, employers and workers in its executive bodies (4). The growing body of evidence ultimately led to the creation of the first trade unions, increasing bargaining power to improve working conditions such as the reduction of working schedules and the protection of female and child labour (3).

More recently, the European Union (EU) had a major contribute in establishing basic rules and directives to protect workers' health and safety: occupational health and safety issues have been considered vital areas for the European Community since the Treaty of Rome, which set up the European Economic Community in 1957 (3). In addition to policy development, Europe has played a leading role in occupational health research. National Research Institutes were

established in many European countries (e.g. FIOH in Finland, HSE in the United Kingdom, INRS in France, BAuA in Germany, ISPESL in Italy), which had an impact in the harmonization of the research agenda, in the creation of a critical mass of occupational health researchers, and in the development of preventive measures and policies at national level (3). Early 21st century databases looking at work-related diseases within different occupations were established at national and international levels as a driver for further clinical research and legislative changes. And a shift of emphasis from historical disease prevention to overall worker health and wellbeing and the impact of health on work has occurred in recent decades (5).

1.2. Work and (its social gradient in) health

Work is tied up with one's sense of identity and well-being. Work is also a major determinant of health. The effect of work on health, including possible damage to health, is the result of influences that act at different levels (Figure 1). The socioeconomic context in which enterprises and institutions operate - which are characterized by the labour market, work relations and the productive structure - influence, on a macro level, employment conditions (salary, type of contract, etc.) and working conditions (places, teams, work organization, etc.). Moreover, the interaction between employment and work conditions with living conditions (environment, home, family, etc.) and individual characteristics (gender, age, behaviour, etc.) is a determinant of worker's health (6).

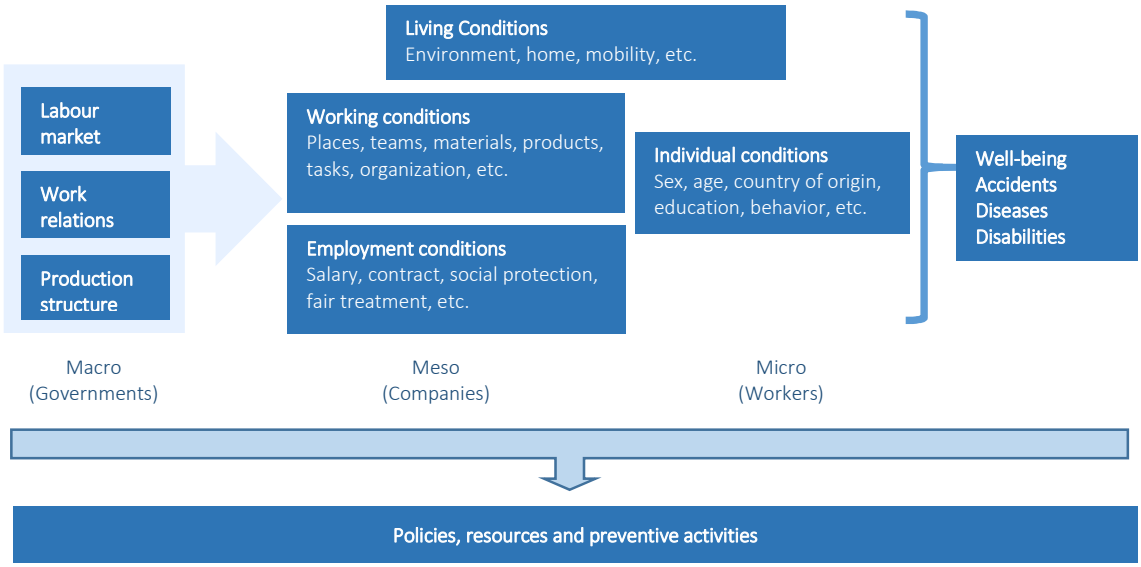


Figure 1. Conceptual causality model in Occupational Health (Adapted and reproduced from Benavides *et al.* (6))

1.2.1. Health-Enhancing Aspects of Work

It has long been recognized that adults with better jobs enjoy better health than their counter parts. In fact, job title was the social gradient metric first used to comprehend the inverse association between social class and chronic disease estimates (7), a core finding now replicated in most developed countries (8). Research on inequalities has recognized the centrality of employment and working conditions as reflections and determinants of individuals' life chances. Employment is positively linked to health, as a predominant source of income and other material benefits, such as health insurance (9). Work is also a source of social integration, prestige, creative self-expression and meaning. While material benefits are obviously crucial when considering its relevance for health, work is far more than a source of income. Individuals working in higher status occupations have substantially better health even after adjusting for their higher education and income, a finding notably demonstrated in the Whitehall study of British civil servants, who all have access to health care and decent working conditions (10). What has been less clear are the mechanisms underlying the protective

aspects of occupational status. It has been hypothesized that lower status workers compare themselves unfavourably to their higher status counterparts and have a lower sense of control, generating harmful stress and potentially leading to risky health behaviours (11). However, other researchers have argued that existing studies focused on occupational status are essentially capturing unmeasured physical and psychosocial job characteristics, other aspects of socioeconomic position, or health behaviours that are associated with occupational status and health (12, 13).

1.2.2. Health-Harming Aspects of Work

Beyond the material and status rewards that come with paid work, work also shapes individuals' exposure to physical environmental conditions, including trauma, chemicals, biologic agents and physical hazards (e.g., heat, noise, radiation), that may negatively influence health. And the most salient consequences are occupational injuries/accidents, and work-related and occupational diseases.

1.2.2.1. Occupational injuries/accidents and work-related diseases

While the terms ‘injury’ and ‘accident’ can often be seen used interchangeably, some criticize the use of the term ‘accident’ since its common meaning is a random or chance event, and thus one that cannot be prevented. And extensive research has yielded solid evidence showing that most injuries are predictable and therefore preventable. For this reason, BMJ specialty journals have banned the word ‘accident’ (14), although there may be times when ‘accident’ seems appropriate - to describe the primary event in a sequence that leads ultimately to injury if that event is genuinely not predictable. Regarding occupational and work-related diseases, while the former are primarily caused by risk factors that arise from work, the latter consists of a wider concept; it covers diseases that have multiple causal agents, where factors in the work

environment may play a role, together with other risk factors such as personal characteristics and other environmental and sociocultural, in the development of such diseases (15). Thus, in occupational diseases, there is a direct cause-effect relationship between hazard and disease, while in work-related diseases, the work environment and the performance of work contribute considerably, but as one of a number of factors, to the causation of a multifactorial disease (16).

Data concerning occupational accidents and work-related diseases form an important basis for goal setting, selecting prevention measures, as well as measuring performance and monitor progress concerning the goals set (17). However, accurate global estimates are difficult to obtain; if available, they are provided by multiple sources such as social security and insurance institutions, labour inspectorates, occupational health services or other authorities and bodies. Under-reporting also constitutes a major barrier as well as heterogeneity among data collection requirements (for instance, the inclusion of workers in the informal economy may vary). Many developing countries do not even have a social security system; but even reports from developed countries, which are usually more comprehensive, often do not report all cases, in particular less severe injuries and diseases (non-fatal) (18).

National data on occupational injuries typically follows the country's legislation requirements. Usually, it includes employees from the private sector, the coverage of self-employed is low and some activities' data such as public administration, agriculture or those in the informal sector is often inexistent. Also, different sources apply different criteria regarding injuries; for instance, regarding the minimum number of days of absence from work or the maximum period following an occupational accident during which a fatality is considered as a work-related fatality (19). Occupational accidents have been given more attention, both at company and national-level, in the form of interventions and regulations that aim towards prevention;

although occupational diseases kill six times more workers than injuries (20), the impact of accident-related interventions is more evident in terms of number of cases as well as costs.

Occupational and work-related diseases are still largely invisible in comparison to accidents. Reliable data on occupational diseases are not available at a global level; the number of cases represents only a fraction of the real burden, which reflects the definition, recognition and reporting challenges it entails. In addition to the problems of low coverage of certain types of professionals - namely rural workers, workers in small and medium-sized companies and in the informal economy - various occupational diseases such as cancers, have a long latency period and are thus diagnosed only when there is a clinical manifestation. The increased job rotation, which leads to different levels of exposure, along with the multifactorial nature of disease occurrence, makes it more difficult to identify an occupational origin. The constant emerging of new risks and the exposure to new substances that have not yet been identified as hazardous, also poses a challenge. Moreover, the diagnosis of a disease by a medical doctor, and subsequent recognition as a work-related disease, requires specific skills and experience that not all developing countries can provide. Also, some countries share the responsibility for Occupational Safety and Health between labour and health ministries and social security institutions. All of this constitutes a challenge for data collection, occupational health surveillance, and international comparability (21).

Globally, an estimated 2.78 million fatalities per year are attributable to occupational injuries and work-related diseases, of which 380,500 are due to occupational injuries and over 2.4 million to work-related diseases (20). In spite of the fact that 86.3% of occupational fatalities are attributable to occupational and work-related diseases, these numbers are expected to be substantially underestimated; more than half of all the countries worldwide do not have adequate official statistics for occupational diseases, making diseases largely invisible when compared to injuries (21). In addition, in 2014 the estimated number of non-fatal occupational

injuries with at least four days of absence from work was 374 million worldwide (20). Although there was an increase in total employment of 4% for all countries compared to 2010, the number of estimated fatal occupational injuries increased by about 8%, to 380,500. The number of fatal occupational injuries decreased in only two WHO regions despite an increase in the total employment; there was an estimated 6% decrease in occupational injuries for high income countries despite a 5% increase in total employment, and occupational injuries decreased by 3% with a 2% increase in employment in low- and middle-income countries of the European Region. Overall, the estimated fatal and non-fatal occupational injury rates in 2014 had increased and was higher than during the global crisis year in 2008 (20). In 2015, the main cause of work-related mortality globally were circulatory diseases (31%), followed by malignant neoplasms (26%), respiratory diseases (17%) and occupational injuries (14%), which accounted for about 90% of all work-related deaths (8). Also, communicable diseases were still a common problem in developing countries. Although the number of fatalities due to neuropsychiatric conditions was low (2%), it increased slightly in 2015, and it could be expected that this number will increase in the future. Together with musculoskeletal disorders, these conditions are usually non-fatal and are relatively more prevalent in higher income countries (20).

1.2.2.2. Other work-related problems

Health at work is not restricted to the absence of injuries or occupational diseases, but also involves physical and psychosocial well-being, which are considered particularly important for the productivity and quality of work of the workforce. Many workers in affluent societies escape the burden of most physical hazards at work, though repetitive strain and nonstandard work hours are broadly and progressively relevant. Yet, contemporary workers in post-industrial and other economies face a variety of psychosocial stressors at work, namely job strain, job insecurity, and negative spillovers from work to other domains (9). Job strain, which

consists of a combination of low task control and high levels of demand with little workplace social support (22), has been associated with a range of health problems including psychiatric morbidity (23), musculoskeletal symptoms (24), insomnia (25), and coronary heart disease (26).

Compared to research on job strain, research on insecure or precarious employment has achieved far less attention as an occupational health risk, although it has become a topic of increasing concern. Over the past few decades, transformative technological, economic, and political changes surrounding work, as well as a worldwide recession, have increased employment flexibility and have left many insecure about the future of their jobs (27). Job insecurity has been characterized as a potential mechanism behind health inequalities (27), and workers who believe that they may lose their job in the near future have been shown to have worse mental and physical health (28), even when adjustment is made for actual job losses or unemployment (29). There are also studies showing associations between precarious employment and higher risk of childlessness/postponed parenthood (30).

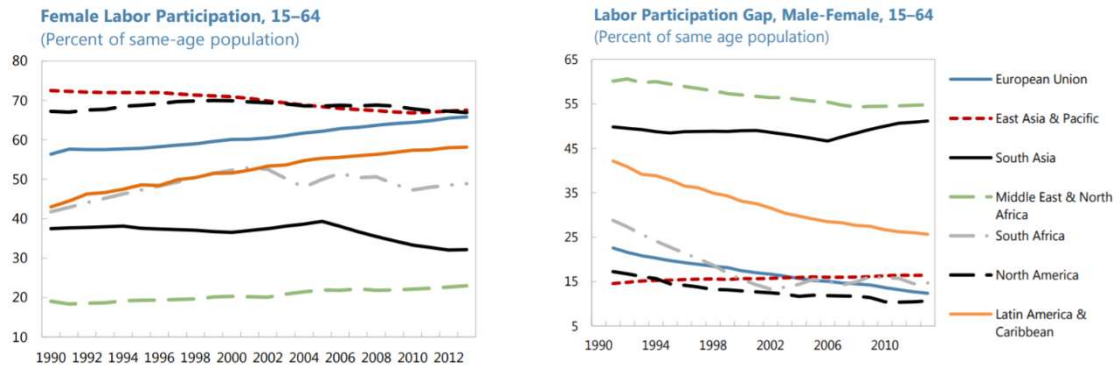
Research on the relations between work and health has also begun to spread beyond the workplace and the individual. As work and family circumstances have changed and diversified in the second half of the 20th century, there has been growing interest in exploring how the intersection of responsibilities in both of these domains affects the health of workers and their families (31). Work-family conflict, or negative work-family spillover, is a type of role conflict that occurs when responsibilities in one domain affects the ability to fulfil responsibilities in the other domain (32). Most research has focused on the association between negative spillover and mental health; evidence from cross-sectional studies have shown a direct association between negative work-family spillover and depressive symptoms, psychological stress and anxiety (33, 34). Studies have also found that greater exposure to work-family spillover was associated with poorer self-rated health, musculoskeletal problems and other

physical symptoms (33, 35, 36). Intervention studies showed that flexible work policies that provide employees with control of their schedules can reduce work-family conflict and help with promoting better health behaviours, such as sleeping more and exercising regularly (37).

Recently, due to the COVID-19 pandemic, telework has been implemented as part of a broad public health measure to prevent the spread of an infectious disease. Since it is likely to become much more common post-crisis, it is important to develop reliable ways to measure emerging hazards at work relevant for those who are teleworking. Although there are advantages to this work system, it is also associated with longer working hours, work and personal life interference, and work intensification. This may lead to high levels of virtual presenteeism and stress with negative consequences for the health and well-being of workers (38).

1.3. Women and work

Over the past three decades, the presence of women in the workforce has increased substantially. Since the early 1980s, female labour force participation rates have more than doubled in countries such as the Netherlands, Spain, and Ireland, substantially lifting the European Union's (EU) average (39), reaching 67.2% in 2019 (40). As a result, the share of employed women in the EU stands among the highest in the world (Figure 2). Still, the gender gap in work participation remains considerable, despite its decrease over the last decades. Also, there has recently been a substantial slowdown in the rate at which gender participation gaps are closing (39). Since 2013, the gap has remained largely unchanged due to sectoral segregation and the nature of the 2008 financial crisis. Although the most affected workers during the 2008 financial crisis were men employed in construction and manufacturing, which had an impact in decreasing the gender gap, from the end of the crisis onwards, the employment trend became positive for both genders, practically at the same pace (40).



Sources: World Bank World Development Indicators and IMF staff calculations.

Figure 2. Female labour force participation across the globe (Reproduced from Christiansen *et al.* (39))

1.3.1. Gender segregation in the labour market

There is a horizontal division of labour market, with women considerably concentrated in certain sectors of activity and certain occupations – which is usually where the salaries are the lowest. The concentration of the female working population in the lower categories of the professional hierarchy – i.e., vertical segregation of the labour market – reinforces the effects of horizontal segregation and also accounts for women's low wages (40). Even when both men and women have the same job title, some studies hypothesize that they may be assigned to different tasks and be exposed to different working conditions (41, 42). For example, female janitors may be more likely to polish furniture, while male janitors are more likely to strip floors (42). Differences in gender tasks imply exposure to different hazards, both physical and psychosocial.

There are also gender differences regarding the number of working hours that may be related to a large extent to differences in family roles. Women are still overrepresented in part-time jobs; in 2019, the percentage of women aged 20-64 working part-time in the EU was almost 30%, compared to 7.8% of men (40). When reflecting a freedom of choice, working part-time provides flexibility and autonomy. However, once involuntary, this working arrangement limits

access to better jobs and social protection. With long-term consequences for financial stability and a risk of precariousness (arising from low wages and low wage progression), part-time employment may also harm women since it decreases their social security entitlements, which in turn prevents a bridging of the gender pension gap. Despite the fact that more women are taking up higher payed jobs in recent years, they continue to be considerably overrepresented in low-paying jobs. While women constituted 48% of employees in 2019, they constituted 58% of minimum wage earners and 62% of workers earning substantially less than the minimum wage (40). In addition, since women's income is strongly linked to children's well-being, the inability to earn adequately (in particular for single mothers) is inevitably associated with child poverty (40). An intergenerational transmission of employment outcomes should also be considered since adult daughters of employed mothers are more likely themselves to be employed (43). This finding emphasizes the dynamic effects that higher female workforce participation might have on closing employment gender gaps in future generations (39).

1.3.2. Gender segregation in domestic work

Female labour force participation varies widely across regions. Yet, a number of striking commonalities can be found, especially in how such participation varies across types of household (Figure 3).

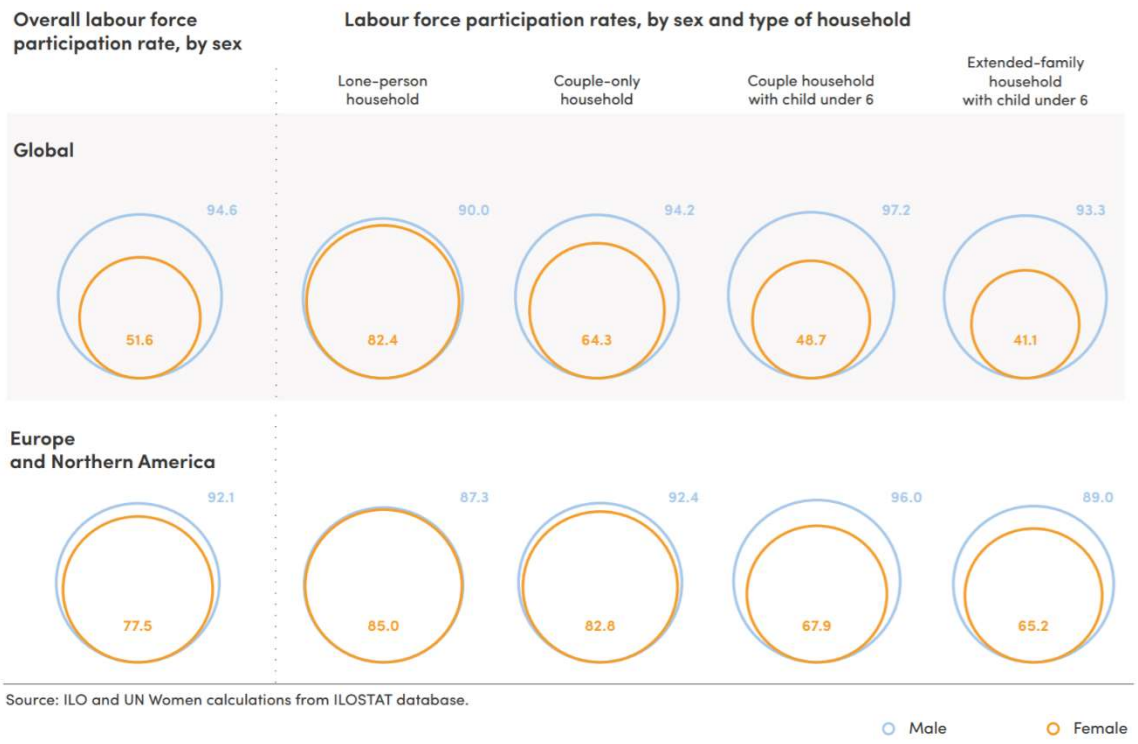


Figure 3. Labour force participation rates of men and women (aged 25-54 years), by household type (percentage) (Adapted and reproduced from Azcona *et al.* (44))

Men tend to have high labour force participation rates regardless of the type of household they live in. Thus, there is little variation in their participation rates (higher than 92% across all regions, except Oceania). Regarding women, on the other hand, labour force participation rates vary considerably, depending on the type of household. Globally, women living with a partner, are less likely to be in the labour force than women living alone (64.3% versus 82.4%, respectively), although their labour force participation rates are higher than average (the average is 51.6%). For men, living with a partner increases participation compared to men living alone (94.2% versus 90.0%, respectively). The presence of children reduces women's labour force participation and increases men's, by similar proportions in terms of percentage-points. This trend is much more pronounced when the couple has at least one child under six years of age. Having young children and having more children increases the intensity of

childcare and domestic work within a household compared to having older, or fewer, children (44), thus increasing women's non-market work burden.

There is still an unequal task division at home, even when both partners work full-time, and women remain primarily responsible for domestic work (such as caring for children, the elderly and disabled). This double burden phenomenon decreases women's time for recovery after a workday, which has been linked to negative mental health outcomes, increased musculoskeletal symptoms (45-47), fatigue, non-occupational stress, response to workplace stressors, and return to work following illness or injury (48), which in turn may hamper everyday family activities, particularly in families with children.

The particularly large fall in labour market participation for women who are both married and have young children can be explained by the higher likelihood of women to perform multiple roles and to face structural or societal barriers to work – and the COVID-19 pandemic has further highlighted this differential impact on men and women, as resulting economic setbacks and shifts in household responsibilities have had a greater impact on women (49). Recent findings from the United States showed that women, particularly mothers, were disproportionately affected by COVID-19. Mothers with young children have reduced their work hours four to five times more than fathers and the gender gap in work hours has grown by 20–50% (50). Even in households in which both parents remained employed and able to telework, mothers reduced work hours to a greater extent than fathers. Furthermore, women were more likely to be unemployed than men, particularly mothers of young children who reported higher unemployment rates compared with fathers during the COVID-19 pandemic (51). These findings might be explained by the fact that women report family responsibilities more than five times as often as men as a reason they were limited from looking for employment and almost four times as often as a reason for not being available to accept employment. Furthermore, even if women are employed, they are significantly more likely

than men to cite family responsibilities as a reason for working fewer hours than a typical workweek (49). The extent to which the negative effects of the pandemic on women go beyond labour market participation seem to warrant a more comprehensive assessment. Eurofound's Living, Working and COVID-19 e-survey showed that a concentration of activity at home during the crisis led to a general deterioration of work-life balance, especially for women. Among parents of children aged up to 11 years, 29% of working women found it hard to concentrate on their job because of family (against 16% of men), while family responsibilities prevented more women (24%) than men (13%) from giving the time they wanted to their job-related tasks. But work is also impinging on family life: 32% of women in this group said that their job prevented them from focusing on their family, against 25% of men (40). While the COVID-19 crisis is a recent and exceptional event, it functions as a magnifying glass by uncovering, among others, women's work participation struggles as well as work-family conflicts, particularly in mothers.

1.4. The Portuguese context

Among EU countries, Portugal experienced one of the sharpest recessions in the wake of the 2008 global crisis, and the recessionary impacts persisted through to 2012–2013. During that period, employment destruction was mainly concentrated in mid-paying jobs, as was also the case of Greece and Spain. The recent rebound of employment (2013-2016) has tended to predominantly occur in the top job-wage quintile (52).

The main national shift of employment composition has been away from the relatively large primary sector to the service sector; Portugal was the EU country with the sharper decline of employment in the primary sector between 2008 and 2016, together with the highest increase of employment in the service sector. Even after 2013 where the recovery has strengthened, there was still an increase in employment losses in the primary sector – agriculture and the

mining and extractive industries. These losses predominantly occurred in low-paid agricultural jobs, as was also the case of other Member States that have comparatively large agricultural workforces, such as Croatia, Greece, Poland and Romania (52).

Prior to the SARS-CoV-2 pandemic, Portugal had reached its 75% employment rate target (76.1% in 2019), which was slightly higher than the EU-27 average of 73.1% (53). The participation of women in the labour market (72.7%) was also higher than the EU average of 67.2% for women between 20-64 years of age (54). Also, female employment rates increase in the presence of one or two children, when compared to childless women, and a sharper drop is only observed from the third child onwards (55).

When looking at the average working hours of employees only, Portugal falls in the range of eastern European countries with 39.3 hours a week, while the EU average working week in the main job corresponded in 2019 to 36.2 hours. Regarding self-employed workers, the EU Member States had on average a longer working week than employees (42.8 hours) and Portugal had a 40.2 average of weekly hours worked (56).

Regarding standard employment, considered as full-time dependent employment with a permanent contract, Portugal has over 60% share of standard employment, which is only slightly higher than the 59% of the EU and the United Kingdom (UK) aggregate estimates. However, while it appears to be decreasing in the EU, Portugal shows one of the major increases in standard employment between 2008 and 2018 (57).

Employment status entails gender differences; there is generally an over-representation of women among part-time and temporary workers, although the latter to a lesser extent, whereas self-employment is predominantly male. In 2018, while 65% of men were in standard employment against 53% of women in the EU and the UK, Portugal's differential was, although only marginally, positive in favour of women (57). The main determinant of this gender difference is part-time work; the differentials tended to be much smaller in countries where

part-time work is less prevalent. In fact, part-time employment – whether permanent, fixed-term or self-employed – has increased at EU level and in the majority of Member States in the period 2008-2018, being Portugal one of the exceptions (57). In fact, part-time work in the country is still limited (7.9% of total employment compared to 18.5% for the EU-28 in 2019), particularly among women (10.7%), when compared to the average of 30.7% female employment at EU-28 level (58).

Often, better macroeconomic circumstances favour improved employment conditions, as employers make greater efforts to adapt to workers' preferences. In these circumstances, flexible work arrangements are more likely to be voluntary on the part of the worker, i.e., there is less recourse to part-time work as a buffer of flexibility. Thus, the proportion of involuntary part-time work among total employment is generally higher in countries with worst labour market performance comparing to those with structurally high part-time shares. On the other hand, and although weak, there is an indirect association between part-time work and involuntary part-time share of total employment; for example, the very high proportion of part-time work in the Netherlands coexists with a very low share of involuntary part-time work, while the opposite occurs in countries such as Portugal. The more prevalent part-time work is, the less likely it is that part-time work is involuntary (57).

Regarding self-employment, approximately 18% of Portuguese workers characterize themselves as being self-employed, which is in line with the EU average. However, and although 45% of self-employed opted for self-employment 'mainly through own personal preferences', a relatively high proportion of self-employed reported 'no other alternatives for work' as their reason (33%). The latter reason is more likely cited by those in elementary occupations (42%) and agricultural workers (26%), as well as by those in the transport (24%) and construction sectors (20%). While 10% of the EU workforce report being self-employed

without employees, Portugal stands out with 18%, together with Italy (18%) and Greece (26%) (59).

In Portugal, issues related to occupational health and safety were, in the early 1990s, a subject of little social relevance and the knowledge was reserved for a restricted set of specialists. That has since changed and occupational health is increasingly seeing its importance recognized among the different work-related actors (60), which has translated in an improvement in work-related health. Between 2005 and 2015, Portugal showed one of the substantial improvement concerning physical risks, with a 7-point increase in the Physical environment index, which comprises 13 indicators related to specific physical hazards, even surpassing the EU average (59). However, data from the Fifth European Working Conditions survey shows that Portuguese workers report more frequently being exposed to ergonomic risk factors compared to the euro area (6). Portugal also shows a less favourable psychosocial profile. According to Karasek's Job Demand Control Model (61), high-strain jobs are the most frequent in Portugal – 34.7% of workers report demanding jobs with very little control, against 27.1% in the euro area – followed by passive jobs, simple jobs with little to no decision latitude (26.0% against 20.5% in the euro area). On the other hand, active jobs are the least frequent in Portugal, particularly when compared to the euro area (16,6% and 23,8%, respectively). Moreover, Portuguese workers report more frequently that work negatively affects their health compared to the euro area (6).

1.4.1. Leave policies and family

Over the last decades, leave entitlements have increased in most European countries and only recently paternal leaves were put in place in many countries (62). In Portugal, although mothers can take up to 30 days of non-mandatory initial parental leave before birth (63), pregnant women opt for a pregnancy-related sick leave. It consists of a 'leave in case of

medical risk during pregnancy', which is possible under the Labour Code at a 100% replacement rate, and is determined by medical examination (64). After birth, initial parental leave comprises 120 days with replacement rates at 100% of the former salary or 150 days of leave with 80% of the salary paid for the whole period. European countries that grant full compensation for the entire duration of the maternity leave include Austria, Croatia, Denmark, Estonia, France, Germany, Lithuania, Luxembourg, the Netherlands and Spain. Poland's replacement settlement is similar to Portugal's as women are paid at 100% only when the shorter leave option is chosen. It is obligatory for the mother to take 42 calendar days (six weeks) following the birth (Mothers-only Initial Parental leave), and the remaining period may be divided between parents by mutual agreement. An extra 30 days ('sharing bonus') is available if both parents share the leave; each parent takes a leave of 30 consecutive days or two periods of 15 consecutive days. It is mandatory for fathers to take 10 working days' exclusive parental leave of which 5 days must be taken consecutively immediately after birth and 5 days during the subsequent 30 days. The father also has an additional leave of 10 days, consecutive or not, which is not mandatory. These days must be used during the mother's initial leave (65). Paternal leave entitlements are obligatory only in three European countries (Portugal, Belgium and Italy) (66). The national incidence of cases where parental leave is shared by both parents has risen considerably: in 2005, 0.5% of fathers shared parental leave with mothers while in 2013 the proportion was 28.3% (67).

Legislation which entitles parents to reduce working hours specifically during their child's early months is fairly common. In Portugal, 'breastfeeding or nursing leave' includes a 2 hours per day reduction until the child is 12 months old with no reduction of earnings, in order to facilitate the (breast)feeding of the child. It can be taken by the father - which is also the case of, for example, Japan, Slovenia and Spain – or parents may share the nursing leave by taking one hour each, per day (66).

Only in a few countries are workers entitled to flexible working. In Portugal, parents with children below 12 years of age (no age limit in the case of a child with an illness or disability living in the same household) are entitled to work part-time or to flexible working, which means that the employee may choose, within certain limits, when to start and finish daily work with no reduction in working hours (66). In spite of the possibility for an easier reconciliation between work and family, these entitlements have a limited impact on the Portuguese labour market; flexibility is higher in the more qualified occupations, namely intellectual and scientific and managerial occupations (68). Grandparents are shown to be a very important source of childcare (69) and formal childcare arrangements are used for 30 hours or more, and the same happens in countries such as Denmark and Slovenia (70).

1.5. Context Relevance and Occupational Epidemiology

Even when focusing on a specific individual-level hypothesis, population-level epidemiology is important once it allows for the understanding of the historical, cultural, economic and social context rather than only searching for universal relationships (71).

It is thus important to emphasize the role of local knowledge. As an example, maternal work participation is likely to vary across countries with varying occupational gender gaps, as well as diverse social, cultural and economic contexts. While the employment rate of mothers with children aged 0-14 years in the EU was 68.2% in 2014, Portugal stood out with a proportion of maternal employment over 75%, together with Nordic countries such as Denmark and Sweden, and more distant from countries like Greece, Italy, and Spain, where maternal employment was below 60% (72), in spite of the Southern European long-hours culture. In addition, Portugal is one of the few European countries where over 90% of employed mothers work full-time hours (72), and the possibility of working part-time or with flexible working hours has a limited impact on the Portuguese labour market where flexibility is more visible in

qualified occupations (68). It is therefore important to take into account that every population has its own history, cultural and economic circumstances which will influence how and why people are exposed to specific risk factors, and how they respond to such exposures (71).

1.5.1. European cohorts and occupation

Official figures provide insight into notified and recognised occupational injuries and diseases, which only covers a very limited group of workers as well as health outcomes. Comprehensive approaches using complementary methods, in addition to official statistics, are required (73). Valuable information to complement data from registries can be obtained using population-based approaches, as they provide the perspective of the target population outside of the workplace setting. Traditionally, occupational epidemiology has focused on the study of causal relationships between adverse exposures and disease in a particular setting, where potential confounders such as socioeconomic status are generally dealt with through restriction. However, there is obviously a need for contrast in the study population (e.g. regarding socioeconomic status) if the role of occupation and job exposures is to be studied. Large population-based prospective studies thus constitute a unique opportunity to obtain information on work-related conditions and to provide worker-centred estimates of the burden associated with work-related health problems with less *a priori* constraints. And Europe has some of the most valuable cohorts for aetiological research worldwide, where information on social context dimensions is frequently collected. Using prospective longitudinal studies that repeatedly survey workers and/or their employers may be desirable once they are least affected by recall error, while also providing an adequate representation of a large spectrum of different occupations thus uncovering occupation groups usually underestimated in official statistics. Moreover, the evaluation setting of a population-based cohort is a key strength, since most studies of occupational health are conducted within the

work environment, where organizational constraints may affect the validity of the reported information. Resorting to cohorts may also introduce a life course perspective into occupational science, since it emphasizes a temporal and social perspective by looking back across an individual's or a cohort's life experiences, or across generations, for clues to current patterns of health and disease (74).

There has recently been an effort to co-ordinate and facilitate the exchange of knowledge and collaboration between cohorts and researchers. Successful EU-funded examples of that include: ENRIECO - Environmental Health Risks in European Birth Cohorts (75); CHICOS - Developing a Child Cohort Research Strategy for Europe (www.chicosproject.eu); EUCCONET – European Child Cohort Network (www.eucconet.com); BRIDGE Health - Health BRidging Information and Data Generation for Evidence-based Health Policy and Research; and LifeCycle - H2020 - Early Life Stressor and Lifecycle Health. CHICOS project has updated and enlarged a web-based database of birth cohorts (www.birthcohorts.net), originally established within the European programme Children Geno Network in 2005. This database contains detailed information on child development and health, child and parental exposures, parental characteristics and reproductive history, parental health, and child and parental biological samples collected at repeated time points throughout pregnancy and childhood (76). The LifeCycle Project brings together pregnancy and childhood cohorts and aims to develop a harmonized set of variables in each cohort necessary to perform multi-cohort analyses on different research questions (77). Thus, existing cohorts have been mainly used to study child health and its determinants, but they also consist of a valuable resource on parental employment and health, which has not yet been fully exploited.

Recently, the Network on the Coordination and Harmonisation of European Occupational Cohorts (OMEGA-NET), a 4-year (2017-2021) European Cooperation in Science & Technology (COST) Action, was created to optimise the use of occupational, industrial, and population

cohorts at the European level. It aims to advance collaboration of cohorts with extensive contemporary information on employment and occupational exposures, as well as advance co-ordination and harmonisation of both new and existing occupational exposure assessment efforts, and facilitation of an integrated research strategy for occupational health in Europe (78). The OMEGA-NET project allows for an efficient exploitation of European cohorts and for research on the complex interplay between work, work-life balance and health, while revealing the differences between genders, countries and socio-economic conditions (79). In fact, one of the tasks within this project consists of investigating employment patterns in the young, including employed mothers. Among other initiatives, they propose to look into data on maternal employment/occupation (e.g., occupation, type of contract, salary changes, number of working hours/week, psychosocial work environment), work-life conflicts (e.g., flexible working time, telework, maternity leaves, child care services, family composition), and lifestyle and health outcomes (including mental health, musculoskeletal pain, sleep disorders, use of medication). In order to provide an overview of the data available in birth cohorts, they have summarized information on maternal employment and health outcomes in those cohorts with occupational information that are registered in www.birthcohorts.net database. A total of 59 out of 103 birth cohorts had some occupational information. Among those, 30 collected information on employment status (e.g., employed, unemployed, inactive, student), 23 on job title (usually classified according to the International Standard Classification of Occupations, 1988 version - ISCO-88), and 44 on chemical occupational exposures. Data on heavy lifting was present in 25 cohorts, working hours in 11, and only 4 gathered information on work address, which can be linked with spatial data in a geographical information system (GIS) and provide information on built and social environments (62). The detail level among the different cohorts is heterogeneous and can be high. However, birth cohorts have the potential to address specific topics that cannot be easily assessed in traditional occupational epidemiology studies, namely working life trajectories in relation to reproductive life and work-family conflicts (18).

2. STUDY OBJECTIVES

The overall aim of this thesis was to explore current features of the relationship between work and health among women in Portugal. To do so, we used prospective data from mothers in the Generation XXI birth cohort, which allowed to not only focus on work-related health outcomes, but also to acknowledge family-level factors that account for the embeddedness of workers in households. Thus, the specific objectives of this thesis were:

Worker as individual

1. To estimate the work-life burden of occupational injuries (Paper I)
2. To identify clusters of co-occurring work-related diseases (Paper II)

Worker as mother

3. To assess the association between work situation at the beginning of pregnancy and sick leave during pregnancy (Paper III)
4. To estimate the association between child neurodevelopmental and behavioural problems and maternal unemployment (Paper IV)

3. PARTICIPANTS AND METHODS

The objectives of this thesis were accomplished through the analysis of data obtained from Generation XXI, a prospective population-based birth cohort study, from the recruitment at birth and follow-up evaluation waves at 7 and 10 years of age. Specifically, data on the history of work-related health problems and occupational injuries was collected at the 10-year-old follow-up, while data on maternal work participation was retrieved from baseline (pregnancy-related sick leave) and the 7- and 10-year-old assessment waves (unemployment). A general description of Generation XXI participants and data collection procedures is provided below. Additional details about the study have been published elsewhere (76, 80). The selection of participants eligible for each paper analysis depends on the specific objectives of the investigations and is described in detail in the methods sections of each individual chapter.

3.1. The Generation XXI cohort study

Generation XXI is the first Portuguese birth cohort study. The cohort was assembled during 2005 and 2006 in the Porto Metropolitan Area. It was established as a multi-purpose prospective population-based cohort that aims to characterize prenatal and postnatal growth and development, and identify their determinants, in order to better understand health in childhood and later in adolescence and adulthood, thereby contributing to health gains among the population.

3.1.1. Participants

Recruitment took place between April 2005 and August 2006 at the five public maternity units providing obstetrical and neonatal care covering, at the time, the metropolitan area of Porto, Portugal. The five maternities included in the study were Centro Hospitalar de Vila Nova de Gaia, Centro Hospitalar do Porto - Maternidade de Júlio Dinis, Hospital de São João, Centro Hospitalar do Porto - Hospital de Santo António and Unidade Local de Saúde de Matosinhos -

Hospital Pedro Hispano. All these maternities corresponded to level III units, with differentiated perinatal support, and in 2004, were responsible for 91.6% of the deliveries in the whole catchment population, with the remaining occurring in private facilities.

In order to be eligible to participate, women had to reside in the catchment area - one of the six municipalities of the metropolitan area of Porto (Figure 4) - and deliver a live-born child with more than 23 weeks of gestation in one of the five units, during the cited period. Seventy percent of the eligible mothers were invited and, of these, 91.4% accepted to participate. A total of 8495 mothers and their infants (n=8647) were enrolled in the cohort study.

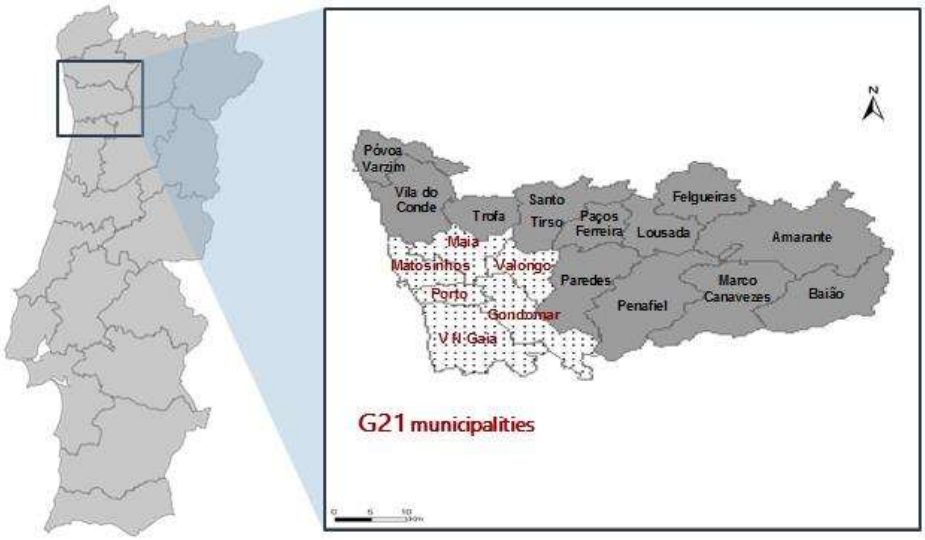


Figure 4. Representation of the six municipalities of the metropolitan area of Porto

3.1.2. Ethical considerations

Generation XXI study protocol complies with the Ethical Principles expressed in the Declaration of Helsinki and was approved by the Ethics Committee of the Hospital de São João and the University of Porto Medical School. The study protocol also conforms with the national legislation and is registered with the Portuguese Data Protection Authority. Procedures were developed in order to guarantee data confidentiality and protection. All participants received an explanation on the purposes and design of the study. Written informed consent was

obtained from all parents or legal guardians, and oral assent was obtained from children at each evaluation. Alternatively, verbal consent was explicitly solicited for the telephone interviews.

3.1.3. Data collection

At baseline, in the first 24 to 72 hours after delivery during the hospital stay, trained interviewers located at the five hospitals were responsible for presenting the Generation XXI study and inviting mothers. Data were collected in a face-to-face interview and clinical records at birth were reviewed by the trained interviewers.

Subsamples of the cohort were evaluated at the ages of 6 months, 15 months and 2 years (n=1555, n=1043 and n=855, respectively). Four years after birth, between April 2009 and July 2011, a follow-up evaluation of the entire cohort was performed and 7459 children, corresponding to 86.3% of the cohort, were re-evaluated. Of these, 5987 children (69.2% of the cohort) were evaluated in a face-to-face interview while for 1472 children (17.0% of the cohort), that were unable to attend an in person evaluation, a shorter version of the questionnaire was completed by legal guardians in a telephone interview. Between April 2012 and April 2014, all families were again invited to attend the 7-year follow-up of the cohort. Overall, 6889 children were reassessed (79.7% of the entire cohort), of which 5849 children (67.6% of the cohort) were evaluated in person and 1040 (12.0% of the cohort) provided information via telephone interview. A subsequent evaluation of the cohort took place between July 2015 and July 2017, when children were 10 years of age, and 6397 children (76.0% of the cohort) were reevaluated.

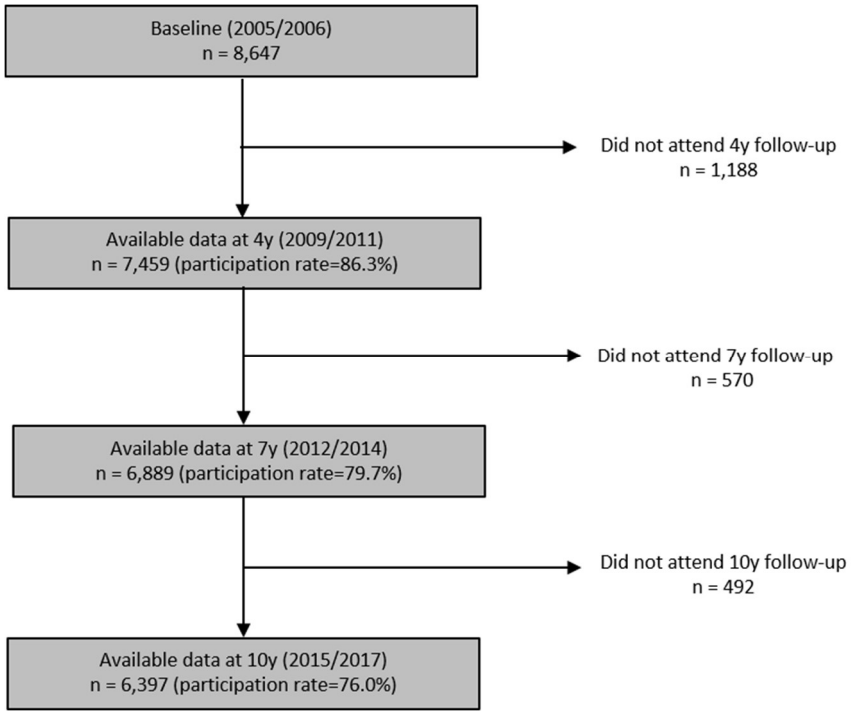


Figure 5. Flowchart of Generation XXI participants.

Follow-up evaluations of the cohort took place at Departamento de Ciências da Saúde Pública e Forenses, e Educação Médica in the University of Porto Medical School. Standard procedures were established and adopted in all evaluations. A multidisciplinary team of interviewers and health professionals, which is periodically trained and supervised by the Generation XXI scientific committee, is responsible for administering structured questionnaires, performing the physical examination of parents and children, and extracting information from clinical records and from the National Health Service official health books.

The following description of procedures refers specifically to data collection sections from the baseline, age seven and age ten follow-up evaluations, since these were the cohort assessment waves from which data were retrieved in order to accomplish the objectives of this thesis.

a) Questionnaires

Face-to-face interviews, using structured questionnaires designed by a multidisciplinary team, were conducted in order to obtain information on the following areas:

- Sociodemographic characteristics: including caregivers' date of birth, educational level, marital status, household income and other socioeconomic indicators.
- Child and family medical history: including maternal smoking status, existence of chronic diseases, child neurodevelopmental and behavioural problems and maternal gynaecologic and obstetric history.
- Work-related characteristics: including history of work-related health problems and occupational injuries, occupation, employment status, nature of employment job autonomy, and maternal work participation, whether measured via unemployment status or sick leave during pregnancy.

b) Physical examination

Anthropometric assessment was obtained by collecting data on weight and height while the participants stood barefoot in light indoor clothing and body mass index was calculated as weight (in kilograms) divided by square height (in metres).

c) Review of clinical records and National Health Service official pregnancy and children's health book

At the baseline evaluation, obstetric clinical records held at the maternity units and the National Health Service official pregnancy booklet were reviewed. The latter consists of a record of check-ups, ultrasounds, tests and medical notes provided as part of routine primary care to all pregnant women. These records were reviewed with the purpose of recovering only data that were missing from the baseline questionnaire, including data on prenatal care, pregnancy complications, pregnancy anthropometrics, and delivery and neonatal characteristics such as childbirth weight, length and gestational age.

4. RESULTS

4.1. Work-life prevalence of self-reported occupational injuries in mothers of a birth cohort

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Work–life prevalence of self-reported occupational injuries in mothers of a birth cohort

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Purpose. This study investigated self-reported occupational injuries among mothers in a large birth cohort study and the relation of their characteristics to different injury outcomes: occurrence, severity, temporal proximity and recurrence. *Methods*. We asked 4338 women whether they had been in 'an accident at work, even if it did not require medical treatment', and the number of accidents throughout their working life, type of injury and whether it occurred within the last 12 months. *Results*. Over one-fifth (21.8%) of working-age mothers reported having at least one occupational injury throughout their working life. Wounds and superficial injuries were the most frequently reported types of occupational injuries (11.0%), followed by dislocated bones and joints, sprains and strains (10.7%). Women who reported a history of occupational injuries also had a higher likelihood of reporting a work-related health problem (adjusted odds ratio [OR] = 2.64; 95% confidence interval [CI] [2.27, 3.07]) and of having a partner who also reported an occupational injury throughout their working life (adjusted OR = 1.86; 95% CI [1.33, 2.62]). Associations remained fairly stable across all outcomes. *Conclusions*. Our findings point towards a broadened understanding of occupational injury consequences and research focusing on family-level factors that account for the embeddedness of workers in households.

Keywords: cohort study; women's health; occupational injuries

1. Introduction

Over the last decades, there has been a shift in the allocation of families' market and non-market time mainly due to two key social transformations. On the one hand, women have moved into the labour market in large numbers, particularly in affluent countries, thus increasing female labour-force participation [1,2] and decreasing the amount of time available for non-market activities. On the other hand, there has been a rise in the number of single-parent families [3], which are typically headed by women, concentrating both work and non-work activities on a single individual. As a consequence, families have less time available and resources are stretched to the point that there is little flexibility to deal with major crises such as an occupational injury, particularly in families with children [1].

Attempts to describe occupational accidents and injuries are often based on routine government statistics [4], or restricted to a specific occupational group, sector of activity or type of injury [5–8]. However, relying on those data sources often results in an underrepresentation of certain professionals or case types that are, by design, less likely to be covered by that specific data system or selection criterion. Population-based sampling approaches may constitute a valuable and complementary source of the target population's perspective, allowing one to obtain comprehensive, worker-centred estimations of the burden of occupational injuries with no a priori constraints related to selective coverage of different occupations or types of injuries. This is especially key when focusing on less well-covered population groups, i.e., workers in the informal economy, self-employed or in precarious jobs, who are usually underrepresented in official statistics [9,10]. The same happens with milder injuries, which are less likely to be formally reported [10] and may be more easily captured outside the workplace. In this regard, ongoing prospective birth cohort studies are privileged settings to capture occupational health from a population perspective, particularly from women. Typically, interval follow-ups of mothers comprise the collection of information on family and social dimensions, including work-related outcomes, thus acknowledging the worker's embeddedness in the household and within the family context. Specifically, birth cohorts allow for the research on the co-occurrence of work-related injuries within the same household.

Thus, we aimed to describe self-reported occupational injuries among mothers of a large birth cohort study and to assess the relationship between their individual and occupational characteristics and different injury outcomes: occurrence, severity, temporal proximity and recurrence.

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2. Methods

2.1. Participants

This study was conducted using data from Generation XXI, a prospective population-based birth cohort established in Porto, Portugal, which has been described in detail elsewhere [11,12]. In brief, recruitment took place between April 2005 and August 2006 at all public level III hospital maternities covering the metropolitan area of Porto, responsible for 91.6% of all deliveries in the catchment area at the time of recruitment. Of the invited mothers, 91.4% agreed to participate. A total of 8495 mothers and 8647 children were enrolled at baseline. The cohort has been followed since the child's birth, with four assessment waves completed as of December 2019 (at birth and 4, 7 and 10 years of age). This study retrieved data from the 7-year-old (April 2012–April 2014) and 10-year-old (July 2015–July 2017) assessment waves.

For the present analysis, we selected all women ($n = 4338$) who accompanied their child to the 10-year-old follow-up and had valid information on occupational injuries, age and educational level. When compared to the remaining mothers ($n = 4156$), women included in this study were older (30.0 vs. 27.9 years), had higher educational level (11.2 vs. 9.7 schooling years) and had a lower probability of having blue-collar jobs (21.3 vs. 25.7%).

The Generation XXI cohort study was approved by the Ethics Committee of São João Hospital/University of Porto Medical School and complies with the Helsinki Declaration and the current national legislation. The project was registered with the National Committee of Data Protection. Written informed consent was obtained for the collection of information and biological samples at all assessment waves.

2.2. Data collection

2.2.1. Work-related characteristics

Mothers accompanying their children to the 7-year-old follow-up were asked about their occupational history. The maternal job title (current or previous if unemployed or retired) was collected and classified according to the Portuguese Classification of Occupations 2010, which is based on the International Standard Classification of Occupations (ISCO-08) [13]. Occupations were grouped as follows: (a) managers and professionals (ISCO codes 1 and 2); (b) technicians and associate professionals (ISCO code 3); (c) clerical support workers (ISCO code 4); (d) services and sales workers (ISCO code 5); (e) skilled agricultural, forestry and fishery workers and craft and related trades workers (ISCO codes 6 and 7); (f) plant and machine operators and assemblers (ISCO code 8); (g) elementary occupations (ISCO code 9). Additionally, the nature of employment was defined as civil service/public sector, private sector, self-employment or other (e.g., homemaker). Participants were also asked about whether they ever had work-related health problems not arising from a work-related accident.

2.2.2. Individual characteristics

Maternal age was collected in the 10-year-old wave. The remaining covariates were collected in the 7-year-old wave. Data on marital status were collected, and education was recorded as the number of completed schooling years and grouped as ≤9, 10–12 or >12 years of education. Regarding household characteristics, a single-mother family was defined as women living with the cohort's child but not with the father or a partner, and the number of children, including stepchildren, was categorized into groups of one, two and three or more children. Monthly household income was recorded in EUR 500 categories and was grouped into three classes: EUR ≤1000, 1001–1500 and >1500. The categories were defined to guarantee a uniform distribution of the participants across the classes, with the first class including a situation where both parents earned at least the minimum national wage at time of evaluation (EUR 485.00 per month in 2013 [14]). Weight and height were measured to the nearest 0.1 kg and 0.1 cm, respectively, by trained examiners and according to standard procedures. Body mass index (BMI) was calculated and categorized as underweight/normal weight, overweight or obesity [15]. Smoking status was assessed and participants were categorized as current smoker (daily or less than daily), former smoker (not smoking for at least 6 months) or never smoker. Sleep duration was assessed by asking mothers how many hours they slept per day, on average, both during workdays and days off. The average number of hours slept per day was computed and sleep length was categorized into <7 and ≥7 h.

2.2.3. Occupational injuries

Mothers accompanying children to the 10-year-old follow-up were asked to complete a self-administered questionnaire, an adaptation of the 2013 Labour Force Survey (LFS) ad-hoc module on 'accidents at work and other work-related health problems' [16]. Participants were asked whether they had ever been in 'an accident at work, even if it did not require medical treatment', commuting accidents excluded. They were also asked the number of accidents at work they had been involved in throughout their working life, which were grouped as none/one versus recurrent (two or more), and whether any of these occurrences resulted in an injury. In the present study, we defined our outcome – occupational injury – as an occurrence at work that resulted in an injury (near misses excluded). Injury classification was based on Eurostat [17] and categorized as follows: (a) wounds and superficial injuries; (b) bone fractures; (c) dislocations, sprains and strains; (d) concussion and internal injuries; (e) burns, scalds and frostbite; (f) (the open-ended option) other types of injuries.

The latter was disaggregated into two additional categories, according to their frequency: (g) traumatic amputations; (h) poisonings and infections. Based solely on the type of injury, its severity was dichotomized as severe, which included injury categories (b), (d), (e), (g) or (h), and absent/mild, which included women with no injuries or with injuries included in categories (a) or (c). Women were also asked whether any of the occupational accidents previously reported occurred within the last 12 months. Data on paternal history of occupational injuries were retrieved from the biological fathers themselves at the same follow-up and only those who were part of the same household as the mother at the time were included in this analysis ($n = 3698$).

2.3. Statistical analysis

A logistic regression model was used to calculate adjusted odds ratios (ORs) and associated confidence intervals (CIs) at 95% in order to estimate the associations between women's characteristics and reported occupational injuries. Only differences with a p value below 0.05 were selected for interpretation. The following four different outcomes were used: occurrence (any injury vs. none), severity (severe injury vs. mild/none), temporal proximity (previous 12 months vs. older/none) and recurrence (two or more vs. one/none). Two-way interactions between age, education, occupational group and reporting work-related health problems were tested, and no significant statistical interactions were found. Statistical analysis was performed using SPSS version 21.0.

3. Results

3.1. Background characteristics

Table 1 summarizes participants' individual and work-related characteristics. Most women were aged 45 years or younger (85.4%), were married or in a civil union (87.1%), lived with a partner (86.6%), had two children (50.3%), had never smoked (63.4%) and had ≥7 h sleep per day (65.0%). Over a third of the participants completed less than 10 years of education (37.9%), 43.5% had a household income of more than EUR 1500 per month and 45.5% were underweight or had normal weight. Services and sales workers as well as professionals were the most frequent occupational groups in our sample (28.6 and 21.5%, respectively), 66.0% of women worked in the private sector and 31.6% reported previous work-related health problems.

3.2. Work-related injuries

Figure 1 shows the breakdown by injury outcome. In our sample, the prevalence of at least one occupational injury since the beginning of working life was 21.8% (95% CI [20.6, 23.0%]; $n = 946$). Regarding specific injury outcomes, 8.6% (95% CI [7.8, 9.5%]) suffered a severe injury, 5.0% (95% CI [4.4, 5.7%]) had an injury within the last 12 months and 9.7% (95% CI [8.8, 10.6%]) had recurrent (≥2) injuries. The most frequently reported type of work injury was wounds and superficial injuries (11.0%), followed by dislocated bones and joints, sprains and strains injury category (10.7%).

Associations between occupational injuries and women's characteristics are depicted in Figure 2. Women had lower odds of reporting occupational injuries if they had over 9 years of schooling (age-adjusted OR = 0.69, 95% CI [0.58, 0.82] and age-adjusted OR = 0.41, 95% CI [0.34, 0.49] for 10–12 and >12 schooling years, respectively), a monthly household income of EUR >1500 (age- and education-adjusted OR = 0.67, 95% CI [0.55, 0.83]) and an average sleep duration of ≥7 h (adjusted OR = 0.77, 95% CI [0.66, 0.90]). Obesity (adjusted OR = 1.40, 95% CI [1.15, 1.71]) and smoking (adjusted OR = 1.19, 95% CI [1.00, 1.41]) were associated with higher odds of occupational injuries (detailed in Supplemental Table 1).

Figure 3 depicts the age- and education-adjusted associations between women's work-related characteristics and occurrence, severity, temporal proximity and recurrence of occupational injuries. Women reporting any occupational injury had higher odds of having a blue-collar job, i.e., skilled agricultural, forestry and fishery workers and craft and related trades workers (adjusted OR = 1.78, 95% CI [1.21, 2.61]), plant and machine operators and assemblers (adjusted OR = 1.82, 95% CI [1.20, 2.74]) and elementary occupations (adjusted OR = 1.56, 95% CI [1.08, 2.25]), or working in services and sales (adjusted OR = 1.69, 95% CI [1.28, 2.24]). When compared to managers/professionals, women in elementary occupations reported severe (adjusted OR = 1.82, 95% CI [1.06, 3.11]) and recent (adjusted OR = 1.99, 95% CI [1.03, 3.86]) injuries more frequently.

Private-sector and self-employed workers were less likely to report an occupational injury when compared to civil service/public sector workers (adjusted OR = 0.77, 95% CI [0.62, 0.95] and adjusted OR = 0.50, 95% CI [0.37, 0.67], respectively), and similar associations were found when the outcomes were recent or recurrent occupational injuries. No clear associations were found between the sector of activity and history of severe injury. Having experienced a non-accident work-related health problem was also significantly associated with reporting an occupational injury (adjusted OR = 2.64, 95% CI [2.27, 3.07]). The magnitude of this association was even stronger when severe, recent and recurrent injuries were the outcome. Women were more likely to report an occupational injury if their partner also reported at least one occupational injury throughout his working life (adjusted OR = 1.86; 95% CI [1.33, 2.62]). With the exception of injuries occurring in the previous year, associations remained similar for injury

Table 1. Individual and work-related characteristics according to occupational injuries' occurrence, severity, temporal proximity and recurrence.

Participants' characteristics	Total (n = 4338)	Any occupational injury: No (n = 3392)	Any occupational injury: Yes (n = 946)	Injury severity: Absent/mild (n = 3964)	Injury severity: Severe (n = 374)	Injury in the last 12 months: No (n = 4119)	Injury in the last 12 months: Yes (n = 219)	Injury number: None or one (n = 3917)	Injury number: Two or more (n = 421)
Individual characteristics									
Age (years), n (%)									
≤35	755 (17.4)	560 (16.5)	195 (20.6)	679 (17.1)	76 (20.3)	703 (17.1)	52 (23.7)	671 (17.1)	84 (20.0)
36–45	2949 (68.0)	2344 (69.1)	605 (64.0)	2707 (68.3)	242 (64.7)	2814 (68.3)	135 (61.6)	2678 (68.4)	271 (64.4)
>45	634 (14.6)	488 (14.4)	146 (15.4)	578 (14.6)	56 (15.0)	602 (14.6)	32 (14.6)	568 (14.5)	66 (15.7)
Education (schooling years), n (%)									
≤9	1646 (37.9)	1176 (34.7)	470 (49.7)	1418 (35.8)	228 (61.0)	1527 (37.1)	119 (54.3)	1418 (36.2)	228 (54.2)
10–12	1324 (30.5)	1038 (30.6)	286 (30.2)	1229 (31.0)	95 (25.4)	1261 (30.6)	63 (28.8)	1207 (30.8)	117 (27.8)
>12	1368 (31.5)	1178 (34.7)	190 (20.1)	1317 (33.2)	51 (13.6)	1331 (32.3)	37 (16.9)	1292 (33.0)	76 (18.1)
Marital status, n (%)									
Married/civil union	3775 (87.1)	2963 (87.4)	812 (85.8)	3459 (87.3)	316 (84.5)	3586 (87.1)	189 (86.3)	3417 (87.3)	358 (85.0)
Separated/divorced/widower	439 (10.1)	335 (9.9)	104 (11.0)	393 (9.9)	46 (12.3)	419 (10.2)	20 (9.1)	391 (10.0)	48 (11.4)
Single	122 (2.8)	92 (2.7)	30 (3.2)	110 (2.8)	12 (3.2)	112 (2.7)	10 (4.6)	107 (2.7)	15 (3.6)
Single-mother family, n (%)									
No	3732 (86.6)	2934 (87.1)	798 (85.0)	3421 (86.9)	311 (84.1)	3547 (86.8)	185 (84.5)	3377 (86.9)	355 (84.5)
Yes	575 (13.4)	434 (12.9)	141 (15.0)	516 (13.1)	59 (15.9)	541 (13.2)	34 (15.5)	510 (13.1)	65 (15.5)
Number of children, n (%)									
1	1631 (37.8)	1290 (38.2)	341 (36.3)	1487 (37.7)	144 (38.8)	1563 (38.2)	68 (31.1)	1485 (38.1)	146 (34.8)
2	2170 (50.3)	1676 (49.7)	494 (52.6)	1991 (50.5)	179 (48.2)	2052 (50.1)	118 (53.9)	1953 (50.2)	217 (51.7)
3+	513 (11.9)	408 (12.1)	105 (11.2)	465 (11.8)	48 (12.9)	480 (11.7)	33 (15.1)	456 (11.7)	57 (13.6)
Monthly household income (EUR), n (%)									
≤1000	1181 (27.9)	871 (26.4)	310 (33.5)	1032 (26.7)	149 (41.0)	1115 (27.8)	66 (30.6)	1037 (27.2)	144 (34.9)
1001–1500	1206 (28.5)	875 (26.5)	331 (35.8)	1081 (28.0)	125 (34.4)	1116 (27.8)	90 (41.7)	1049 (27.5)	157 (38.0)
>1500	1839 (43.5)	1555 (47.1)	284 (30.7)	1750 (45.3)	89 (24.5)	1779 (44.4)	60 (27.8)	1727 (45.3)	112 (27.1)
BMI categories, n (%)									
Underweight/normal weight	1811 (45.5)	1481 (47.5)	330 (38.3)	1695 (46.6)	116 (33.9)	1739 (46.1)	72 (35.6)	1668 (46.4)	143 (37.1)
Overweight	1315 (33.1)	1010 (32.4)	305 (35.4)	1196 (32.9)	119 (34.8)	1243 (32.9)	72 (35.6)	1181 (32.9)	134 (34.8)
Obesity	852 (21.4)	626 (20.1)	226 (26.2)	745 (20.5)	107 (31.3)	794 (21.0)	58 (28.7)	744 (20.7)	108 (28.1)

(*Continued*)

Table 1. Continued.

Participants' characteristics	Total (n = 4338)	Any occupational injury: No (n = 3392)	Any occupational injury: Yes (n = 946)	Injury severity: Absent/mild (n = 3964)	Injury severity: Severe (n = 374)	Injury in the last 12 months: No (n = 4119)	Injury in the last 12 months: Yes (n = 219)	Injury number: None or one (n = 3917)	Injury number: Two or more (n = 421)
Smoking status, n (%)									
Never	2748 (63.4)	2171 (64.1)	577 (61.1)	2531 (64.0)	217 (58.0)	2612 (63.5)	136 (62.1)	2513 (64.3)	235 (56.0)
Former	618 (14.3)	492 (14.5)	126 (13.3)	567 (14.3)	51 (13.6)	583 (14.2)	35 (16.0)	555 (14.2)	63 (15.0)
Current	965 (22.3)	724 (21.4)	241 (25.0)	859 (21.7)	106 (28.3)	917 (22.3)	48 (21.9)	843 (21.6)	122 (29.0)
Sleep length (h), n (%)									
<7	1483 (35.0)	1120 (33.8)	363 (39.5)	1341 (34.6)	142 (39.1)	1399 (34.8)	84 (39.8)	1311 (34.3)	172 (41.7)
≥7	2751 (65.0)	2196 (66.2)	555 (60.5)	2530 (65.4)	221 (60.9)	2624 (65.2)	127 (60.2)	2511 (65.7)	240 (58.3)
Self-reported history of partner's occupational injuries, n (%)									
No	539 (59.6)	459 (63.1)	80 (44.9)	507 (60.9)	32 (43.8)	523 (60.3)	16 (43.2)	507 (61.7)	32 (38.6)
Yes	366 (40.4)	268 (36.9)	98 (55.1)	325 (39.1)	41 (56.2)	345 (39.7)	21 (56.8)	315 (38.3)	51 (61.4)
Work-related characteristics									
Occupational group, n (%)									
Managers	158 (3.8)	127 (3.9)	31 (3.3)	144 (3.8)	14 (3.8)	148 (3.7)	10 (4.6)	141 (3.7)	17 (4.1)
Professionals	900 (21.5)	767 (23.6)	133 (14.3)	872 (22.9)	28 (7.5)	875 (22.1)	25 (11.6)	845 (22.4)	55 (13.2)
Technicians and associate professionals	457 (10.9)	380 (11.7)	77 (8.3)	425 (11.1)	32 (8.6)	442 (11.1)	15 (6.9)	424 (11.3)	33 (7.9)
Clerical support workers	587 (14.0)	504 (15.5)	83 (8.9)	558 (14.6)	29 (7.8)	570 (14.4)	17 (7.9)	563 (14.9)	24 (5.8)
Services and sales workers	1197 (28.6)	856 (26.3)	341 (36.7)	1055 (27.7)	142 (38.2)	1118 (28.2)	79 (36.6)	1044 (27.7)	153 (36.7)
Skilled agricultural, forestry and fishery workers	13 (0.3)	5 (0.2)	8 (0.9)	11 (0.3)	2 (0.5)	11 (0.3)	2 (0.9)	8 (0.2)	5 (1.2)
Craft and related trades workers	258 (6.2)	182 (5.6)	76 (8.2)	230 (6.0)	28 (7.5)	242 (6.1)	16 (7.4)	219 (5.8)	39 (9.4)
Plant and machine operators and assemblers	196 (4.7)	135 (4.1)	61 (6.6)	164 (4.3)	32 (8.6)	182 (4.6)	14 (6.5)	165 (4.4)	31 (7.4)
Elementary occupations	418 (10.0)	298 (9.2)	120 (12.9)	353 (9.3)	65 (17.5)	380 (9.6)	38 (17.6)	358 (9.5)	60 (14.4)
Nature of employment, n (%)									
Civil service/public sector	801 (19.1)	632 (19.4)	169 (18.2)	761 (19.9)	40 (10.8)	760 (19.1)	41 (19.1)	723 (19.1)	78 (18.9)
Private sector	2768 (66.0)	2123 (65.0)	645 (69.4)	2487 (65.0)	281 (76.2)	2622 (65.9)	146 (67.9)	2487 (65.8)	281 (68.0)
Self-employed	526 (12.5)	441 (13.5)	85 (9.1)	486 (12.7)	40 (10.8)	510 (12.8)	16 (7.4)	488 (12.9)	38 (9.2)
Other (e.g., homemaker)	100 (2.4)	70 (2.1)	30 (3.2)	92 (2.4)	8 (2.2)	88 (2.2)	12 (5.6)	84 (2.2)	16 (3.9)
Work-related health problems, n (%)									
No	2960 (68.4)	2470 (73.0)	490 (52.1)	2782 (70.4)	178 (48.0)	2860 (69.6)	100 (45.9)	2780 (71.2)	180 (43.0)
Yes	1365 (31.6)	915 (27.0)	450 (47.9)	1172 (29.6)	193 (52.0)	1247 (30.4)	118 (54.1)	1126 (28.8)	239 (57.0)

Note: BMI = body mass index

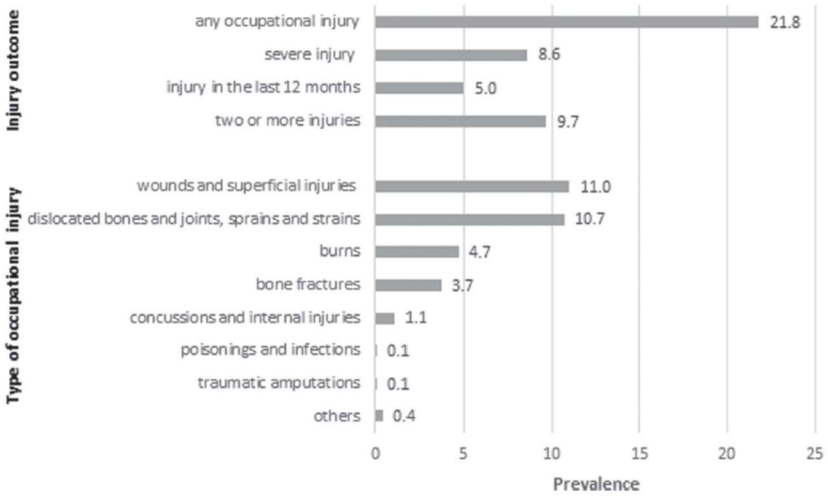

Figure 1. Prevalence (%) of each injury outcome and of type of occupational injury in Generation XXI mothers.

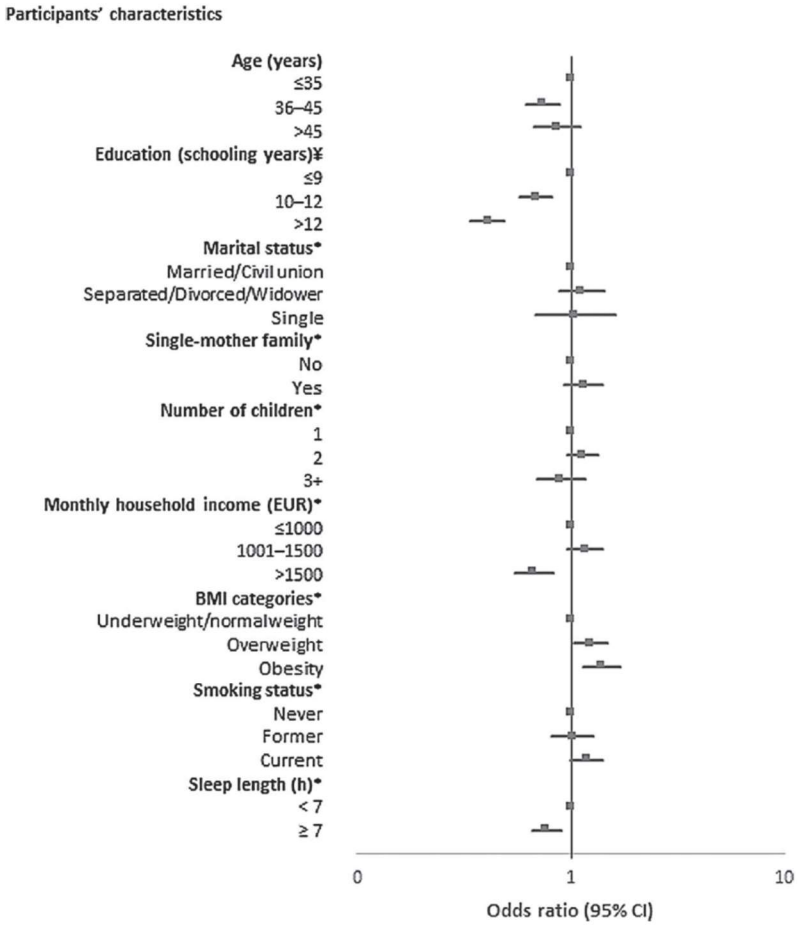

Figure 2. Association between participants' characteristics and reporting at least one occupational injury.
Note: The odds ratios and 95% confidence intervals (CIs) presented are estimated by logistic regression models and showed on a log scale with base 10. ¥Adjusted for age (years). *Adjusted for age and education (years). BMI = body mass index.

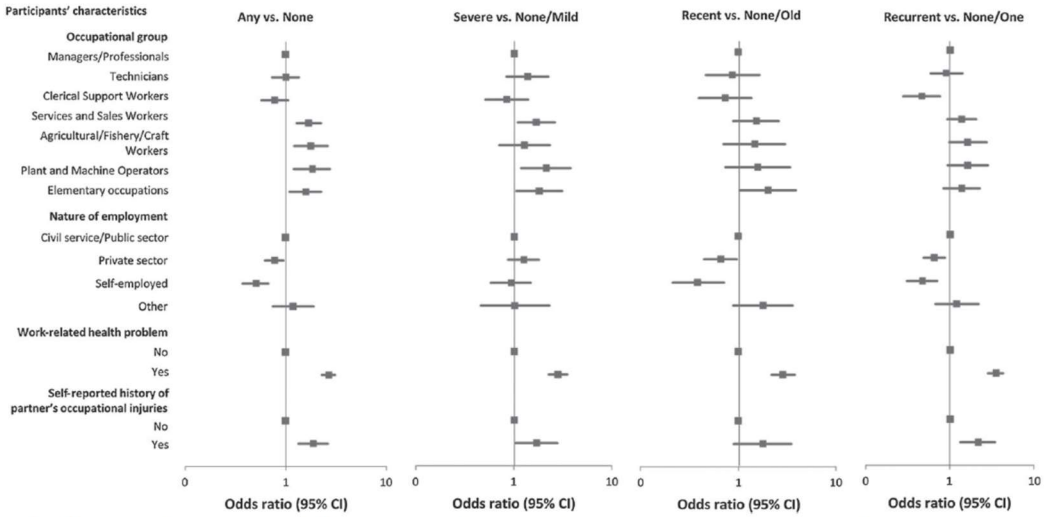

Figure 3. Association between women's characteristics and reporting at least one occupational injury, according to its occurrence, severity, temporal proximity and recurrence.
Note: The odds ratios and 95% confidence intervals (CIs) presented are estimated by logistic regression models, adjusted for age and education (years) and showed on a log scale with base 10.

severity and recurrence. The predictive performance of the model was low, with r^2 estimates below 10%, and the predictive accuracy of the model varied between 77.8 and 95.9%. Detailed estimates are presented in Supplemental Table 2.

4. Discussion

In our study, over a fifth of working-age mothers reported at least one occupational injury throughout their working life, while 5% had sustained an injury in the previous year. The latter is considerably higher than other national and European estimates of occupational injury based on self-reporting by women in 2013: 2.9 and 2.3%, respectively [18]. Wounds and superficial injuries were the most frequently reported type of injury sustained, followed by dislocated bones and joints, sprains and strains, which is in line with previous descriptions at both national and European levels [4,19]. Most importantly, women who reported a history of occupational injuries also had higher likelihood of reporting a work-related health problem and of having a partner who reported an occupational injury throughout their working life. This pattern remained fairly stable throughout the analysis for all injury outcomes – occurrence, severity, temporal proximity and recurrence.

Although occupational injury research is commonly shaped by the higher burden of work-related accidents among men, understanding occupational accidents among women is also of key importance. In fact, despite men typically taking up higher-risk nature jobs (accidents are more frequent in the mining, manufacturing or construction sectors, which tend to be male-dominated) and spending more total time at work [19], some studies show women may be at higher injury risk than men when performing the same occupation [20,21] while also more frequently holding non-standard contracts [22]. This emphasizes the potential of using a large population-based cohort of mothers as a valuable and complementary source of information to describe occupational accidents.

The extent to which non-work-related factors may increase the risk of occupational injuries has been previously studied. Our findings that younger employees have higher chances of reporting occupational injuries are consistent with several previous estimates [4,23], even though this pattern is usually less evident in women [24]. Since the recall period in our study is the whole working life, three considerations should be taken into account when interpreting the above-mentioned result, even though the mechanistic explanations behind our findings were not covered by this study. The first hypothesis consists of a combination of two phenomena: younger women being at higher risk [25] and/or older women selectively underreporting accident history. This, however, cannot fully explain our results, as the odds of reporting recent injuries among older women remain lower than those in younger women and change only marginally (OR = 0.72; 95% CI [0.46, 1.13]) when compared to reporting any injury. Secondly, another possible explanation for our findings is a birth cohort effect in the underlying risk: at a given age, women born more recently may have higher risk occupations when compared to women in older cohorts. Although we did not assess risk directly, this does not seem to fully explain our results

since work conditions and safety interventions have been improving over the last years and, subsequently, occupational injuries have been slightly decreasing [26]. Lastly, our findings may also be explained by an increase in awareness by younger employees regarding work and safety issues, even though we did not measure this aspect.

Lower educational level and household income were also strong predictors of occupational injuries in our sample, a finding that is consistent with previous estimates [24] and likely influenced by the different distribution of occupations among the different levels of educational attainment. As in previous studies [23,27–30], obesity was associated with occupational injuries in the present analysis. Chronic disease, fatigue or sleepiness and physical limitations are proposed mechanisms by which obesity influences accident occurrence, although the mechanism is still unclear [31]. Previous research has addressed the mechanisms explaining the association between smoking and occupational injuries. In addition to fire hazards, smoking may lead to cognitive and vision impairment, and heavy smoking tends to decrease sleep quality, thus leading to a higher risk of fatigue [32–34]. Smoking may also function as a marker of risk-taking personality or behavioural traits [32,35]. Regarding sleep duration, our findings are in line with previous reviews on the topic of sleep problems and workplace injuries [36,37]. In fact, it has been estimated that approximately 13% of work injuries could be attributed to sleep problems [36].

Regarding work-related risk factors, our results are consistent with other self-reported estimates. European self-reported estimates show that women in blue-collar jobs report higher frequency of accidents at work, i.e., 'plant and machine operators, assemblers and elementary occupations', closely followed by 'skilled agricultural, forestry and fishery workers, craft and related trades workers' and 'clerical support workers, service and sales workers'. Also, injuries are less common among self-employed women, which may reflect the observation that self-employed workers tend to perform more managerial/administrative tasks that comprise a lower risk of accident [24].

In our study, women who experienced a work-related health problem were more likely to report an occupational injury, and this finding was consistent across severity, temporal proximity and recurrence outcomes. This may be explained by the sharing of common occupational hazards of both work-related health problems and occupational injuries, and also by some level of misclassification, e.g., acute episodes of chronic musculoskeletal problems, such as those occurring after lifting of heavy loads, may have been reported and classified as accidents. Moreover, injuries tended to aggregate in the same household since women were more likely to report an occupational injury if the partner also reported at least one injury at work, and this pattern remained fairly stable across all injury outcomes. Our results suggest that research efforts with a greater attention on broadened, family-level findings regarding work and health may provide important information, and prospective birth cohort studies are a privileged setting to consider the embeddedness of workers in households.

Research focusing on women's occupational injuries is limited but of great importance. Women are more likely than men to work part-time jobs and labour market segregation remains high; the uneven concentration of women in typically lower-paid sectors of the labour market is still a concern [38]. Also, in recent decades, women's work participation has increased considerably [1,2] as well as the number of single-parent households [3]. Women now have less time available for non-market activities (i.e. time for housework, childcare, leisure and even sleep) and, in the event of a crisis such as an accident, families are increasingly less equipped to cope with it [1]. This is particularly relevant for women once there is still an uneven task distribution at home – even when both partners work full time – and women are still a family's primary caregiver [1,39]. In addition to the financial burden and the workplace consequences, occupational injuries can also impose considerable time demands on the families. However, the family and social consequences of these injuries are often less visible. Research has shown that injured workers report a reduction in non-work activities, including household chores, outdoor chores, childcare and leisure activities with their spouses [40,41]. Also, while some household activities may go undone, other family members tend to cut back on their work, school and household tasks in order to fill in for the injured member and to take care of them [1]. Consequently, injuries can also have an impact on the injured worker's mental health, potentially leading to depression and strained family relationships [40,41]. Even though we did not collect information on the consequences of work-related injuries for families in this cohort, our results support that focusing solely on the economic and workplace consequences of occupational injuries provides a limited understanding of the social and family impacts of work-related injuries.

The interpretation of our findings needs to take into account several methodological issues. Our sample of mothers of a population-based birth cohort may have limited generalizability to the entire female workforce. Our participants are comparatively homogeneous with regard to certain sociodemographic characteristics, since they constitute a group of women from an urban setting who gave birth to a child in a specific period of time. In fact, women included in this study had a higher educational level (31.5% in our sample vs. 15.3% with more than 12 schooling years in the general female population resident in the northern region of Portugal) [42] and blue-collar jobs were underrepresented, particularly plant and machine operators and assemblers (4.7 vs. 12.2%) and elementary occupations (10.0 vs. 18.7%) [43]. Nonetheless, our sample had an unemployment rate of 17.6%, which

is in line with the 18.0% female unemployment rate in the region in 2013 [44]. In our study, while our estimates of injury prevalence used the entire working life as the reference period, participants' sociodemographic characteristics, job title and nature of employment referred only to the moment of data collection, which means they may not capture the whole working life exposure. However, 81.4% of women remained in the same occupational group (between low-skilled blue collar, high-skilled blue collar, low-skilled white collar and high-skilled white collar) from baseline until the 7-year-old assessment wave, and thus our assumption of job stability seems reasonable. Moreover, the classification of injury severity was based on broad types of injuries, which may have led to some misclassification given that we cannot guarantee homogeneity in severity within the same injury category.

Nevertheless, using a large population-based sample provided us with the complementary perspective of the target population outside the workplace setting, thus valuing an important fraction of less protected workers, such as those with informal or precarious jobs. Moreover, due to our strategy of sample selection from a prospective population-based birth cohort, our results point towards a broadened understanding of the health burden caused by occupational injury and research focusing on family-level factors that takes into account the embeddedness of workers in households, thus providing information for the design and implementation of interventions with working women's family context in mind.

In conclusion, over a fifth of working-age mothers reported at least one occupational injury throughout their working life and injury history was associated with also reporting non-accident work-related health problems. In terms of household burden, there was a clear association between mothers' and partners' history of occupational injury across all outcomes assessed, which may pose a double challenge for family and child well-being.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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Supplemental data and research materials

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Supplemental Table 1. Association between participants' individual characteristics and reporting at least one occupational injury.

Participants' characteristics	Occupational injury OR (95%CI)	p-value	Accuracy§	R^2¤
Individual characteristics				
Age (years)				
≤35	1			
36-45	0.74 (0.62-0.89)	0.002	78.2	0.004
>45	0.86 (0.67-1.10)	0.227		
Education (schooling years)¥				
≤9	1			
10-12	0.69 (0.58-0.82)	<0.001	78.2	0.034
>12	0.41 (0.34-0.49)	<0.001		
Marital status*				
Married/Civil union	1			
Separated/Divorced/Widower	1.12 (0.89-1.42)	0.341	78.2	0.027
Single	1.05 (0.69-1.61)	0.820		
Single mother family*				
No	1		78.2	0.027
Yes	1.15 (0.93-1.41)	0.200		
Nr. of children*				
1	1			
2	1.14 (0.97-1.33)	0.115	78.2	0.028
3+	0.90 (0.70-1.16)	0.428		
Monthly household income (euros)*				
≤1000	1			
1001-1500	1.17 (0.97-1.41)	0.096	78.1	0.039
>1500	0.67 (0.55-0.83)	<0.001		
BMI categories*				
Underweight/normal weight	1			
Overweight	1.24 (1.04-1.48)	0.020	78.4	0.033
Obesity	1.40 (1.15-1.71)	0.001		
Smoking status*				
Never	1			
Former	1.02 (0.82-1.27)	0.852	78.2	0.028
Current	1.19 (1.00-1.41)	0.053		
Sleep length (hours)*				
< 7	1		78.3	0.030
≥ 7	0.77 (0.66-0.90)	0.001		

The odds ratios and 95% confidence intervals presented are estimated by logistic regression models.

¥ Adjusted for age, in years.

* Adjusted for age and education, in years.

§ Predictive accuracy of the model (% correctly classified).

¤ Nagelkerke R^2

Supplemental Table 2. Association between women's characteristics and reporting at least one occupational injury, according to its occurrence, severity, temporal proximity and recurrence (OR and respective 95%CI).

Participants' characteristics	Any occupational injury Any vs None	*p*	Accuracy¥	R^{2}*	Injury's severity Severe vs None/Mild	*p*	Accuracy¥	R^{2}*	Injury in the last 12 months Recent vs None/Old	*p*	Accuracy¥	R^{2}*	Number of injuries Recurrent vs None/One	*p*	Accuracy¥	R^{2}*
Occupational group																
Managers/Professionals	1				1				1				1			
Technicians and Associate Professionals	0.99 (0.73-1.35)	0.963			1.37 (0.84-2.24)	0.202			0.87 (0.46-1.64)	0.667			0.91 (0.59-1.42)	0.678		
Clerical Support Workers	0.77 (0.57-1.05)	0.094			0.84 (0.51-1.40)	0.512			0.72 (0.39-1.35)	0.312			0.47 (0.28-0.77)	0.003		
Services and Sales Workers	1.69 (1.28-2.24)	<0.001	77.8	0.045	1.70 (1.09-2.64)	0.020	91.1	0.064	1.51 (0.88-2.59)	0.131	94.8	0.029	1.39 (0.94-2.06)	0.094	90.0	0.044
Agricultural/Forestry/Fishery/Craft Workers	1.78 (1.21-2.61)	0.003			1.29 (0.71-2.33)	0.401			1.45 (0.70-3.00)	0.322			1.65 (0.99-2.75)	0.057		
Plant and Machine Operators and Assemblers	1.82 (1.20-2.74)	0.005			2.12 (1.18-3.80)	0.012			1.56 (0.73-3.36)	0.254			1.64 (0.95-2.84)	0.076		
Elementary Occupations	1.56 (1.08-2.25)	0.017			1.82 (1.06-3.11)	0.029			1.99 (1.03-3.86)	0.041			1.38 (0.84-2.27)	0.203		
Nature of employment																
Civil service/Public sector	1				1				1				1			
Private sector	0.77 (0.62-0.95)	0.013			1.25 (0.87-1.80)	0.233			0.65 (0.44-0.96)	0.029			0.66 (0.49-0.88)	0.005		
Self-employed	0.50 (0.37-0.67)	<0.001	77.8	0.039	0.93 (0.58-1.49)	0.769	91.2	0.057	0.38 (0.21-0.71)	0.002	94.9	0.033	0.47 (0.31-0.71)	<0.001	90.2	0.037
Other (e.g. homemaker)	1.18	0.495			1.03	0.943			1.77	0.107			1.21	0.528		

	(0.74-1.89)				(0.46-2.31)				(0.88-3.57)				(0.67-2.21)			
Work-related health problems																
No	1				1				1				1			
Yes	2.64 (2.27-3.07)	<0.001	78.2	0.081	2.82 (2.27-3.52)	<0.001	91.4	0.091	2.86 (2.17-3.77)	<0.001	95.0	0.056	3.50 (2.84-4.31)	<0.001	90.3	0.092
Self-reported history of partner's occupational injuries																
No	1				1				1				1			
Yes	1.86 (1.33-2.62)	<0.001	80.3	0.066	1.69 (1.03-2.77)	0.039	91.9	0.067	1.76 (0.89-3.49)	0.102	95.9	0.043	2.15 (1.34-3.46)	0.002	90.8	0.079

The odds ratios and 95% confidence intervals presented are estimated by logistic regression models and adjusted for age and education, in years.

¥ Predictive accuracy of the model (% correctly classified).

* Nagelkerke R^2

4.2. History of work-related health problems in a population-based sample of women: An exploratory factor analysis

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History of work-related health problems in a population-based sample of women: An exploratory factor analysis

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Abstract.
BACKGROUND: Beyond the health-enhancing effects, work also has the potential of causing or worsening different health conditions in the same individual. However, research on within-worker aggregation of work-related health problems is scarce.
OBJECTIVE: To describe the history and aggregation of work-related health problems in a population-based sample of women.
METHODS: A total of 4330 women were asked whether they had ever had "a physical or mental health problem that was caused or made worse by your work". The aggregation of work-related health problems was assessed using an exploratory factor analysis.
RESULTS: Five groups were identified. Factor 1 included all items on musculoskeletal disorders - lower socioeconomic position, higher BMI, smokers and history of occupational accidents. Factor 2 included mental disorders together with headache and/or eyestrain - higher socioeconomic position. Factor 3 included the other disorders item with some loading from digestive disorders - older and public sector workers. Factor 4 included respiratory disorders - lower socioeconomic position and history of occupational accidents. Factor 5 included hearing and ear problems - blue-collar workers.
CONCLUSIONS: There was a relevant aggregation of work-related health problems, which may inform the selection of specific components for interventions that aim to improve women's work-related health.

Keywords: Disease aggregation, factor analysis, cohort study, women's health, work-related health problems

1. Introduction

Work can have health enhancing effects as a source of paid income and financial security, as well as social integration. However, it also exposes workers to a wide range of physical and psychosocial stressors that can have a negative impact on health [1]. As a result, work has the potential to contribute to the onset or worsening of different health conditions in the same individual throughout working life. Nevertheless, research focusing on within-worker aggregation of work-related health problems is scarce.

The population burden of work-related diseases is still underestimated due to shortcomings in the available data [2], which reflect the definition, recognition and reporting challenges it entails. The low coverage of certain types of professionals by the social security system – namely rural workers, self-employed

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workers, workers in small-sized enterprises and in the informal economy – is another limitation of official data [3]. The constant emergence of new risks and the exposure to new substances that have not yet been identified as hazardous also pose a challenge to the acquisition of up-to-date and accurate data [3]. Moreover, the underreporting of less severe cases of disease is a constraint even in high-income countries that usually have better surveillance coverage. Among physicians, the difficulty in assigning an occupational origin, lack of awareness regarding reporting requirements and insufficient knowledge of diseases with an occupational aetiology constitute major challenges to disease diagnosis and attribution [3–5]. Conversely, worker-related barriers to disease reporting include less severe disorders, insufficient knowledge on reporting and compensation, and fear of retribution by the employer [6–8]. Thus, official figures provide insight into notified, recognised and compensated occupational diseases, which only covers a very limited group of disorders, while not encompassing the broader concept of work-related health problems.

Gender segregation in the labour market remains high; the uneven concentration of women in typically lower-paid sectors is still a concern [9]. Although women's work participation has increased considerably in recent decades [10], women still face a double burden phenomenon where women working full-time in the labour market often face a second shift at home. Furthermore, though there are more men in informal employment globally, women in the informal economy are more often found in vulnerable work-related situations; for example, as domestic workers, home-based workers or contributing family workers [11]. Work-related health conditions among these women are less likely to be reported, and as a result are underestimated. Thus, comprehensive approaches using complementary methods in addition to official statistics are required [12], particularly when studying work-related health in women.

Valuable information to complement data from registries can be obtained using population-based approaches, as they provide the perspective of the target population outside of the workplace setting. In particular, large population-based prospective studies constitute a unique opportunity to obtain information on work-related conditions and to provide worker-centred estimates of the burden associated with work-related health problems with less *a priori* constraints, while also keeping up with the rapidly growing changes of the labour market. Although not designed for that purpose, a specific dimension where birth cohorts may be particularly interesting is in the study of women's occupational health, since they imply regular follow-ups of working age women and frequently collect information on social context dimensions.

Thus, we aimed to describe the history and aggregation of work-related health problems in a population-based sample of women from a large birth cohort study, and to quantify their association with sociodemographic, health and other work-related characteristics.

2. Methods

2.1. Participants

This study was based on the prospective population-based birth cohort study Generation XXI [13, 14]. Newborns and their mothers were recruited during 2005/2006 from the five public maternities covering the metropolitan area of Porto, which included 91.6% of all deliveries in the catchment area at the time of recruitment. Of the mothers invited, 91.4% accepted to participate. A total of 8495 mothers and their 8647 children were enrolled at baseline. The cohort has been followed since childbirth, with four assessment waves of the overall cohort already completed. Only data collected regarding mothers were used to accomplish the objectives of this study. Data were obtained in the context of two follow-up waves, when their children were seven (April 2012 to April 2014) and ten years of age (July 2015 to July 2017).

For the present analysis, all women ($n = 4330$) who accompanied their child to the 10-year-old follow-up, and who had valid information on work-related health problems, age and educational level were included. When compared to the remaining mothers ($n = 4165$), women included in this study were older (30.0 vs. 27.9 years), had a higher educational level (11.2 vs. 9.7 schooling years) and were less likely to have a blue collar job (21.3 vs. 25.8%).

The Generation XXI cohort study protocol was approved by the Ethics Committee of the São João Hospital/University of Porto Medical School, and complies with the Ethical Principles expressed in the Helsinki Declaration and with the current national legislation. The project was registered with the Portuguese Authority for Data Protection. Written informed consent was obtained for all assessments.

2.2. Data collection

2.2.1. Sociodemographic characteristics

Women's age and marital status were collected, and level of education was recorded as ≤ 9, 10–12, or > 12 years of completed education. Monthly household income was recorded in EUR 500 categories, and was grouped into EUR ≤ 1000, 1001–2000 and > 2000. The first class included the situation where both parents received around the minimum national wage (EUR 485.00 in 2013 [15]). Apart from women's age, which was collected at the children's 10-year-old assessment wave, the additional sociodemographic characteristics were only available from the seven-year evaluation.

2.2.2. Work-related characteristics

Mothers accompanying their children to the seven-year-old follow-up were asked about five groups of work-related characteristics: i) maternal occupation (current or previous if unemployed or retired) was collected and classified according to the Portuguese Classification of Occupations 2010, which is based on the International Standard Classification of Occupations (ISCO-08) [16], and was grouped as follows: (a) managers, (b) professionals, (c) technicians and associate professionals, (d) clerical support workers, (e) services and sales workers, (f) skilled agricultural, forestry and fishery workers, and craft and related trades workers, (g) plant and machine operators and assemblers, and (h) elementary occupations; ii) participants were asked about the number of concurrent jobs, which were categorized as none, one, or two or more jobs; iii) data on employment status was grouped as employed as a full-time worker, employed as a part-time worker, unemployed, or other (including unpaid family worker, student, retired, homemaker); iv) the nature of employment was defined as civil service or public sector, private sector, self-employment or other (e.g. homemaker); and v) participants were also asked about whether they were in managerial positions.

2.2.3. Health-related characteristics

Weight and height were measured to the nearest 0.1 kg and 0.1 cm respectively, by trained examiners and according to standard procedures. Body mass index (BMI; kg/m^2) was calculated and categorized into three groups - underweight/normal weight (≤ 24.9 kg/m^2), pre-obesity (25.0–29.9 kg/m^2) and obesity (≥ 30.0 kg/m^2) - according to WHO standards [17]. Smoking status was assessed and participants were categorized as current smoker (daily or less than daily), former smoker (not smoking for at least six months) or never smoker. Participants were also asked whether they had ever had a work accident (commuting accidents excluded). Health-related variables were collected at the seven-year evaluation.

2.2.4. Work-related health problems

Mothers accompanying their children to the 10-year-old follow-up were asked to report, via a self-administered questionnaire adapted from the 2013 Labour Force Survey (LFS) ad-hoc module on 'accidents at work and other work-related health problems', whether they had ever had "a physical or mental health problem that was caused or made worse by your current work or any previous work". If an affirmative answer was provided, additional information on the type of condition was obtained and categorized as follows: (a) bone, joint or muscle problem that mainly affects the back, (b) bone, joint or muscle problem that mainly affects the neck, shoulders, arms or hands, (c) bone, joint or muscle problem that mainly affects the hips, knees, legs or feet, (d) stress, depression, anxiety or mental disorders, (e) breathing or lung problems, (f) headache and/or eyestrain, (g) heart disease, stroke or other circulatory system problems, (h) kidney, stomach, liver or other digestive problems, (i) hearing and ear problems, (j) skin problems, (k) infectious diseases (virus, bacterium or other type of infection), and an open-ended option (l) other health problems. The open-ended option category included, with decreasing frequency, immune-mediated, neurological, voice-related and endocrine conditions. Women were also asked whether any of those health problems had been officially recognized as an occupational disease. Data on the spouse's history of work-related health problems were retrieved from the same questionnaire applied to biological fathers of the Generation XXI children who accompanied their child to the seven-year assessment wave, and those who were part of the same household as the mother at the time were included in this analysis.

2.3. Statistical analysis

The characteristics of the study population were described at the seven-year-old assessment wave by summarizing categorical variables as counts and proportions. The different types of work-related health problems reported in 2013 were also described as relative frequencies.

The associations between reporting at least one work-related health problem and sociodemographic, health and work-related characteristics were estimated using a logistic regression model to calculate adjusted odds ratios (ORs) and the respective 95% confidence intervals (CIs).

Exploratory factor analysis (EFA) based on tetrachoric correlation with varimax rotation due to the dichotomous nature of the variables on work-related health problems were applied to reveal clusters of work-related health problems [18]. The number of factors was set equal to the number of eigenvalues ≥ 1.0 [19]. In order to assess the robustness of the results, other strategies were used, namely removing the 'Others' category due to its heterogeneity or using a different criterion to determine the number of factors (sample size adjusted BIC - Bayesian Information Criterion). Within factors, variable loadings with an absolute value of 0.40 [20] or higher were interpreted as having a meaningful contribution to the corresponding underlying factor. For each participant, a factor score was calculated using the weights of each of the variables for that particular factor. In order to compare the mean component scores by sociodemographic, health and work-related characteristics, and thus interpret the factors resulting from EFA, a one-way analysis of variance (ANOVA) was performed.

Data were analyzed using the statistical software IBM SPSS Statistics for Windows, Version 21.0 (Chicago, Illinois), and the R package version 3.3.0 ('psych' package).

3. Results

Table 1 summarizes the participants' sociodemographic, health and work-related characteristics. Most women were younger than 45 years of age (85.3%), had 12 or less years of education (68.5%), were married (87.0%), were pre-obese or obese (54.5%), and had never smoked (63.5%). Regarding their spouses, 29.3% reported ever having had a work-related health problem. The most common occupational groups among women were Services and Sales Workers followed by Professionals (28.6% and 21.5%, respectively). Most participants had one job (73.2%), were full-time workers (70.8%), worked in the private sector (65.9%), and were not in managerial positions (70.2%). A history of occupational accidents was reported by 23.7% of the women.

The overall prevalence of reporting at least one work-related health problem since the beginning of working life was 31.5% ($n = 1366$). Fig. 1 shows the proportion of each type of health problem. Mental disorders were the most prevalent (21.3%), followed by those related to the neck and/or upper limbs (17.0%), and headache and/or eyestrain (16.9%). The prevalence of reporting an officially recognized occupational disease was 11.4%.

Figure 2 and Supplementary Table 1 show the associations between participants' sociodemographic, health and work-related characteristics, and reporting at least one work-related health problem throughout working life. Women more likely to report a work-related health problem were 36–45 years of age (OR = 1.23, 95%CI: 1.04–1.47), had more than 12 years of education (age-adjusted OR = 1.16, 95% CI: 1.00–1.36), were single (age- and education-adjusted OR = 1.44, 95%CI: 0.99–2.09), had a EUR 1001–1500 monthly household income (adjusted OR = 1.23, 95%CI: 1.03–1.47), were obese (adjusted OR = 1.21, 95%CI: 1.01–1.44), were current smokers (adjusted OR = 1.24, 95%CI: 1.06–1.45), had reported any work accidents since the beginning of working life (adjusted OR = 2.52, 95%CI: 2.17–2.92) or had a spouse with a history of work-related health problems (adjusted OR = 2.60, 95%CI: 1.92–3.52). Concerning work-related characteristics, women were more likely to report a work-related health problem if they had more than one concurrent job (adjusted OR = 2.16, 95%CI: 1.58–2.94), and were in a managerial position (adjusted OR = 1.18, 95%CI: 1.02–1.36). Compared to workers in the civil service or public sector, those from the private sector and self-employed participants had lower odds of work-related health problems (adjusted OR = 0.81, 95%CI: 0.67–0.96 and adjusted OR = 0.69, 95%CI: 0.54–0.89, respectively). No strong associations between occupational group and health problems were found. Women who were unemployed or had an unpaid occupation at the time of the questionnaire had lower odds of reporting a history of work-related health problems throughout life (adjusted OR = 0.70, 95%CI: 0.59–0.84 and adjusted OR = 0.26, 95%CI: 0.17–0.41, respectively).

Five groups describing health problem aggregation (Table 2), which accounted for 57.2% of the observed variance, were identified using an EFA among women who reported at least one work-related health problem ($n = 1366$). Factor 1, which accounted for the largest proportion of variance (17.9%), included all items on musculoskeletal disorders, i.e. those affecting the

Table 1
Prevalence of reporting at least one work-related health problem by sociodemographic, health and work characteristics among Generation XXI mothers

	Total	Any work-related health problems	
	$n = 4330$	No $n = 2964$	Yes $n = 1366$
Sociodemographic and health characteristics			
Age (years), n (%)			
≤ 35	751 (17.3)	538 (18.2)	213 (15.6)
36–45	2946 (68.0)	1979 (66.8)	967 (70.8)
> 45	633 (14.6)	447 (15.1)	186 (13.6)
Education (school years completed), n (%)			
≤ 9	1645 (38.0)	1159 (39.1)	486 (35.6)
10–12	1321 (30.5)	892 (30.1)	429 (31.4)
> 12	1364 (31.5)	913 (30.8)	451 (33.0)
Marital status, n (%)			
Married/Civil union	3767 (87.0)	2578 (87.0)	1189 (87.1)
Separated/Divorced/Widower	439 (10.1)	310 (10.5)	129 (9.5)
Single	122 (2.8)	75 (2.5)	47 (3.4)
Monthly household income (euros), n (%)			
≤ 1000	1185 (28.0)	843 (29.1)	342 (25.5)
1001–1500	1211 (28.6)	791 (27.3)	420 (31.3)
> 1500	1841 (43.5)	1261 (43.6)	580 (43.2)
BMI categories (kg/m^2), n (%)			
Underweight/normal weight	1806 (45.5)	1253 (46.2)	553 (44.1)
Pre-obesity	1312 (33.1)	892 (32.9)	420 (33.5)
Obesity	851 (21.4)	569 (21.0)	282 (22.5)
Smoking status, n (%)			
Never	2747 (63.5)	1906 (64.4)	841 (61.7)
Former	613 (14.2)	426 (14.4)	187 (13.7)
Current	963 (22.3)	628 (21.2)	335 (24.6)
Occupational accidents, n (%)			
No	3301 (76.3)	2413 (81.5)	888 (65.1)
Yes	1025 (23.7)	548 (18.5)	477 (34.9)
Self-reported history of paternal work-related health problems, n (%)			
No	636 (70.7)	477 (77.1)	159 (56.6)
Yes	264 (29.3)	142 (22.9)	122 (43.4)
Work characteristics			
Occupational group, n (%)			
Managers	158 (3.8)	101 (3.6)	57 (4.2)
Professionals	896 (21.5)	579 (20.5)	317 (23.5)
Technicians and Associate Professionals	457 (10.9)	313 (11.1)	144 (10.7)
Clerical Support Workers	587 (14.1)	420 (14.9)	167 (12.4)
Services and Sales Workers	1193 (28.6)	817 (28.9)	376 (27.8)
Skilled Agricultural, Forestry and Fishery Workers	13 (0.3)	10 (0.4)	3 (0.2)
Craft and Related Trades Workers	259 (6.2)	173 (6.1)	86 (6.4)
Plant and Machine Operators and Assemblers	195 (4.7)	126 (4.5)	69 (5.1)
Elementary Occupations	417 (10.0)	285 (10.1)	132 (9.8)
Number of jobs, n (%)			
0	931 (21.5)	711 (24.0)	220 (16.1)
1	3166 (73.2)	2115 (71.5)	1051 (77.0)
≥ 2	228 (5.3)	134 (4.5)	94 (6.9)
Employment status, n (%)			
Full-time worker	3065 (70.8)	2013 (68.0)	1052 (77.0)
Part-time worker	312 (7.2)	220 (7.4)	92 (6.7)
Unemployed	762 (17.6)	562 (19.0)	200 (14.6)
Other (e.g. unpaid family worker, student, retired, homemaker)	188 (4.3)	166 (5.6)	22 (1.6)
Nature of employment, n (%)			
Civil service/Public sector	799 (19.1)	498 (17.5)	301 (22.3)
Private sector	2761 (65.9)	1895 (66.7)	866 (64.2)
Self-employed	527 (12.6)	377 (13.3)	150 (11.1)
Other (e.g. homemaker)	100 (2.4)	69 (2.4)	31 (2.3)
Managerial position, n (%)			
No	2924 (70.2)	2015 (71.6)	909 (67.4)
Yes	1240 (29.8)	800 (28.4)	440 (32.6)

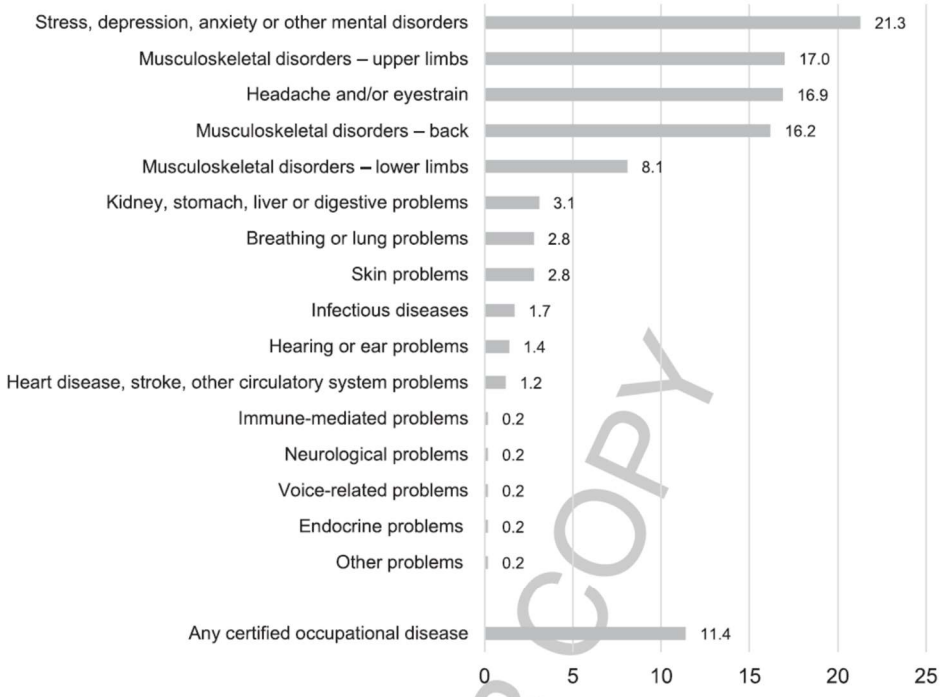


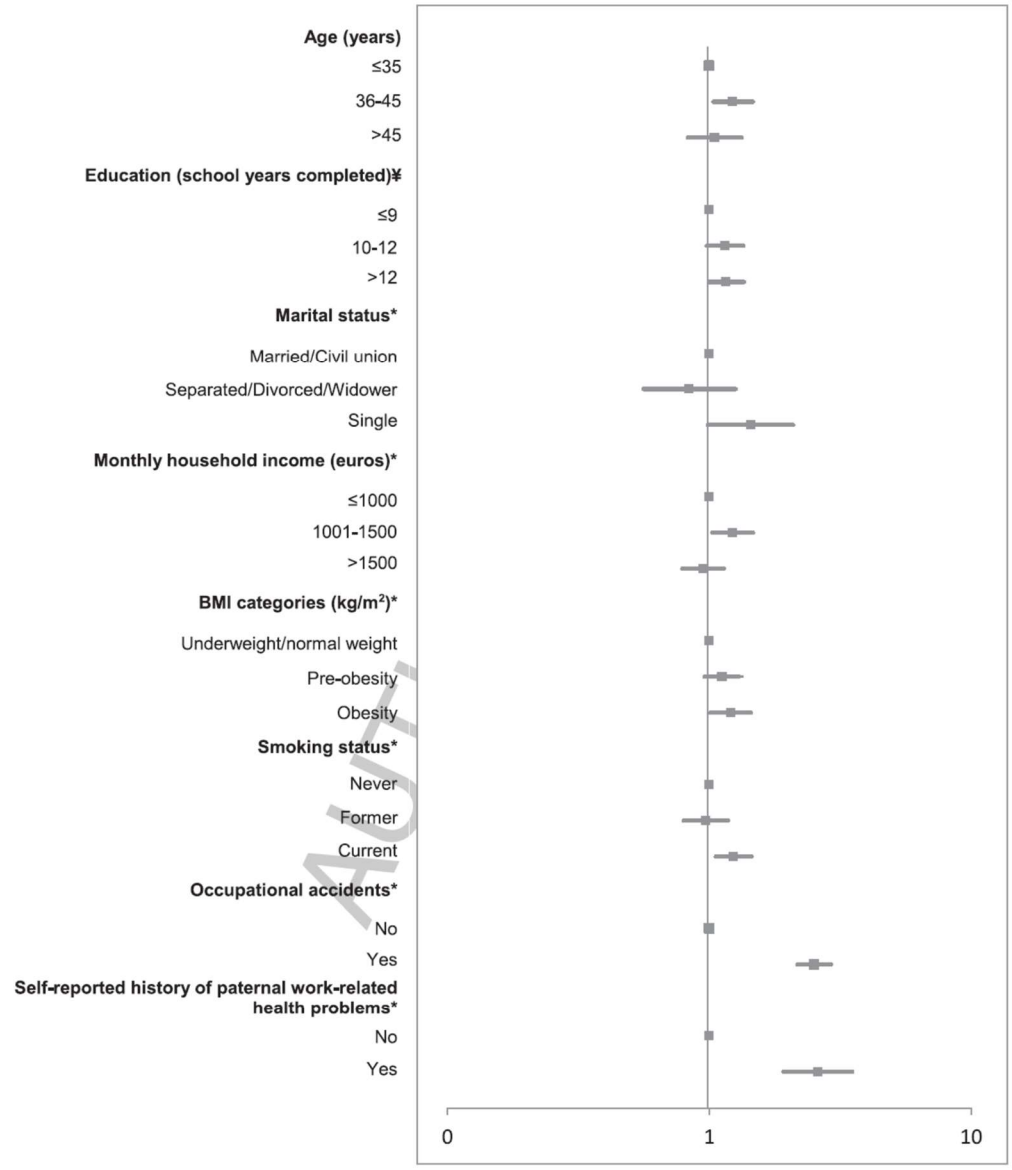
Fig. 1. Proportion (%) of each work-related health problem and of recognized occupational diseases among Generation XXI mothers.

back, neck and/or upper limbs, and lower limbs. Factor 2 included the items on stress, depression, anxiety and other mental disorders, as well as headache and/or eyestrain (11.6% of the variance explained). Factor 3 included mostly systemic organic diseases and/or dysfunctions, namely the item on other types of disorders comprising immune-mediated, neurological, voice-related and endocrine problems, and also had some loading from kidney, stomach, liver or digestive disorders. Factor 4 included breathing or lung problems and factor 5 included hearing or ear problems. Heart disease, stroke, other circulatory system problems, as well as skin conditions and infectious diseases did not clearly load into any of the factors using this approach. The robustness of the factor solution using two alternative approaches was tested. First, the category 'Others' was removed from the EFA with the percentage of total variance explained decreasing (51.3%), and only factors 1 (musculoskeletal disorders) and 2 (mental disorders, and headache and/or eye strain) remaining stable (Supplementary Table 2). Alternatively, an EFA with seven factors was performed, according to a different number of factors extraction criterion - sample size adjusted BIC (Supplementary Table 3) - and the same two factors 1 and 2 emerged. In both approaches, with the exception of factors 1 and 2, the remaining factors did not clearly overlap with the original EFA solution.

Figure 3 shows the mean scores for each factor across sociodemographic, health and work characteristics. Women scoring higher on musculoskeletal disorders (Factor 1) had a lower educational level, a higher BMI, were more likely to be current smokers, had a lower income, were not in a managerial position, had a history of occupational accidents, and were predominantly blue-collar workers (skilled agricultural, forestry and fishery workers, craft and related trades workers, plant and machine operators and assemblers, and elementary occupations) as well as services and sales workers. Factor 2 (mental disorders, and headache and/or eye strain) showed higher scores among participants with a higher educational level, a higher income, and with white-collar jobs. Factor 3 (systemic organic diseases and/or dysfunctions) presented higher scores in older and in public sector working participants. Factor 4 (breathing or lung problems) was associated with a lower educational level, a lower income and reporting work-related accidents. Finally, factor 5 (hearing or ear problems) scores were higher among blue-collar workers.

4. Discussion

In this study, we found that almost one third of working age mothers, selected independently of occupational exposures, reported at least one work-related health problem during their working life. Mental and musculoskeletal disorders were the most frequent work-related health problems, and were also the main features of the two most robust aggregation factors identified using exploratory factor analy-



The odds ratios and 95% confidence intervals presented are estimated by logistic regression models and showed on a log scale with base 10.
¥ Adjusted for age, in years.
* Adjusted for age and educational level, in years.

Fig. 2. *Continued*

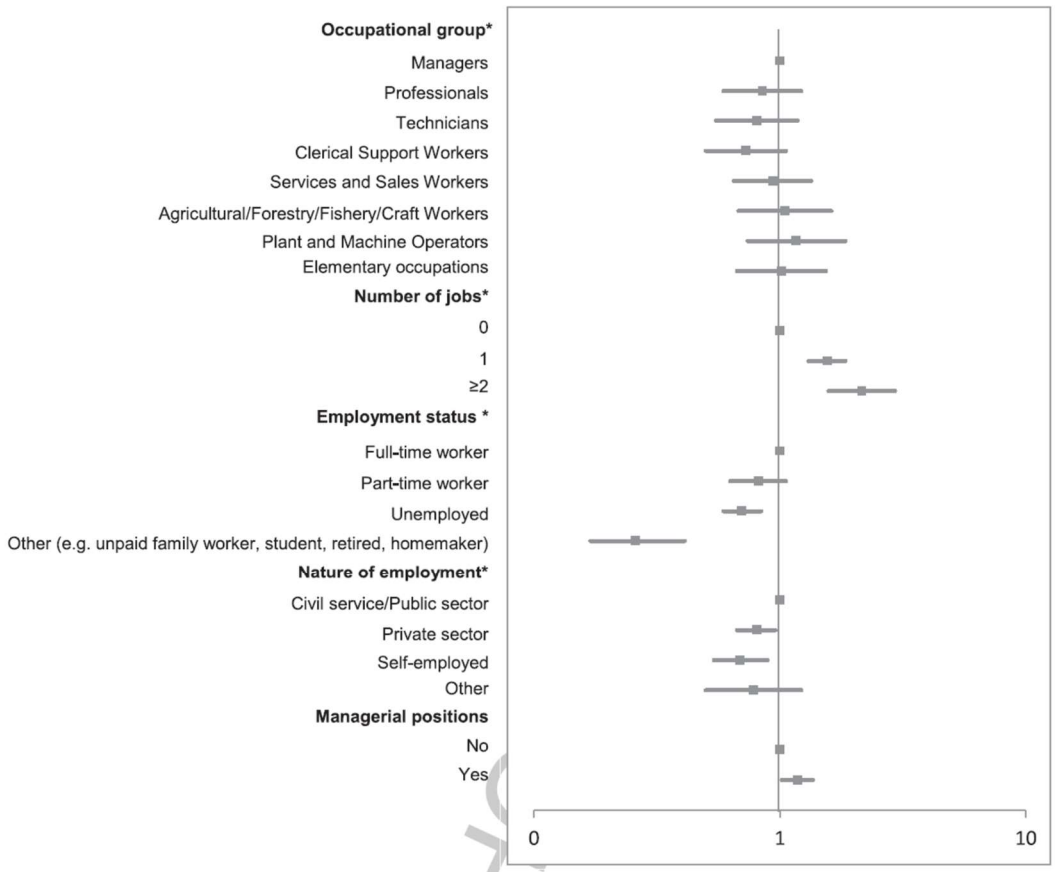


Fig. 2. Association between participants' (a) sociodemographic and health characteristics, and (b) work characteristics and reporting at least one work-related health problem (odds ratio, OR, and respective 95% confidence interval, CI).

Table 2
Exploratory factor analysis with tetrachoric correlation for reporting at least one work-related health problem (eigenvalue ≥ 1.0 criteria)

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Musculoskeletal disorders – back	**0.80**	0.04	0.04	–0.01	0.03
Musculoskeletal disorders – neck/upper limbs	**0.80**	–0.05	–0.01	–0.03	0.15
Musculoskeletal disorders – lower limbs	**0.67**	0.13	0.11	0.17	0.11
Stress, depression, anxiety or other mental disorders	–0.21	**0.91**	0.09	–0.01	0.01
Headache and/or eyestrain	0.34	**0.57**	–0.04	0.06	0.04
Other*	–0.03	–0.03	**0.99**	0.03	0.12
Breathing or lung problems	0.06	0.05	0.08	**0.99**	0.03
Hearing or ear problems	0.29	0.16	0.18	0.11	**0.92**
Heart disease, stroke, other circulatory system problems	0.09	0.05	0.19	0.03	–0.19
Kidney, stomach, liver or digestive problems	0.26	0.35	**0.41**	0.26	0.04
Skin problems	0.23	0.05	0.04	0.06	–0.03
Infectious diseases	0.18	0.25	0.07	0.22	0.05
Variance explained (%)	17.9	11.6	10.4	9.5	7.8
Cumulative variance (%)	17.9	29.5	39.9	49.4	57.2

*Includes immune-mediated, neurological, voice-related and endocrine conditions, among others.

sis. Different factors were associated with specific sociodemographic, health and work characteristics that were not evident when estimating the association between any work-related health problem and the same characteristics. This study demonstrates the potential of using a large population-based birth cohort as a valuable and complementary source of information to describe work-related health problems. In particular, for work-related psychological distress and musculoskeletal disorders, which were

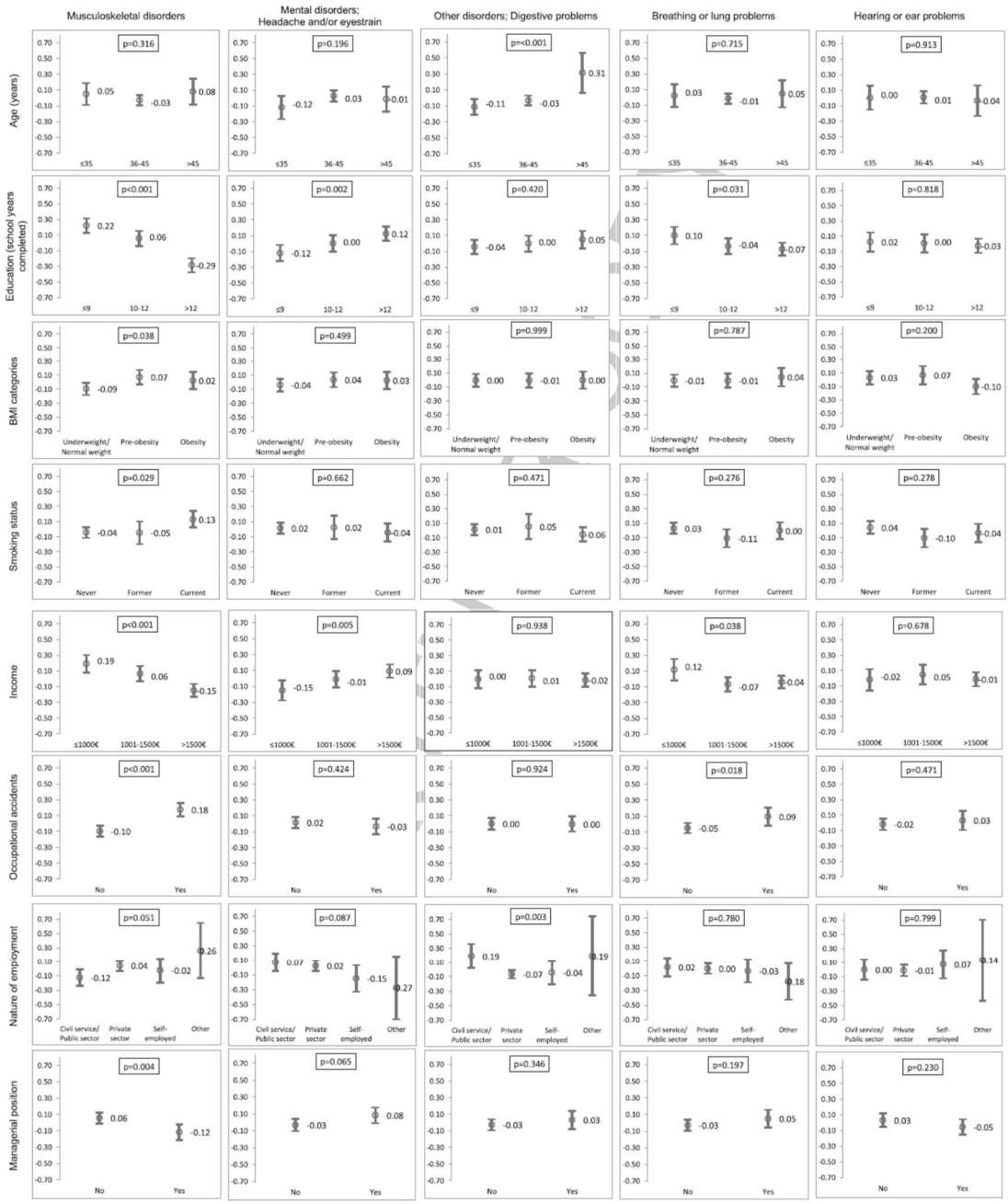


Fig. 3. *Continued*

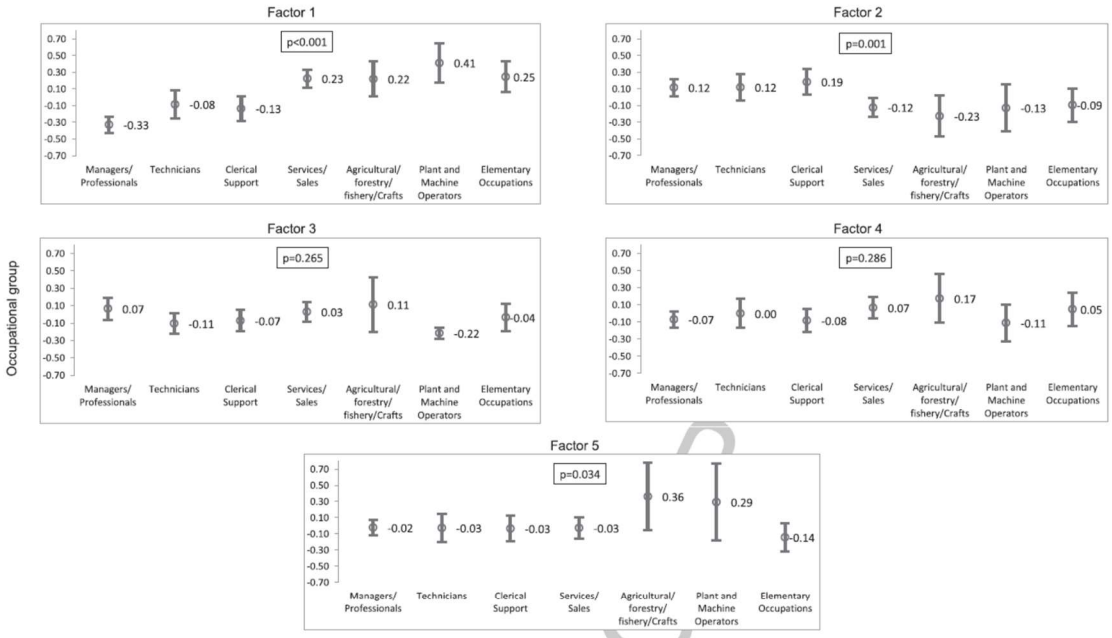


Fig. 3. Mean and 95%CI factor scores by sociodemographic, health and work-related characteristics.

the most prevalent health problems in our sample, assessing the worker's own perspective is informative, and even more significant in countries that do not recognize mental disorders as occupational diseases [21] or in countries that do not include certain types of musculoskeletal disorders in their national list of occupational diseases [22].

A low proportion of women reported having one work-related health problem officially certified as an occupational disease, which shows the discrepancy in estimates between the latter and the broader concept of work-related health problem, and is a reflection of the definitional, identification and recording issues that work-relatedness entails.

The study of work-related conditions among women is particularly relevant in our context, as Portugal constitutes one of the 13 out of 29 European countries where the prevalence of self-reported work-related health problems is higher in women than in men (7.0% vs 5.5%) [23, 24]. Accordingly, we also observed the same pattern in data stemming from official statistics [25], where 70.1% of officially recognized occupational diseases occur in women [26]. Specifically, women present an increased prevalence of negative mental health outcomes than their male counterparts [27], which may be explained by the cumulative exposure to psychosocial risk factors that women face both at home and in the workplace. Additionally, although the number of women in the workforce has increased considerably in recent decades, there is still an unequal task division at home, even when both partners work full-time, and women remain primarily responsible for domestic work (such as caring for children, the elderly and disabled). This double burden phenomenon decreases women's time for recovery after a workday, which has been linked, not only to negative mental health outcomes, but also to increased musculoskeletal symptoms [28–30], which in turn may hamper everyday family activities, particularly in families with children.

Our results are in line with previous national self-reported estimates from 2013, in which mental and musculoskeletal disorders were shown to be the most frequently reported work-related problems by women regarding the previous year [25, 31]. Likewise, a similar pattern has been described throughout Europe [23]. However, contrasting our finding of a higher burden attributed to mental disorders, back-related musculoskeletal disorders throughout working life were the most prevalent in 2013 [31]. This may be explained by the comparative overrepresentation of white-collar workers in our sample, when compared to national data [25], who are more likely to be affected by mental disorders [32, 33]. Additionally, we estimated working life prevalence, with the aim

of providing a picture of workers' entire professional life. When compared to shorter reference periods, our option may have introduced some recall bias leading to the underestimation of disorders of shorter duration that are more likely to be forgotten, as may be the case for acute episodes of musculoskeletal symptoms.

Our approach suggests that looking at associations between participants' characteristics and reporting at least one work-related health problem is likely to hide a heterogeneous group of problems. We looked into how these health problems could aggregate using an exploratory approach to summarize work-related health problems. EFA was compatible with five clusters of co-occurring work-related health problems and specific sociodemographic, health and work-related characteristics. The factor that included all items on musculoskeletal disorders (Factor 1) was associated with a low educational level, obesity, smoking, low income, blue-collar jobs, not being in a managerial position and a history of occupational accidents. This is in line with the frequently reported risk factors for work-related musculoskeletal disorders that include, in addition to smoking and high BMI, high biomechanical and psychosocial demands [34] – which are commonly linked to a low educational level and low income blue-collar jobs [35]. Furthermore, the presence of co-morbidities, including previous musculoskeletal injuries, constitutes a risk factor for work-related musculoskeletal disorders [34]. Our finding of a second factor, which grouped mental disorders and headache and/or eyestrain, and was associated to qualified occupations is also in line with previous findings of a higher prevalence of psychosocial problems among white-collar workers when compared to blue-collar workers [33]. Moreover, the use of visual display units, predominantly linked to white-collar jobs, has been associated with headache and other eyestrain symptoms [36]. Our hypothesis that older participants are more likely to report systemic organic conditions that are usually associated with ageing and aggravated rather than caused by work, was reflected in Factor 3, which aggregated the item on other types of disorders (immune-mediated, neurological, endocrine and other problems) and also kidney, stomach, liver or digestive disorders. Workers from the public sector also scored higher in Factor 3, which may translate a healthy worker effect whereby individuals with chronic conditions might be less likely to remain in more competitive and insecure workplaces, such as private and informal sectors. Regarding the associations between Factor 4 (breathing and lung problems) and a lower education and income, previous research on work-related respiratory problems has traditionally focused on men. Indeed, work environments affected by occupational exposures associated with lung health, such as primary and secondary industries, are dominated by men [25], and there is limited understanding of how these exposures affect women. Nevertheless, the most frequently recognized occupational respiratory diseases in Portugal [25] are highly prevalent in industries where female workers are largely employed: silicosis (crystalline silica particles' exposure) and the ceramic industry [37], and asthma and exposure to cleaning agents [38, 39]. The latter is also an exposure that disproportionately affects women in the household when compared to men. Some studies have also linked occupational asthma in women to biologic agents, the textile industry, flour dust, and occupations such as hairdressers/beauticians and healthcare professionals [38–41]. The association between lung problems and a low education and income can thus be explained by the higher prevalence of manual jobs, or alternatively by reverse causation, as work-related asthma is linked to adverse economic and employment consequences, particularly among manual workers [42–44]. Finally, in our study, women reporting hearing or ear problems (Factor 5) were predominantly blue-collar workers, which is in line with current knowledge that noise-induced hearing loss is not only associated with age but also blue-collar jobs [25, 45, 46].

We acknowledge that multiple factoring solutions could be applicable to our data, each implying different interpretations and associations with background characteristics. Indeed, when we tested two slightly different analytical options, the clustering of factors 3 to 5 or 7, which involve comparatively infrequent conditions, the results obtained differed. Due to our sampling frame, our findings are likely to be more robust to detect work exposures and general health profiles that are more frequent in the general working population. Factors 1 and 2 loaded in the same manner when using different approaches, showing that musculoskeletal conditions and headache and/or mental health conditions are likely to represent a stable and meaningful grouping of work-related health problems in the general female working population. The factoring solution found by our EFA had a cumulative percentage of variance explained slightly below the commonly accepted threshold of 60% [47], which may be explained by the fact that our latent variables are difficult to identify.

Our sample of mothers from a population-based birth cohort may have limited the generalizability of our findings to the entire female workforce. These women may be homogeneous with regards to some sociodemographic characteristics as they represent a target population of women from an urban setting that gave birth to a child at a specific moment in time. Indeed, in comparison to the female population in the Northern region (Portuguese NUTS II classification) in 2013, women included in this study had a higher educational level (15.3 vs 31.5% with more than 12 years of education [48]) and blue-collar jobs were underrepresented, particularly Plant and Machine Operators and Assemblers (12.2 vs 4.7%) and Elementary Occupations (18.7 vs 10.0%) [49]. Nevertheless, our sample had an unemployment rate of 17.6%, which is similar to the 18.0% female unemployment rate in the Northern region in 2013 [50]. The nature of our data did not allow us to infer on the co-occurrence of work-related health problems at the same time, only that they were reported by the same individual throughout their working life. Also, the participants' characteristics presented refer to one moment in time and may not be an accurate proxy for the entire lifetime exposure. Nevertheless, the fact that only 18.6% of women changed their occupational category (between low skilled blue collar, high skilled blue collar, low skilled white collar and high skilled white collar [51]) from the baseline to the follow-up evaluation occurring seven years later, leads us to believe there was a substantial stability over time regarding occupations and exposure to professional risks in these women. Moreover, we relied on self-reported information to define work-related health problems without clinical validation, which may introduce some level of misclassification. For instance, the finding that reporting a work-related health problem was associated with reporting an occupational injury may be explained not only by the exposure to occupational hazards that contribute to both problems, but also by the possibility that acute episodes of chronic problems may have been reported and classified as accidents, such as musculoskeletal disorders occurring after lifting heavy loads. However, symptoms are a key component of any clinical diagnosis of the most prevalent health problems in our sample. As a result, it has been shown that problems, such as musculoskeletal, are often accurately self-reported while underrepresented in clinical records [52]. In other cases, such as depression and anxiety, there is no relevant difference between data stemming from health surveys and electronic health records [52]. Also, the fact that associations were stronger for work characteristics when compared to sociodemographic and health characteristics reinforces that, in general, participants were able to assess work-relatedness. Overall, using a large population-based sample provided us with the perspective of the target population outside the workplace, with no *a priori* constraints, such as occupational group, sector of activity or type of health problem. It also allowed us to focus, not only on occupational diseases, but especially on the wider concept of work-related health problems as experienced by female workers.

5. Conclusion

By using a population-based sample, this study provided a worker's perspective on work-related health problems since the beginning of working life, including the identification of groups of health problems with specific characteristics. We found that the factor that gathered all items on musculoskeletal disorders as well as the factor that gathered the item on stress, depression, anxiety and other mental disorders, and headache and/or eyestrain, were the most reliable factors. As such, our analysis supports the need for a shift from a disease-by-disease approach towards a worker-centered perspective, while forming a basis for the selection of specific bundles of interventions that aim to improve women's work-related health that are better targeted, prioritized and integrated.

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Conflict of interest

None to report.

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Supplementary material

The supplementary Tables are available in the electronic version of this article: https://dx.doi.org/10.3233/WOR-203394.

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Supplemental table 1. Association between participants' sociodemographic, health and work characteristics and reporting at least one work-related health problem.

	OR	95%CI
Sociodemographic and health characteristics		
Age (years)		
≤35	1	
36-45	1.23	1.04-1.47
>45	1.05	0.83-1.33
Education (school years completed)¥		
≤9	1	
10-12	1.15	0.98-1.35
>12	1.16	1.00-1.36
Marital status*		
Married/Civil union	1	
Separated/Divorced/Widower	0.91	0.73-1.13
Single	1.44	0.99-2.09
Monthly household income (euros)*		
≤1000	1	
1001-1500	1.23	1.03-1.47
>1500	0.95	0.79-1.14
BMI categories (kg/m^2)*		
Underweight/normal weight	1	
Pre-obesity	1.12	0.96-1.30
Obesity	1.21	1.01-1.44
Smoking status*		
Never	1	
Former	0.97	0.80-1.18
Current	1.24	1.06-1.45
Self-reported history of paternal work-related health problems*		
No	1	
Yes	2.60	1.92-3.52
Work characteristics		
Occupational group*		
Managers	1	
Professionals	0.85	0.59-1.22
Technicians and Associate Professionals	0.81	0.55-1.18
Clerical Support Workers	0.73	0.50-1.06
Services and Sales Workers	0.94	0.65-1.34
Agricultural/Forestry/Fishery and Craft Workers	1.05	0.68-1.62
Plant and Machine Operators and Assemblers	1.17	0.74-1.85
Elementary Occupations	1.02	0.67-1.54
Number of jobs*		
0	1	
1	1.56	1.31-1.85
≥2	2.16	1.58-2.94

Employment status*		
Full-time worker	1	
Part-time worker	0.82	0.63-1.06
Unemployed	0.70	0.59-0.84
Other (e.g. unpaid family worker, student, retired, homemaker)	0.26	0.17-0.41
Nature of employment*		
Civil service/Public sector	1	
Private sector	0.81	0.67-0.96
Self-employed	0.69	0.54-0.89
Other (e.g. homemaker)	0.78	0.50-1.22
Managerial position*		
No	1	
Yes	1.18	1.02-1.36
Occupational accidents*		
No	1	
Yes	2.52	2.17-2.92

The odds ratios (OR) and 95% confidence intervals (CI) presented are estimated by logistic regression models.

¥ Adjusted for age, in years.

* Adjusted for age and educational level, in years.

Supplemental table 2. Exploratory factor analysis with tetrachoric correlation for reporting at least one work-related health problem (without the 'Others' category).

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Musculoskeletal disorders – back	0.76	0.02	0.05	0.05	0.06
Musculoskeletal disorders – neck/upper limbs	0.85	-0.05	0.07	-0.05	-0.04
Musculoskeletal disorders – lower limbs	0.69	0.09	0.14	0.69	0.12
Stress, depression, anxiety or other mental disorders	-0.20	0.97	0.08	0.06	0.01
Headache and/or eyestrain	0.32	0.51	0.15	-0.00	0.05
Breathing or lung problems	-0.01	-0.04	0.70	0.20	0.01
Heart disease, stroke, other circulatory system problems	0.04	0.04	0.07	0.03	0.59
Kidney, stomach, liver or digestive problems	0.25	0.32	0.50	-0.08	0.04
Hearing or ear problems	0.39	0.17	0.26	0.09	-0.24
Skin problems	0.19	0.04	0.06	0.06	0.05
Infectious diseases	0.17	0.21	0.40	-0.15	0.16
Variance explained (%)	20.1	12.7	9.4	5.1	4.1
Cumulative variance (%)	20.1	32.7	42.1	47.2	51.3

Supplemental table 3. Exploratory factor analysis with tetrachoric correlation for reporting at least one work-related health problem (sample size adjusted BIC criteria).

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7
Musculoskeletal disorders – back	0.77	-0.05	-0.02	-0.07	-0.01	0.08	0.16
Musculoskeletal disorders – neck/upper limbs	0.73	-0.17	-0.07	-0.11	-0.03	0.19	0.26
Musculoskeletal disorders – lower limbs	0.76	0.10	0.07	0.16	0.09	0.17	-0.01
Stress, depression, anxiety or other mental disorders	-0.14	0.97	0.06	-0.00	0.01	0.03	0.18
Other	0.01	-0.02	0.98	0.03	0.08	0.13	0.11
Breathing or lung problems	0.08	-0.01	0.04	0.96	0.01	0.06	0.25
Heart disease, stroke, other circulatory system problems	0.06	0.02	0.08	0.01	0.99	-0.07	0.10
Hearing or ear problems	0.24	0.08	0.15	0.07	-0.08	0.94	0.15
Kidney, stomach, liver or digestive problems	0.20	0.20	0.33	0.15	-0.02	0.06	0.59
Headache and/or eyestrain	0.33	0.46	-0.10	0.01	0.03	0.09	0.29
Skin problems	0.24	0.04	0.02	0.05	0.01	-0.01	0.02
Infectious diseases	0.09	0.13	-0.00	0.13	0.09	0.08	0.45
Variance explained (%)	16.7	10.4	9.3	8.4	8.4	8.2	7.2
Cumulative variance (%)	16.7	27.1	36.5	44.9	53.3	61.5	68.7

4.3. Occupational correlates of pregnancy sick leave in a population-based birth cohort

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OCCUPATIONAL CORRELATES OF PREGNANCY SICK LEAVE IN MOTHERS OF A POPULATION-BASED BIRTH COHORT

ABSTRACT

Objective: To assess the association between work situation at the beginning of pregnancy and sick leave during pregnancy among mothers of a large birth cohort.

Methods: As part of the population-based birth cohort Generation XXI, we asked 5638 mothers, at the index child's birth, whether they had been on sick leave during pregnancy and, if so, in what trimester(s). Sociodemographic and work- and pregnancy-related data were also retrieved. Three different leave outcomes were created: being on sick leave in all three trimesters, in at least one of the first two trimesters, and during the third trimester. Binomial logistic regression models were used to estimate associations.

Results: Nearly two thirds of mothers had been on sick leave by the third trimester (62.2%) and 4.3% had been on sick leave throughout all three trimesters. Compared to managers/professionals, mothers in blue-collar jobs were more likely to be on sick leave, even at an earlier stage of their gestation – OR[adjusted]=1.72, 95% CI [1.14-2.60] for skilled agricultural and fishery workers and craft and related trades workers and OR[adjusted]=2.03, 95% CI [1.28-3.20] for plant and machine operators and assemblers. Being an own-account worker (OR[adjusted]=0.56, 95%CI [0.33-0.93]) and having low job autonomy (OR[adjusted]=1.80, 95%CI [1.29-2.49]) and low decision authority (OR[adjusted]=1.45, 95%CI [1.14-1.84]) held as main determinants of earlier sick leave during pregnancy, even after excluding high-risk pregnancies.

Conclusions for practice: Independently of occupational group, employment status, job autonomy and decision authority at work were major determinants of sick leave during pregnancy, including in low-risk pregnancies.

Keywords: Cohort study; Employment; Generation XXI; Pregnancy; Sick leave

INTRODUCTION

Over the past decades, the presence of women in the workforce has grown substantially (1), thus increasing the number of women with an active professional role during their childbearing years. This progressive entry into the workforce has changed traditional gendered roles and, despite persistent inequalities, namely in the distribution of domestic labour or income (2), women's detachment from a primarily reproductive role to one that is also productive has generated policies for both maternity and work-life balance (3). Job adjustment during pregnancy, where possible, has been associated with reduced sick leave (4). Accordingly, European Union (EU) legislation requires employers to assess any risks to the health and safety of pregnant workers and, when necessary, to temporarily adjust their working conditions and/or working hours, so that the exposure to such risks is avoided (5). Yet, such adaptations are not always effective, which may motivate the resort to formal sickness absence even in low-risk pregnancies.

In addition to its direct physical and mental health causes, sickness absence is also determined by contextual factors at individual (e.g. age, socioeconomic status, occupation, psychological traits), group (e.g. work conditions, organisation) and societal levels (e.g. labour force characteristics, macroeconomics) (6, 7). Among the macro-level determinants, policies on sick leave entitlements overall vary widely between countries. Countries with the most complete benefit schemes such as Germany, Austria and Luxembourg (100% income replacement rates) show lower rates of sickness-related absence compared to countries with more limited benefits such as Slovakia, Czech Republic and Sweden. On the other hand, countries with little or no compensation for sick leave (such as the USA and the UK) had fewer days lost due to sickness (8). Therefore, although sick leave patterns may be associated with each country's sick leave benefits, they are not fully explained by this.

Different occupational groups may have different sick leave patterns (9, 10) and, regarding pregnant workers, previous findings have consistently shown a variation in sick leave according to working conditions, in particular physical workload, time schedules and organisational factors (e.g., decision latitude, job control) (4, 11-13). In addition to being a consequence of disease and pregnancy-related problems, sickness absence during pregnancy may thus reflect incompatibility, whether more or less objective, between work and pregnancy. Also, pregnancy-related sick leave may vary according to job security (14, 15), as previous research showed that workers with temporary or fixed-term contracts (regardless of pregnancy status) reported lower levels of absenteeism despite showing higher levels of adverse health indicators such as fatigue, backache and muscular pain (14).

In spite of an increasing number of women working throughout their childbearing years, the number of studies focusing on sickness absence during pregnancy is still limited (9, 11, 12, 16). Also, studies have been conducted in countries with different schemes of paid absence during pregnancy and sociocultural factors, so their results cannot be extrapolated to other countries. National population-based information about the factors associated with sick leave in this period is therefore important in order to guide employers' decisions around women's work organization, as well as to better inform healthcare professionals and policy makers, particularly regarding prenatal paid leave policy. Thus, this study aimed to assess the association between work situation at the beginning of pregnancy and sick leave during pregnancy among mothers of a large birth cohort study in Portugal.

METHODS

Participants

This study was embedded in Generation XXI, a prospective population-based birth cohort study, which has been described in detail elsewhere (17-19). Mothers were recruited up to 72 hours after birth, between April 2005 and August 2006 at the five public maternity units providing obstetrical and neonatal care covering the metropolitan area of Porto, which included 91.6% of all deliveries in the catchment area at the time of recruitment. Of the invited mothers, 91.4% accepted to participate and a total of 8495 mothers and their 8647 children were enrolled at baseline. For the purpose of this study, we included 5638 mothers that were employed at the time they got pregnant and had no missing information on maternal sick leave during pregnancy. When compared to the remaining cohort participants (n=2857), included mothers were slightly older (29.9 vs. 27.2 years) and more likely to have a higher socioeconomic position than nonparticipants, in terms of educational level (11.3 vs. 8.7 schooling years) and monthly household income (38.6% vs. 12.7% with more than EUR 1500).

The Generation XXI cohort study protocol was approved by the Ethics Committee of São João Hospital/University of Porto Medical School and complies with the Ethical Principles expressed in the Helsinki Declaration and with the current European and national legislation. The project was registered with the Portuguese Authority for Data Protection. Written informed consent was obtained at all assessments.

Data collection

Data was collected in face-to-face interviews at recruitment (up to 72 hours after birth) using structured questionnaires administered by trained interviewers concerning sociodemographic characteristics, child and family medical history, and parental work-related characteristics. A physical examination including anthropometric assessment was performed to children and mothers.

Sociodemographic characteristics

Maternal age was retrieved, and educational level was recorded as the number of completed schooling years and grouped as ≤9, 10-12, or >12 years. Monthly household income was recorded in EUR 500 categories and was categorized into three groups: EUR ≤1000, 1001-1500 and >1500. The categories were defined to guarantee a uniform distribution of the participants across the classes, with the first class including a situation where both parents earned the minimum national wage or less [EUR 437.20 per worker-month in 2005 (20)]. Regarding household characteristics, data on the number of children, besides the index child, living in the same household were retrieved and mothers were also asked about partner's employment status, which was grouped into 'no partner', 'partner unemployed' and 'partner employed'.

High-risk pregnancy

Women were considered to have a high-risk pregnancy if they had any of the following conditions: multiple index pregnancy, parity before the index child ≥ 5, obesity (body mass index [BMI] ≥ 30 m^2/kg), history of 3 or more spontaneous abortions, prior child with a birthweight ≥ 4000 g, history of foetal death, medical history of diabetes (preconception and gestational) or heart disease, or if the current pregnancy was pathological (included bleeding, hypertension, pre-eclampsia, eclampsia or intrauterine growth restriction). Maternal age was not included in the definition of high-risk pregnancy since it was used as an adjustment variable.

Work-related characteristics

Mothers were asked about their occupation, and job titles were coded according to the National Classification of Occupations 1994, based on the International Standard Classification of Occupations (ISCO-88), which identifies ten main occupational groups based on a combination of education and skill level. Occupations were grouped as follows: a) legislators, senior officials and managers, and professionals (ISCO groups 1 and 2), b) technicians and associate professionals (ISCO group 3), c) clerks (ISCO group 4), d) service workers and shop and market sales workers (ISCO group 5), e) skilled agricultural and fishery workers, and craft and related trades workers (ISCO groups 6 and 7), f) plant and machine operators and assemblers (ISCO group 8), and g) elementary occupations (ISCO group 9). Mothers were also categorized according to employment status as employee, own-account worker, employer, and other situation (such as family worker). Women were also asked to rate themselves on a five-point Likert scale on both job autonomy and decision authority (5 being total job autonomy or decision authority), which was later categorized into 'high' (4-5 on the Likert scale), 'medium' (3 on the Likert scale) and 'low' (1-2 on the Likert scale).

Maternal sick leave during pregnancy

Mothers were asked whether they had been on sick leave during pregnancy and, if so, in what trimester(s), and for how many days. Three dichotomous variables were created: having a sick leave in all of the three trimesters, having a sick leave in at least one of the first two trimesters, and having a sick leave during the third trimester.

Data analysis

The characteristics of the study population at baseline were described by summarizing categorical variables as counts and proportions, and median and 25th-75th percentile was

used to present the duration of sick leave during gestation, in days. A logistic regression model was used to calculate adjusted odds ratios (ORs) and associated confidence intervals (CIs) at 95% for sick leave during pregnancy on work-related characteristics, adjusted for potential confounders – age, education, monthly household income, number of children in the household, and partner's employment status. The analysis was repeated after excluding women with a high-risk pregnancy (n=1374) because of the known link between pregnancy health and maternal activity (12). Also, taking into account that job autonomy and decision authority may not be independent from employment status, analysis was also restricted to employees (n=4874). Statistical analysis was performed using the statistical software IBM SPSS Statistics for Windows, Version 21.0.

RESULTS

In our study, 3697 (65.6%) women had been on sick leave at some point during pregnancy, 62.2% were on sick leave by the third trimester and 4.3% were on sick leave throughout all three trimesters. Table 1 summarizes participants' sociodemographic, pregnancy and work-related characteristics. Most mothers in our sample had between 25 and 34 years of age (68.2%) and had 12 or less years of schooling (69.5%). Over a third (38.6%) of women had a monthly household income over EUR 1500, 59.3% had no children living in the same household, and 94.4% had an employed partner. Services and sales workers was the most frequent occupational group in our sample (33.8%), followed by managers and professionals (19.0%) and clerks (17.2%). The majority of the mothers were hired by an employer (87.1%), reported high job autonomy (64.9%) and 41.9% had high decision authority. Women under 25 years of age or over 35, with lower educational level and monthly household income, with 2 or more children in the same household, and with an unemployed partner and a high-risk pregnancy had longer sick leaves during pregnancy, as well as women in predominantly blue-collar jobs (21), that were employers, and that had low job autonomy and low decision authority.

Associations between women's characteristics and having a sick leave during pregnancy are presented in Table 2. Women reporting being on sick leave during all three trimesters had higher odds of having a blue-collar job, i.e. skilled agricultural and fishery workers and craft and related trades workers (OR[adjusted]=4.09, 95% CI [1.92-8.70]), and elementary occupations (OR[adjusted]=2.48, 95% CI [1.13-5.44]), or of working in services and sales (OR[adjusted]=2.30, 95% CI [1.24-4.28]). The same was observed for skilled agricultural and fishery workers and craft and related trades workers (OR[adjusted]=1.72, 95% CI [1.14-2.60]) and plant and machine operators and assemblers (OR[adjusted]=2.03, 95% CI [1.28-3.20])

when the outcome was being on sick leave during the first or second trimesters. Clerks were less likely to be on sick leave during the first or second trimesters (OR[adjusted]=0.74, 95% CI [0.54-1.01]). Women on sick leave during the third trimester had higher odds of being on any of the blue-collar occupational groups, as well as of working in services and sales. When compared to employees, own-account workers and employers reported being on sick leave less frequently throughout all sick leave outcomes. Having medium to low job autonomy was also associated with being on sick leave, particularly during the first or second trimesters outcome as well as the third trimester one, and the same was true for decision authority. After restricting the analysis to employees only, results on job autonomy and decision authority remained similar.

After excluding high-risk pregnancies (Table 3), clerks were again less likely to be on sick leave during the first or second trimesters (OR[adjusted]=0.62, 95% CI [0.43-0.90]), compared to the managers/professionals category. When compared to employees, own-account workers reported being on sick leave less frequently during the first or second trimesters (OR[adjusted]=0.56, 95% CI [0.33-0.93]). Low job autonomy was again associated with being on sick leave during the first or second trimesters (OR[adjusted]=1.80, 95% CI [1.29-2.49]), as well as low decision authority (OR[adjusted]=1.45, 95% CI [1.14-1.84]). The third trimester outcome had a similar pattern when compared to the whole sample.

DISCUSSION

In our study, nearly two thirds of mothers were on sick leave by the third trimester of pregnancy (62.2%) and 4.3% were on sick leave throughout all three trimesters. Mothers in blue-collar jobs were more likely to be on sick leave, even at an earlier stage of their gestation. Being an own-account worker, and having low job autonomy and low decision authority also held as main determinants of sick leave, whether or not high-risk pregnancies were excluded.

It is known that paid sick leave is strongly linked to occupation, as women in the lowest employment grades report more frequently paid sick leave than the ones in the highest grades, and manual workers report higher duration of paid sick leave days than non-manual workers (8). As in our study, previous research showed that clerks were less likely to report earlier sick leave in Southern California (22). Previous findings have also found that self-employment is highly associated with late leave (9). Self-employed women may experience added pressure regarding the timing they choose to take a leave, since they may feel the decrease in occupational activity will impair the success of the business or their income level. They may also be more able to adjust working conditions and hours than employees, thus avoiding the need to resort to sick leave – as shown by the inverse association between low autonomy and increased sick leave. Regarding job control, our findings are in line with previous studies that found high job strain and low job control to be associated with increased risk for sick leave among pregnant women (11, 13). It is also known that blue-collar occupations are more often characterized by low job control when compared to white-collar occupations, and low job control has a negative effect on health overall, particularly at older ages (23); for instance, low job control increases the risk of coronary heart disease (24, 25). A reduction in women's risk of sick leave during pregnancy should therefore be obtained by

increasing the level of their influence on work contents, breaks and improving autonomy and control overall, regardless of the educational level of the employees (13, 26).

Although sick leave during pregnancy may have negative implications at work, such as loss of interesting work opportunities and promotions, it also consists of a relevant adjustment tool used to promote a healthy pregnancy for both mother and child. One important argument for a prenatal paid leave policy is the potentially harmful effects of stress and fatigue induced by work in the last month of pregnancy on women's well-being and child health. Women working in their last month of pregnancy have less night and day sleep than nonworking women, and they also report considerably higher levels of both morning and evening fatigue (27). And both decreased night-time sleep duration and poor sleep quality in healthy third-trimester pregnant women, as well as fatigue, have been associated with an increased risk of clinical depression (28, 29). Furthermore, women who experience occupational strain from low rewards at work are at increased risk of hypertension and preeclampsia, and late prenatal leave has shown to decrease caesarean deliveries and to prolong gestation (22). In our sample, women on sick leave during the first or second trimesters had more caesarean sections than the ones who were not (42.9% vs. 36.3%), although there were no relevant differences regarding women on leave during the third trimester (37.7% vs. 36.7%) or when looking into small for gestational age – 14.8% vs. 14.5% and 14.2% vs. 15.1%, respectively (data not shown).

The productivity argument for a prenatal paid leave policy is also a relevant one. According to the World Health Organization, higher expenditure on paid sick leave is often linked to higher economic productivity at national level, and working while sick may not only have a detrimental effect on health but may also reduce workers' productivity for the workplace (8). Thus, the cost of taking a leave during pregnancy may be low in the long-term and may result in a total positive effect for both the individual and society.

This study was based on self-reported data after birth, which may be subject to misclassification, particularly with respect to sick leave, which was not validated using complementary sources. However, previous studies have found good agreement between self-reported and recorded information on sickness absence, thus concluding that self-reported data on sickness absence may be useful in common epidemiological applications (30, 31). Also, our assessment of sick leave during pregnancy may potentially include non-pregnancy-related sick leave. And although our sample had a slightly higher socioeconomic position compared to the remaining cohort, this study used a large representative sample of mothers from a prospective and population-based birth cohort with a high participation rate to assess work-related factors associated with sick leave during pregnancy. Though previous studies have looked into maternal sick leave during pregnancy, research is usually focused on more affluent countries with different maternity-related entitlements, and cultural and social characteristics. Also, different methodologies, namely the study design and the time period considered to assess sick leave, impair estimate comparisons with different studies.

In conclusion, the present study showed that, independently of occupational group, employment status, job autonomy and decision authority at work were major determinants of working during pregnancy, even in healthier pregnancies. Understanding the relationship between work characteristics and working during pregnancy may help to adjust and organize work for pregnant women, including paid sick leave if needed, in a way that guarantees their physical, mental and financial well-being. This requires flexibility as well as balancing both employers' and employees' needs.

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Table 1. Proportion of maternal sick leave during pregnancy and median days of sick leave by maternal characteristics, in Generation XXI

	Total	All trimesters	1st or 2nd trimester	3rd trimester	Days of sick leave
	n (%) n=5638	n (%) n=245	n (%) n=997	n (%) n=3509	Median (P_{25}-P_{75})
Sociodemographic characteristics					
Age (years)					
<25	801 (14.2)	24 (9.8)	152 (15.2)	536 (15.3)	45.0 (30.0-90.0)
25-34	3847 (68.2)	161 (65.7)	642 (64.4)	2377 (67.7)	30.0 (20.0-75.0)
≥35	990 (17.6)	60 (24.5)	203 (20.4)	596 (17.0)	44.5 (20.0-90.0)
Education (schooling years)					
≤9	2276 (40.4)	132 (53.9)	469 (47.0)	1546 (44.1)	45.0 (25.0-90.0)
10-12	1636 (29.1)	67 (27.3)	271 (27.2)	1033 (29.5)	30.0 (20.0-70.0)
>12	1718 (30.5)	46 (18.8)	257 (25.8)	924 (26.4)	30.0 (15.0-60.0)
Monthly household income (euros)					
≤1000	1509 (29.5)	79 (34.8)	269 (30.3)	995 (31.1)	41.0 (23.5-90.0)
1001-1500	1628 (31.8)	75 (33.0)	296 (33.3)	1067 (33.3)	38.0 (20.0-90.0)
>1500	1976 (38.6)	73 (32.2)	324 (36.4)	1138 (35.6)	30.0 (17.0-65.0)
Nr. children in household					
No children	3313 (59.3)	120 (49.4)	579 (58.7)	2079 (59.9)	34.0 (20.0-75.0)
1	1862 (33.4)	95 (39.1)	336 (34.1)	1169 (33.7)	30.0 (20.0-90.0)
≥2	408 (7.3)	28 (11.5)	71 (7.2)	224 (6.5)	60.0 (21.0-90.0)
Partner's employment status					
No partner	101 (1.8)	0 (0.0)	13 (1.3)	61 (1.7)	32.0 (15.3-60.0)
Unemployed	213 (3.8)	8 (3.3)	40 (4.0)	141 (4.0)	45.0 (21.5-90.0)
Employed	5293 (94.4)	235 (96.7)	937 (94.6)	3286 (94.2)	34.0 (20.0-90.0)
High-risk pregnancy					
No	4264 (75.6)	151 (61.6)	647 (64.9)	2583 (73.6)	30.0 (19.0-70.0)
Yes	1374 (24.4)	94 (38.4)	350 (35.1)	926 (26.4)	45.0 (30.0-90.0)
Work-related characteristics					
Occupational group					
Managers/Professionals	1068 (19.0)	26 (10.6)	160 (16.1)	547 (15.6)	30.0 (15.0-60.0)
Technicians and Associate Professionals	626 (11.1)	22 (9.0)	112 (11.2)	368 (10.5)	30.0 (15.0-60.0)
Clerks	970 (17.2)	31 (12.7)	130 (13.1)	577 (16.5)	30.0 (15.0-60.0)
Services and Sales Workers	1903 (33.8)	91 (37.1)	343 (34.4)	1240 (35.4)	42.0 (26.0-90.0)
Agricultural/Fishery/Craft Workers	430 (7.6)	39 (15.9)	108 (10.8)	332 (9.5)	60.0 (24.0-90.0)
Plant and Machine Operators and Assemblers	199 (3.5)	10 (4.1)	60 (6.0)	163 (4.6)	56.0 (30.0-103.5)
Elementary Occupations	438 (7.8)	26 (10.6)	83 (8.3)	280 (8.0)	45.0 (25.0-90.0)
Employment status					
Employee	4874 (87.1)	226 (92.2)	904 (91.1)	3252 (93.4)	32.0 (20.0-84.0)

Own-account worker	297 (5.3)	3 (1.2)	27 (2.7)	60 (1.7)	36.5 (25.0-90.0)
Employer	355 (6.3)	11 (4.5)	50 (5.0)	137 (3.9)	60.0 (30.0-115.0)
Other situation	72 (1.3)	5 (2.0)	11 (1.1)	33 (0.9)	65.0 (30.0-131.3)
Job autonomy					
High	3604 (64.9)	128 (53.8)	573 (58.9)	2085 (60.3)	30.0 (20.0-70.0)
Medium	1580 (28.4)	90 (37.8)	303 (31.1)	1078 (31.2)	40.0 (20.0-90.0)
Low	370 (6.7)	20 (8.4)	97 (10.0)	292 (8.5)	45.0 (30.0-90.0)
Decision authority					
High	2295 (41.4)	86 (36.1)	336 (34.6)	1229 (35.6)	30.0 (20.0-80.0)
Medium	2031 (36.7)	86 (36.1)	373 (38.4)	1351 (39.2)	30.0 (20.0-75.0)
Low	1214 (21.9)	66 (27.7)	263 (27.1)	869 (25.2)	45.0 (21.0-90.0)

Table 2. Association between women's work-related characteristics and sick leave during pregnancy

	All trimesters	1st or 2nd trimesters	3rd trimester
Occupational group			
Managers/Professionals	1	1	1
Technicians and Associate Professionals	1.33 (0.72-2.47)	1.16 (0.87-1.55)	1.20 (0.97-1.49)
Clerks	1.24 (0.66-2.32)	0.74 (0.54-1.01)	1.11 (0.89-1.38)
Services and Sales Workers	2.30 (1.24-4.28)	1.19 (0.87-1.63)	1.47 (1.16-1.86)
Agricultural/Fishery/Craft Workers	4.09 (1.92-8.70)	1.72 (1.14-2.60)	2.45 (1.71-3.51)
Plant and Machine Operators and Assemblers	2.02 (0.80-5.12)	2.03 (1.28-3.20)	3.16 (2.02-4.95)
Elementary Occupations	2.48 (1.13-5.44)	1.31 (0.86-1.99)	1.50 (1.08-2.10)
Employment status			
Employee	1	1	1
Own-account worker	0.25 (0.08-0.78)	0.49 (0.32-0.75)	0.15 (0.11-0.21)
Employer	0.49 (0.24-1.01)	0.71 (0.51-1.00)	0.32 (0.25-0.41)
Other situation	1.41 (0.50-3.97)	0.77 (0.38-1.58)	0.35 (0.20-0.59)
Job autonomy			
High	1	1	1
Medium	1.64 (1.22-2.20)	1.23 (1.04-1.45)	1.40 (1.22-1.61)
Low	1.23 (0.72-2.11)	1.69 (1.29-2.23)	2.19 (1.66-2.89)
Decision authority			
High	1	1	1
Medium	1.07 (0.77-1.48)	1.26 (1.06-1.50)	1.56 (1.36-1.78)
Low	1.33 (0.93-1.90)	1.53 (1.26-1.87)	1.80 (1.53-2.12)

The odds ratios and 95% confidence intervals (CIs) presented are estimated by logistic regression models, adjusted for age, education (years), monthly household income (euros), number of children in the household, and partner's employment status.

Table 3. Association between women's work-related characteristics and sick leave during pregnancy, excluding high-risk pregnancies

	All trimesters	1st or 2nd trimesters	3rd trimester
Occupational group			
Managers/Professionals	1	1	1
Technicians and Associate Professionals	1.10 (0.52-2.34)	1.01 (0.72-1.43)	1.21 (0.95-1.54)
Clerks	1.20 (0.57-2.52)	0.62 (0.43-0.90)	1.08 (0.84-1.38)
Services and Sales Workers	1.90 (0.90-4.01)	1.03 (0.71-1.49)	1.58 (1.20-2.07)
Agricultural/Fishery/Craft Workers	2.16 (0.82-5.69)	1.28 (0.77-2.14)	2.93 (1.89-4.53)
Plant and Machine Operators and Assemblers	1.33 (0.41-4.38)	1.35 (0.77-2.39)	2.76 (1.66-4.57)
Elementary Occupations	1.44 (0.53-3.93)	0.90 (0.54-1.50)	1.46 (1.00-2.15)
Employment status			
Employee	1	1	1
Own-account worker	0.43 (0.13-1.36)	0.56 (0.33-0.93)	0.17 (0.12-0.24)
Employer	0.61 (0.26-1.41)	0.95 (0.65-1.39)	0.36 (0.27-0.48)
Other situation	1.66 (0.50-5.46)	0.76 (0.32-1.82)	0.28 (0.15-0.51)
Job autonomy			
High	1	1	1
Medium	1.83 (1.26-2.65)	1.18 (0.96-1.45)	1.37 (1.17-1.60)
Low	1.42 (0.73-2.78)	1.80 (1.29-2.49)	2.02 (1.48-2.76)
Decision authority			
High	1	1	1
Medium	0.94 (0.62-1.42)	1.15 (0.93-1.42)	1.55 (1.33-1.80)
Low	1.34 (0.86-2.09)	1.45 (1.14-1.84)	1.69 (1.40-2.03)

The odds ratios and 95% confidence intervals (CIs) presented are estimated by logistic regression models, adjusted for age, education (years), monthly household income (euros), number of children in the household, and partner's employment status.

4.4. Association of child neurodevelopmental and behavioural problems with maternal unemployment in a population-based birth cohort

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[Under review]

ASSOCIATION OF CHILD NEURODEVELOPMENTAL OR BEHAVIOURAL PROBLEMS WITH MATERNAL UNEMPLOYMENT IN A POPULATION-BASED BIRTH COHORT

ABSTRACT

This study estimates associations between suspected or diagnosed neurodevelopmental or behavioural problems in 7-year-old children and maternal unemployment at child ages seven and ten, in a Portuguese birth cohort. We evaluated 5754 mothers and their children of the population-based birth cohort Generation XXI in Porto, Portugal. Data on suspected and diagnosed child neurodevelopmental and behavioural problems (exposures) – learning, attention and language problems, externalizing behaviours, developmental delay, autism spectrum disorders, and other neurodevelopmental problems - were retrieved at 7 years of age by interviewing caregivers. Maternal employment status (outcome) was collected at the 7- and 10-year-old follow-up waves. Robust Poisson regression models were used to estimate associations. After adjustment for maternal and household characteristics, women were more likely to be unemployed at child age 10 if the child had, up to age 7, any of the following suspected problems: an autism spectrum disorder (PR=1.73; 95%CI 1.07, 2.79), developmental delay (PR=1.58; 95%CI 1.20, 2.06), externalizing behaviours (PR=1.29; 95%CI 1.11, 1.50) or learning problems (PR=1.26; 95%CI 1.07, 1.48). When the exposure was restricted to clinically diagnosed disorders, the magnitude of associations remained similar but estimates were less precise. Associations with unemployment were stronger at child age 10 (prospective analyses), than at child age 7 (cross-sectional). In conclusion, having a child with learning, developmental or behavioural problems, or an autism spectrum disorder up to age 7 was associated with maternal unemployment three years later, even in a less affluent European economy where the dual-earner family structure is often necessary to make ends meet.

Key terms: Child health; Cohort study; Employment; Neurodevelopmental Disorders

INTRODUCTION

The participation of women in the workforce has increased substantially throughout the last decades and, in European Union countries, the share of employed women is among the highest in the world. Still, the gender gap in work participation, although decreasing, remains considerable (Christiansen et al., 2016), and it increases with the number of children in the household (Eurostat, 2020). Mothers commonly adjust their work participation in order to meet family needs (Mainiero & Sullivan, 2005), and make employment decisions based on a number of family-related factors, including their children's health and behaviour (DeRigne, 2012). Since women are traditionally the primary caregiver, maternal work participation decreases around birth and increases as the child ages (Eurostat, 2009). However, this return-to-work pattern is not evident among mothers of children with special needs (Gordon et al., 2008).

The impact of children's health on maternal work participation is likely to vary across countries with varying occupational gender gaps, as well as diverse social and economic contexts. While the employment rate of mothers with children aged 0-14 years in the EU was 68.2% in 2014, Portugal stood out with a proportion of maternal employment over 75%, together with Nordic countries such as Denmark and Sweden, and more distant from the other Southern European countries such as Greece, Italy, and Spain, where maternal employment was below 60% (Organisation for Economic Co-operation and Development (OECD), 2016). In addition, and according to the Organisation for Economic Co-operation and Development (OECD), Portugal is one of the few countries where over 90% of employed mothers work full-time hours (over 30-35 hours weekly), along with the Czech Republic, Latvia, Poland and Slovenia (Organisation for Economic Co-operation and Development (OECD), 2016). Thus, Portugal combines high rates of maternal full-time employment with less developed state-supported care services when

compared to other countries, namely the Scandinavian countries. In fact, grandparents are important providers of child care (Lewis et al., 2008). It is also characterized by labour market factors that generally increase female employment (Christiansen et al., 2016) such as low wages and lack of availability of part-time jobs (Lewis et al., 2008).

Previous studies in the more affluent countries have found an association between maternal employment-related outcomes and having a child with a variety of developmental or behavioural needs. These include children with language impairment (Nes et al., 2015), developmental disabilities (DeRigne, 2012), internalizing/externalizing behavioural problems (Nes et al., 2014), as well as children with mental health care needs overall, or with less prevalent conditions such as autism (DeRigne, 2012). In addition to the direct impact of child neurodevelopmental and behavioural problems on the family, maternal nonparticipation in the workforce may indirectly add to the long-term impact of these conditions, namely on family well-being. However, there is scarce evidence on the impact of children's poor mental health on maternal employment in less affluent European economies where the dual-earner family structure is often necessary to make ends meet. Thus, we aimed to estimate the association between children suspected or diagnosed neurodevelopmental or behavioural problems up to age seven and maternal unemployment at child ages seven and ten in a Portuguese birth cohort.

METHODS

Participants

This study was embedded in Generation XXI, a prospective population-based birth cohort study, which has been described in detail elsewhere (Alves et al., 2012; Larsen et al., 2013). Newborns and their mothers were recruited up to 72 hours after birth, between April 2005 and August 2006 at the five public level III maternities covering the metropolitan area of Porto, which included 91.6% of all deliveries in the catchment area at the time of recruitment. Of the invited mothers, 91.4% accepted to participate and a total of 8495 mothers and their 8647 children were enrolled at baseline. The cohort has been followed-up regularly, with five assessment waves completed, at birth, 4, 7, 10 and 13 years of age. This study was based on data from the 7- and 10-year follow-up waves (from April 2012 to April 2014 and July 2015 to July 2017, respectively).

For the purpose of this study, we included 5754 mothers and their children, that lived in the same household and had complete information on child neurodevelopmental and behavioural problems at 7 years of age, and on maternal employment at child ages 7 and 10. When compared to the remaining cohort participants (n=2741), mothers included were slightly older (29.8 vs. 27.3 years), more likely to have a higher socioeconomic position - higher educational level (11.0 vs. 9.2 schooling years) and monthly household income with more than EUR 2000 (17.4% vs. 11.8%) - than nonparticipants.

The Generation XXI cohort study protocol was approved by the Ethics Committee of Ethics Committee of São João Hospital/University of Porto Medical School and complies with the Ethical Principles expressed in the Helsinki Declaration and with the current national legislation. The project was registered with the Portuguese Authority for Data Protection. Written informed consent was obtained at all assessments.

Data collection

Child neurodevelopmental and behavioural problems

When the child was 7 years of age, caregivers reported whether they or their child's teacher had ever suspected that the child had (a) learning, (b) attention, (c) language, (d) behavioural or (e) socialization problems, (f) developmental delay or (g) an autism spectrum disorder (including Asperger's syndrome). They were also asked whether the children had a clinical diagnosis of any of these problems. The question on behavioural problems was open-ended and the answers were classified in 'externalizing behaviours' or 'other problems', both suspected and diagnosed, separately. Externalizing behaviours included impulse-control disorders, hyperactivity disorders and aggressive behaviour. The 'other problems' category included socialization problems, anxiety, depression, fear, lack of self-confidence and shyness. The number of both suspected and diagnosed problems were separately categorized into 'no problems', 'one problem' and 'two or more problems'.

Maternal unemployment

When the child was 7 years of age, mothers were asked about their employment status, which was later dichotomized into 'unemployed' vs. the remaining categories (full- or part-time worker, unpaid family worker, student, retired, homemaker, or other situation). At the 10-year-old assessment wave, mothers were asked whether they were currently unemployed, and whether they had been unemployed since 2009 (corresponding to child age 4) as well as the duration of the longest unemployment spell, in months. The latter was categorized into 'not unemployed', '≤12 months', '13-36 months' and '>36 months'.

Covariates

Maternal age at the 7-year-old follow-up was retrieved, and education was recorded as the number of completed schooling years and grouped as ≤9, 10-12, or >12 years of education.

Regarding household characteristics, single mother families were defined as women living with the index child but without the biological father or another partner. Data on having a singleton/multiple index pregnancy and on having other children and/or stepchildren below age 6, were also retrieved. Since maternal report on child's behavioural and emotional problems has been shown to be affected by maternal psychopathology, particularly depression and anxiety (De Los Reyes & Kazdin, 2005; Muller et al., 2011), mother-reported history of diagnosed mental disorders was also included as an adjustment variable. It was computed based on two binary questions (diagnosis of depression that requires regular medical care and previous diagnosis of postpartum depression) and an open-ended one on other health problems, which included mental disorders. Women were considered as having a diagnosis of a mental disorder if they had at least one positive response in any of these three variables. All adjustment variables were retrieved from the age 7 follow-up.

Data analysis

Several factors may affect both child's neurodevelopment and behaviour, and maternal work participation, thus potentially confounding our effect estimates (Figure 1), thus, we adopted a 3-step approach. Robust Poisson regression models were used to calculate prevalence ratios (PRs) and 95% confidence intervals (CIs) in order to estimate associations between child neurodevelopmental or behavioural problems up to 7 years of age (suspected and diagnosed, separately) and maternal unemployment when the child was 7 and 10 years old (model 1). The analysis was further adjusted for maternal socioeconomic position, which included age and educational level (model 2). The analysis was additionally adjusted for family structure-related variables, such as being part of a single mother household, having a singleton/multiple pregnancy and having other children under the age of 6 years in the household, as well as for maternal history of diagnosed mental disorders (model 3). The fully adjusted model was also

run using maternal unemployment at both 7 and 10-year assessment waves as outcome (vs. all other situations). Ordinal logistic regression was used to calculate odds ratios (ORs) in order to estimate the association between child neurodevelopmental or behavioural problems until 7 years of age and duration of maximum maternal unemployment spell between child's age 4 and 10 years. Statistical analysis was performed using the statistical software IBM SPSS Statistics for Windows, Version 21.0 (Chicago, Illinois).

Sensitivity analysis

Assuming that unemployment may be dependent on the affluence of the household, estimates were computed after excluding families with household income of more than EUR 3000 (higher available category) (n=501). Additional sensitivity analyses to assess the impact of long-term unemployment not attributable to child-related factors were carried out by excluding mothers who were unemployed at child birth (n=995). In order to assess the impact of unemployment not attributable to child organic diseases, estimates were also computed after excluding mothers whose children had a diagnosis of cerebral palsy, congenital malformations, growth problems, heart problems, renal problems, liver problems, epilepsy, type 1 diabetes, or lymphoma/leukaemia (n=1287).

RESULTS

In our study, the most frequently suspected neurodevelopmental and behavioural problems in children during the first 7 years of life were attention problems (21.0%) followed by language problems (16.0%). The latter was also the most prevalent clinically diagnosed problem (11.4%). Autism spectrum disorders had the lowest prevalence, both suspected (0.9%) and diagnosed (0.5%). Table 1 summarizes maternal unemployment at child ages 7 and 10, according to maternal individual and household-related characteristics. When the child was 7 years of age, most mothers in our sample had more than 30 years of age (88.4%), had 12 or less years of schooling (69.9%), lived with a partner (86.0%), and had no children under the age of 6 in the household (75.0%). Having a mental disorder diagnosis was reported by 10.4% of the mothers. The prevalence of maternal unemployment was 18.5% at the 7-year-old follow-up, 16.7% when the child was 10 years of age, and 8.7% at both assessment waves. Unemployment was more frequent among women under 30 years of age, women with 9 or less schooling years, women living in single mother households, and with a history of a mental disorder diagnosis.

Associations between child neurodevelopmental or behavioural problems and maternal unemployment at child ages 7 and 10 are presented in Table 2. Women had higher risk of unemployment at the 7-year-old follow-up if their child had suspected developmental delay, learning problems or externalizing behaviours – crude PRs 1.60, 1.53 and 1.31, respectively. A similar pattern was found for clinically diagnosed problems, with developmental delay, learning problems and externalizing behaviours showing an association with increased maternal unemployment at child age 7 – crude PRs 1.69, 1.56 and 1.29, respectively. After adjustment for maternal age and educational level (model 2), most estimates were attenuated but the same overall pattern remained with positive associations for suspected developmental delay, learning problems or externalizing behaviours – adjusted PRs 1.36, 1.25 and 1.15,

respectively. Regarding diagnosed problems, only developmental delay and learning problems showed an association with maternal unemployment at child age 7 - adjusted PRs 1.42 and 1.31, respectively (model 2). Additional adjustment for other reasons for a demanding home situation and maternal mental health (model 3) was responsible for further attenuation of estimates, and associations remained strongest for developmental delay and learning problems, both suspected – adjusted PRs 1.33 and 1.20, respectively – and diagnosed – adjusted PRs 1.39 and 1.28, respectively.

Associations were overall stronger with unemployment at child age 10, when compared to child age 7. Women were more likely to be unemployed at child age 10 if they suspected their child had an autism spectrum disorder, developmental delay, externalizing behaviours or learning problems – adjusted PRs 1.73, 1.58, 1.29 and 1.26, respectively (model 3). When the exposure was restricted to clinically diagnosed disorders, the magnitude of associations remained similar to suspected disorders but estimates were less precise, and only seemingly more severe problems, such as developmental delay, showed a clear association with maternal unemployment – adjusted PR 1.42 (model 3).

Estimates for unemployment at both waves of assessment were overall higher for mothers who had children with suspected and diagnosed developmental delay, externalizing behaviours and learning problems (Table 2). There were no clear associations between attention or language problems, suspected or diagnosed, and maternal unemployment at any assessment wave after adjustment for covariates. However, there was an association between having children with two or more neurodevelopmental or behavioural problems, particularly suspected ones, and maternal unemployment – adjusted PRs 1.13 and 1.14, for child age 7 and 10 respectively (model 3).

When looking into the longest unemployment spell, women were more likely to have unemployment spells of more than 3 years between child age 4 and 10, if the child had

suspected or diagnosed developmental delay (OR[adjusted]=2.06; 95%CI [1.48, 2.87] and OR[adjusted]=1.93, 95%CI [1.32, 2.83], respectively), or learning problems (OR[adjusted]=1.31, 95%CI [1.11, 1.56] and OR[adjusted]=1.33, 95%CI [1.03, 1.73], respectively), or a suspected autism spectrum disorder (OR[adjusted]=1.68, 95%CI [0.98, 2.86]) (results not shown).

Figure 2 shows the results of the sensitivity analyses excluding households with a monthly household income over EUR 3000, mothers who were unemployed at baseline, or mothers whose children had an organic disease diagnosis (estimates presented in supplemental tables 1, 2 and 3). When excluding families with a household income of more than EUR 3000, estimates were similar to those found for the whole sample. When excluding mothers unemployed at child birth, results showed an overall increase in the likelihood of maternal unemployment, particularly at the 7-year-old follow-up, when children had learning problems (adjusted PRs 1.34 vs. 1.20 for suspected and 1.46 vs. 1.28 for diagnosed) or developmental delay (adjusted PRs 1.69 vs. 1.33 for suspected and 1.72 vs. 1.39 for diagnosed). After excluding mothers whose children had an organic disease diagnosis, maternal unemployment was more likely, at the 7-year-old assessment, when children had a developmental delay (adjusted PRs 1.55 vs. 1.33 for suspected and 1.54 vs. 1.39 for diagnosed) and, at the 10-year-old assessment, when children had an autism spectrum disorder (adjusted PRs 2.21 vs. 1.69 for suspected and 2.10 vs. 1.66 for diagnosed) and a suspected developmental delay (adjusted PRs 1.78 vs. 1.54), but estimates were less precise.

DISCUSSION

In our study, mothers of children with learning problems, externalizing behaviours, developmental delay or an autism spectrum disorder up to age seven had a higher likelihood of being unemployed at child age 10. Regarding learning problems, developmental delay and autism, these findings held among previously employed mothers, and associations were stronger among families with a low to middle-category household income and mothers of children without chronic organic diseases. Previous research has shown that families of children with mental health care needs are more likely to cut work hours or to stop work altogether when compared to families with children without mental health care needs or with children with other health care needs (Busch & Barry, 2007, 2009). Moreover, although maternal work participation typically increases as the child grows (Eurostat, 2009), this return-to-work pattern is not apparent among mothers of children with special health care needs (Gordon et al., 2008). This lasting effect on maternal work participation is reflected by our findings where nearly all estimates increased between the 7- and 10-year-old follow-ups, thus suggesting that children's behavioural and developmental problems may have a sustained long-term impact on maternal employment, in addition to their direct impact on overall family well-being. This study adds to our understanding of the impact of a child's neurodevelopmental or behavioural problems on maternal unemployment by using a large prospective population-based birth cohort, and particularly by focusing on school-age children of a less affluent economy, such as the southern European one, where research on the subject is scarce.

Although evidence is scarce concerning learning disabilities' impact on maternal work participation, previous research has shown an association between children's intellectual disability and maternal work participation (Chou et al., 2018; Seltzer & Greenberg, 2001),

which may include learning problems, among others types of disorders. Concerning behaviour problems, our results are in line with findings from previous studies in toddlers and pre-schoolers to be associated with lower maternal employment (Nes et al., 2014; Nes et al., 2015). Behaviour problems in early adolescents have also been shown to contribute to the multiple barriers to women's accessing and retaining stable and quality employment, particularly in economically disadvantaged families (Coley et al., 2011). Although our assessment of behaviour problems may entail a myriad of different emotional and developmental problems of varying severity, previous research comparing the impact on families of having young adults with intellectual disabilities (namely Down syndrome, cerebral palsy and autism) showed that the relationship between diagnostic group and maternal well-being was almost entirely accounted for by the level of behaviour problems (Blacher & McIntyre, 2006). Regarding our findings that having a child with a developmental delay is a predictor of maternal unemployment with lasting effects up until middle childhood, previous research has found that mothers with children with developmental disabilities had lower rates of overall employment and greater likelihood of part-time employment even as their children grew older (Parish et al., 2004).

Despite its low prevalence in our sample, we also found an association between autism spectrum disorders and maternal unemployment. Autism spectrum disorders have also been found to preclude maternal employment and the number of hours worked per week (Cidav et al., 2012; Kogan et al., 2008; McCall & Starr, 2018). In fact, children with an autism spectrum disorder often have co-occurring conditions that require a broader range of health services, thus creating additional family burden, whether it is financial, stress or other mental problems for families (Blacher & McIntyre, 2006; DeRigne, 2012; Duarte et al., 2005; Montes & Halterman, 2007).

Although we found no association with other, seemingly less severe, neurodevelopmental or behavioural problems, previous findings showed that mothers with a preschool child with language impairment had increased risk of not being employed and of taking long-term sick leaves (Nes et al., 2015). Since our outcome, unemployment, consists of an extreme measure of maternal nonparticipation at work, we expect that only the more severe and chronic child conditions, i.e. the ones that require frequent health services utilization or cause serious functional disability such as developmental delay, learning problems and autism spectrum disorders, will have an effect on maternal unemployment. These findings held when looking into the longest unemployment spell since child age 4 as an outcome, where women were more likely to have unemployment spells of more than 3 years if the child had either suspected or diagnosed developmental delay or learning problems, or a suspected autism spectrum disorder.

Children's health status may constitute an important risk factor for maternal unemployment, affecting thus a family's work-life balance. Most research on child healthcare needs and maternal work participation focuses on preschool children. Although access to high quality childcare for toddlers and pre-schoolers is a major factor for parents' employment decisions, childcare for school-age children must also be considered (Rosenzweig et al., 2008). In fact, in about half of the European Union Member States, being a mother decreases the likelihood of working 40 or more hours per week; whereas Portugal stands out as one of the few European countries where mothers are more likely to work more than 40 hours per week than childless women (RAND Europe, 2014). The latter might be explained by cultural differences, less flexible working arrangements, long working hours and the perception that leadership cannot be executed part-time (Haupfleisch et al., 2015). In addition to schedule differences between child and parents affecting all mothers and families, schoolchildren may inhibit maternal employment via other possible explanations, particularly if the child has special care needs.

Decreased maternal work participation may be the product of an individual and voluntary choice or the consequence of a suboptimal performance at home or at work. The conflict between job and parenting demands may be higher for parents of children with emotional or behavioural problems, leading to the disruption of work-family balance and increased levels of stress (Rosenzweig et al., 2008). Stress might lead parents, and mothers in particular, to decrease the number of hours worked or even to stop work altogether. Decreased maternal work participation may also be explained by the fact that childcare activities could interfere with job performance and work hours, since children may require enhanced attention and supervision, meetings with educational personnel, and medical visits (Bernheimer et al., 2003; Coley et al., 2011). The increased need to provide child-care may interfere with mothers' ability to not only perform other personal and family-related activities, but also with the ability to meet occupational requirements and to retain employment. Therefore, having a child with special care needs is likely to increase maternal disadvantage regarding career advancement, income opportunities and pension entitlements, which will economically affect families in the long term, leaving mothers and their families more vulnerable to adversity. There is even an intergenerational transmission of unemployment (D'Addio, 2007). Also, leaving employment for a long period of time may have negative consequences on mothers since, depending on the child's condition, work may have a respite effect on mothers of older children with special needs (Morris, 2012).

Our findings are particularly relevant and must be understood in view of the Portuguese context, a less affluent European economy where reconciling work and family via part-time jobs is rarely an option (Eurostat, 2018; RAND Europe, 2014) - in our sample, only 7.5% of mothers worked part-time at child age 7. In Portugal, parents with children under 12 years of age (no age limit in the case of a child with an illness or disability living in the same household) are entitled to work part-time or to flexible working arrangements, which means that the employee may choose, within certain limits, when to start and finish daily work without

reducing working hours (Koslowski et al., 2020). However, these entitlements have a limited impact on the Portuguese labour market – and flexibility is higher in the more qualified occupations (Plantenga & Remery, 2005). In Portugal, in 2015, the employment rate of mothers of children under the age of 6 was higher than the employment rate of childless women, followed by Croatia, Slovenia and Luxembourg, while the reverse was observed in most European countries (European Comission, 2017). Furthermore, female employment rates remain fairly stable as the age of the youngest child increases (Eurostat, 2009). Also, female employment rates increase in the presence of one or two children when compared to childless women, which is consistent with the cost and the 'logistics' involved in childcare; a sharper drop is only observed from the third child onwards (Eurostat, 2009).

Although previous studies have looked into the association between child neurodevelopmental or behavioural problems and maternal work participation, prospective research in school-age children of a less affluent economy, such as the southern European one, with its cultural and childcare services characteristics, is scarce. However, the interpretation of our findings needs to take into account several methodological issues. Firstly, due to the nature of the data collected, we were not able to explore the severity of the child's condition or the specific types of problems within the larger groups used to assess exposure, which may have underestimated our results on some of the conditions studied. Secondly, we only had information on the health of the child that was part of the Generation XXI birth cohort, and so the impact of other potential siblings' health problems on maternal employment could not be measured. Also, we did not include partner's work participation, which may influence maternal employment, due to missing information; yet, including the variable on monthly household income in the sensitivity analysis may partially account for it. Lastly, although our cohort's participants reported on the child's diagnosis of a neurodevelopmental or behavioural problem, and we relied on self-reported information without clinical validation, it may have introduced some level of misclassification. Thus, inferences must be made with caution.

In conclusion, the present study showed that having a child with learning, developmental or behavioural problem, or an autism spectrum disorder was associated with maternal unemployment up to age 10, even in a less affluent European economy where the dual-earner family structure is often necessary to make ends meet. Children's learning, developmental and behavioural problems, and autism spectrum disorders thus entail long-term consequences related to families' well-being, financial condition, and companies' human capital. A more comprehensive depiction of the employment patterns of mothers, including flexible work arrangements, needs to be addressed and developed, in order for mothers, families and companies to prosper.

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Figure 1. Causal diagram displaying the association between child neurodevelopmental and behavioural problems and maternal unemployment, and potential confounders.

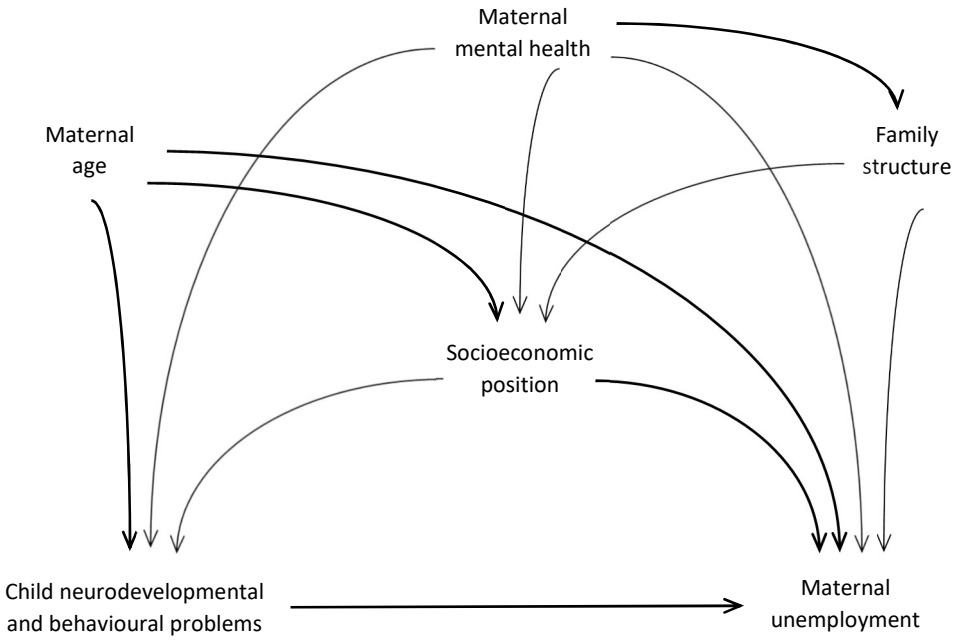


Table 1. Prevalence of unemployment among mothers at child age 7 and 10 years by maternal characteristics, in Generation XXI

	Total	Unemployed at 7	Unemployed at 10	Unemployed at 7 and 10
	n=5754	n=1065	n=963	n=499
	n (%)	n (%)	n (%)	n (%)
Maternal characteristics				
Age (years)				
≤30	665 (11.6)	191 (28.7)	156 (23.5)	78 (11.7)
31-40	3612 (62.8)	611 (16.9)	543 (15.0)	279 (7.7)
>40	1474 (25.6)	263 (17.8)	263 (17.8)	142 (9.6)
Education (schooling years)				
≤9	2274 (39.6)	603 (26.5)	565 (24.8)	311 (13.7)
10-12	1743 (30.3)	313 (18.0)	252 (14.5)	134 (7.7)
>12	1729 (30.1)	147 (8.5)	145 (8.4)	53 (3.1)
Single mother family				
No	4939 (86.0)	883 (17.9)	798 (16.2)	408 (8.3)
Yes	805 (14.0)	181 (22.5)	162 (20.1)	90 (11.2)
Singleton/multiple pregnancy				
Singleton	5647 (98.1)	1043 (18.5)	949 (16.8)	493 (8.7)
Multiple	107 (1.9)	22 (20.6)	14 (13.1)	6 (5.6)
Children below age 6				
No	4293 (75.0)	784 (18.3)	717 (16.7)	368 (8.6)
Yes	1434 (25.0)	276 (19.2)	240 (16.7)	128 (8.9)
Maternal mental disorders				
No	5153 (89.6)	856 (17.8)	760 (15.8)	395 (8.2)
Yes	601 (10.4)	209 (22.4)	203 (21.7)	104 (11.1)

Table 2. Associations between child neurodevelopmental and behavioural problems and maternal unemployment at child age 7 and 10 years (prevalence ratio, PR, and respective 95% confidence interval, CI)

		Model 1		Model 2		Model 3		Model 3
	N (%) (n=5754)	Child age 7	Child age 10	Child age 7	Child age 10	Child age 7	Child age 10	7 and 10
Suspected								
Learning problems								
No	5184 (90.2)	1	1	1	1	1	1	1
Yes	562 (9.8)	1.53 (1.32-1.77)	1.56 (1.33-1.83)	1.25 (1.08-1.44)	1.27 (1.08-1.49)	1.07 (0.92-1.23)	1.14 (0.97-1.34)	1.12 (0.89-1.40)
Attention problems								
No	4528 (79.0)	1	1	1	1	1	1	1
Yes	1207 (21.0)	1.12 (0.99-1.28)	1.03 (0.90-1.19)	1.04 (0.92-1.18)	0.97 (0.84-1.11)	0.97 (0.86-1.09)	0.93 (0.81-1.07)	1.02 (0.84-1.23)
Language problems								
No	4825 (84.0)	1	1	1	1	1	1	1
Yes	918 (16.0)	1.14 (0.99-1.32)	1.17 (1.01-1.36)	1.06 (0.93-1.22)	1.09 (0.94-1.25)	1.03 (0.90-1.18)	1.06 (0.92-1.23)	1.02 (0.83-1.26)
Externalizing behaviours								
No	5080 (88.7)	1	1	1	1	1	1	1
Yes	649 (11.3)	1.31 (1.13-1.52)	1.50 (1.29-1.74)	1.15 (0.99-1.33)	1.32 (1.14-1.53)	1.04 (0.90-1.21)	1.20 (1.03-1.40)	1.32 (1.07-1.64)
Developmental delay								
No	5596 (97.7)	1	1	1	1	1	1	1
Yes	133 (2.3)	1.60 (1.22-2.09)	1.92 (1.49-2.49)	1.36 (1.04-1.77)	1.61 (1.24-2.11)	1.23 (0.94-1.60)	1.46 (1.12-1.91)	1.50 (1.03-2.17)
Autism								
No	5670 (99.1)	1	1	1	1	1	1	1
Yes	54 (0.9)	1.10 (0.65-1.87)	1.55 (0.99-2.45)	1.25 (0.74-2.12)	1.77 (1.10-2.85)	1.23 (0.73-2.09)	1.62 (0.99-2.65)	1.49 (0.69-3.23)
Other problems[a]								
No	5387 (93.9)	1	1	1	1	1	1	1
Yes	352 (6.1)	1.08 (0.87-1.34)	1.11 (0.88-1.39)	1.06 (0.85-1.31)	1.09 (0.87-1.37)	1.03 (0.84-1.28)	1.02 (0.80-1.28)	1.09 (0.79-1.50)

Diagnosed								
Learning problems								
No	5510 (96.0)	1	1	1	1	1	1	1
Yes	231 (4.0)	1.56 (1.26-1.93)	1.51 (1.20-1.91)	1.31 (1.06-1.61)	1.26 (1.00-1.59)	1.14 (0.94-1.40)	1.12 (0.88-1.41)	1.15 (0.83-1.58)
Attention problems								
No	5438 (95.0)	1	1	1	1	1	1	1
Yes	288 (5.0)	1.13 (0.90-1.43)	1.31 (1.04-1.64)	1.03 (0.82-1.28)	1.19 (0.95-1.49)	0.99 (0.80-1.23)	1.14 (0.91-1.43)	1.25 (0.92-1.69)
Language problems								
No	5078 (88.6)	1	1	1	1	1	1	1
Yes	653 (11.4)	1.03 (0.87-1.22)	1.16 (0.98-1.37)	0.97 (0.82-1.14)	1.08 (0.91-1.27)	0.95 (0.81-1.12)	1.05 (0.89-1.25)	0.91 (0.71-1.18)
Externalizing behaviours								
No	5521 (96.7)	1	1	1	1	1	1	1
Yes	191 (3.3)	1.29 (0.99-1.67)	1.49 (1.16-1.93)	1.11 (0.86-1.44)	1.31 (1.03-1.67)	1.00 (0.78-1.29)	1.16 (0.90-1.51)	1.32 (0.93-1.88)
Developmental delay								
No	5626 (98.3)	1	1	1	1	1	1	1
Yes	100 (1.7)	1.69 (1.26-2.28)	1.82 (1.34-2.47)	1.42 (1.06-1.91)	1.50 (1.10-2.06)	1.32 (0.99-1.76)	1.36 (0.97-1.89)	1.57 (1.03-2.38)
Autism								
No	5692 (99.5)	1	1	1	1	1	1	1
Yes	30 (0.5)	0.72 (0.29-1.79)	1.60 (0.88-2.90)	0.78 (0.31-1.96)	1.73 (0.94-3.18)	0.82 (0.34-2.01)	1.77 (0.96-3.23)	1.38 (0.49-3.89)
Other problems[a]								
No	5636 (98.3)	1	1	1	1	1	1	1
Yes	98 (1.7)	1.11 (0.74-1.64)	1.29 (0.88-1.89)	1.15 (0.78-1.71)	1.36 (0.93-2.0)	1.14 (0.79-1.65)	1.28 (0.86-1.89)	1.29 (0.72-2.29)
Nr. of suspected problems								
0	3514 (62.1)	1	1	1	1	1	1	1
1	1219 (21.5)	1.13 (0.99-1.29)	1.09 (0.94-1.26)	1.07 (0.94-1.22)	1.04 (0.90-1.20)	1.02 (0.90-1.17)	1.07 (0.92-1.24)	1.05 (0.85-1.30)
2+	924 (16.3)	1.36 (1.19-1.56)	1.36 (1.18-1.57)	1.16 (1.01-1.33)	1.17 (1.01-1.35)	1.03 (0.90-1.17)	1.01 (0.88-1.17)	1.15 (0.93-1.41)
Nr. of diagnosed problems								
0	4748 (84.5)	1	1	1	1	1	1	1
1	552 (9.8)	0.91 (0.75-1.10)	1.08 (0.89-1.31)	1.04 (0.96-1.13)	1.04 (0.86-1.25)	0.84 (0.69-1.01)	1.02 (0.84-1.23)	0.74 (0.54-1.02)
2+	321 (5.7)	1.32 (1.08-1.62)	1.42 (1.15-1.75)	1.16 (1.05-1.27)	1.23 (1.00-1.51)	1.05 (0.87-1.26)	1.13 (0.92-1.40)	1.24 (0.93-1.64)

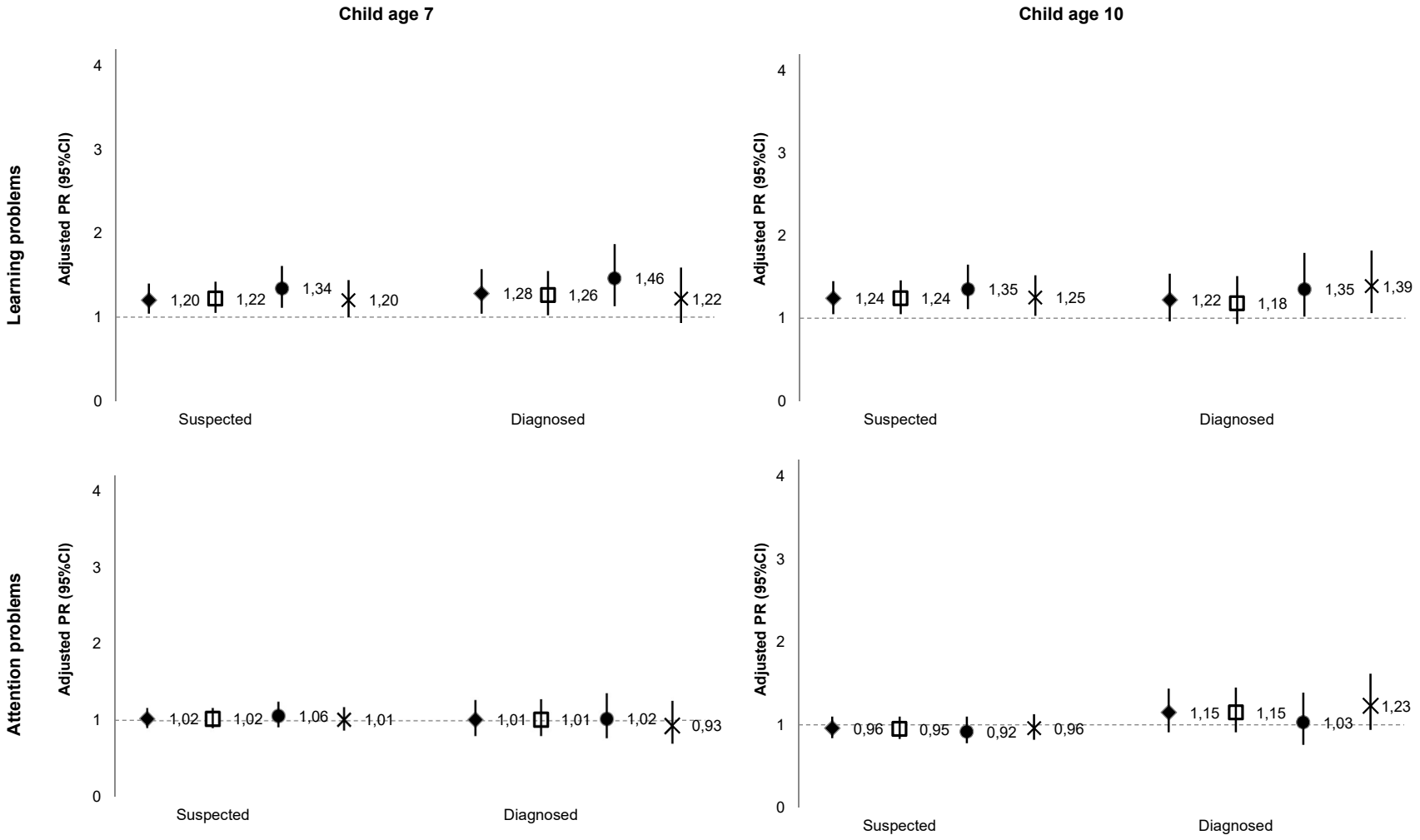
Model 1 - crude associations

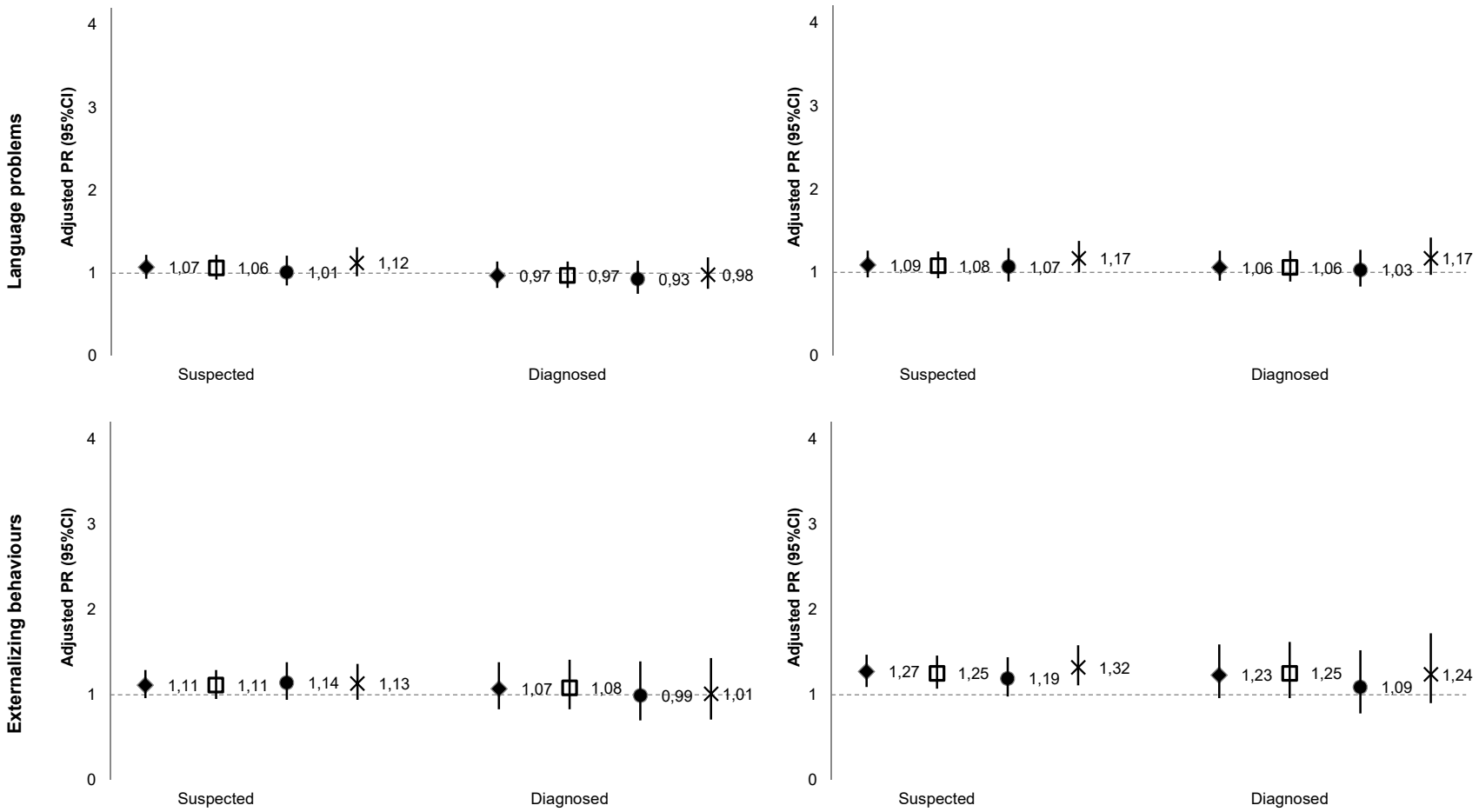
Model 2 - Adjusted for maternal age and educational level, in years.

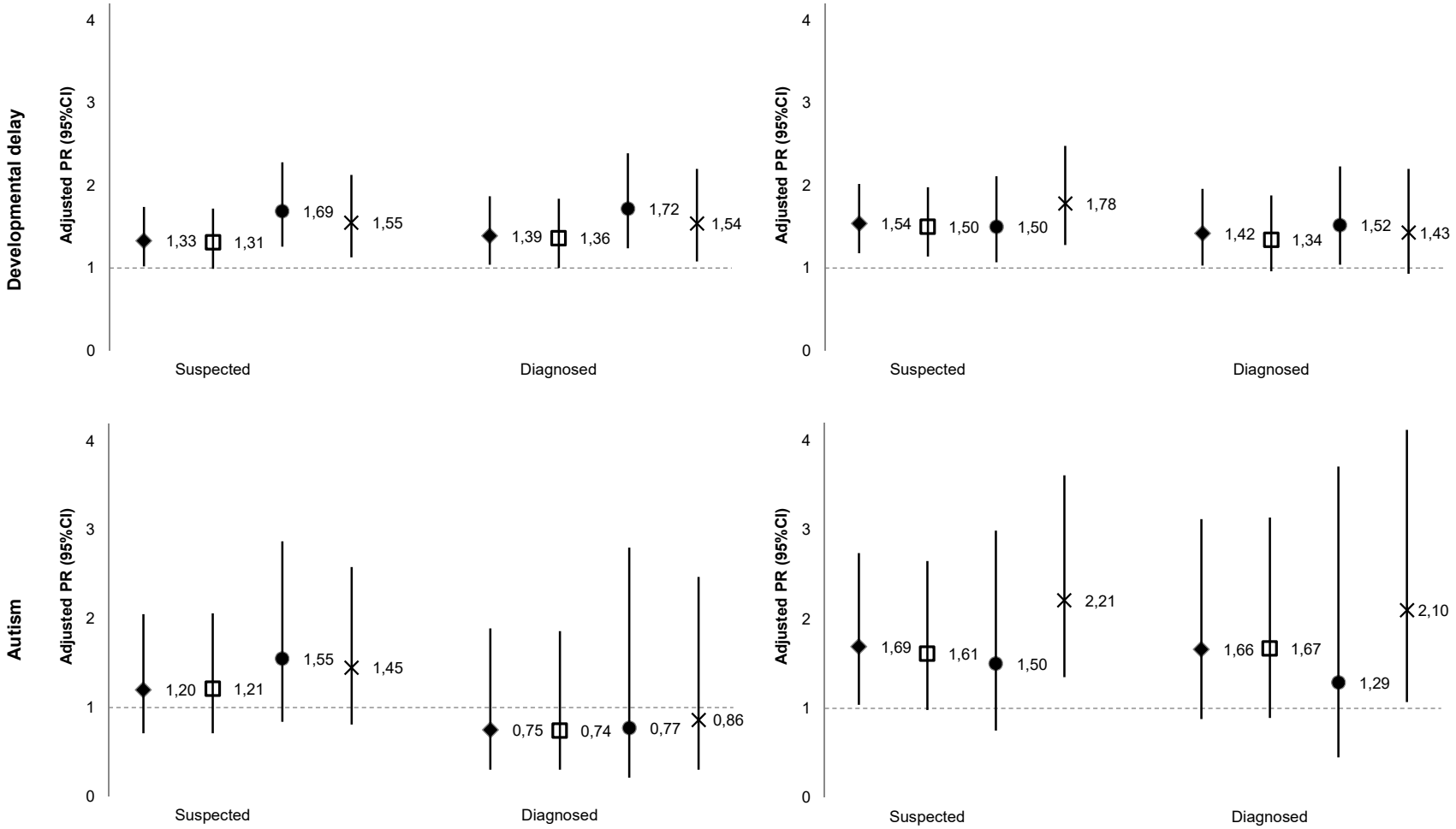
Model 3 - Adjusted for maternal age (in years), maternal educational level (in years), single mother household, singleton/multiple pregnancy, having children with less than 6 years of age in household, monthly household income and maternal history of a diagnosed mental disorder.

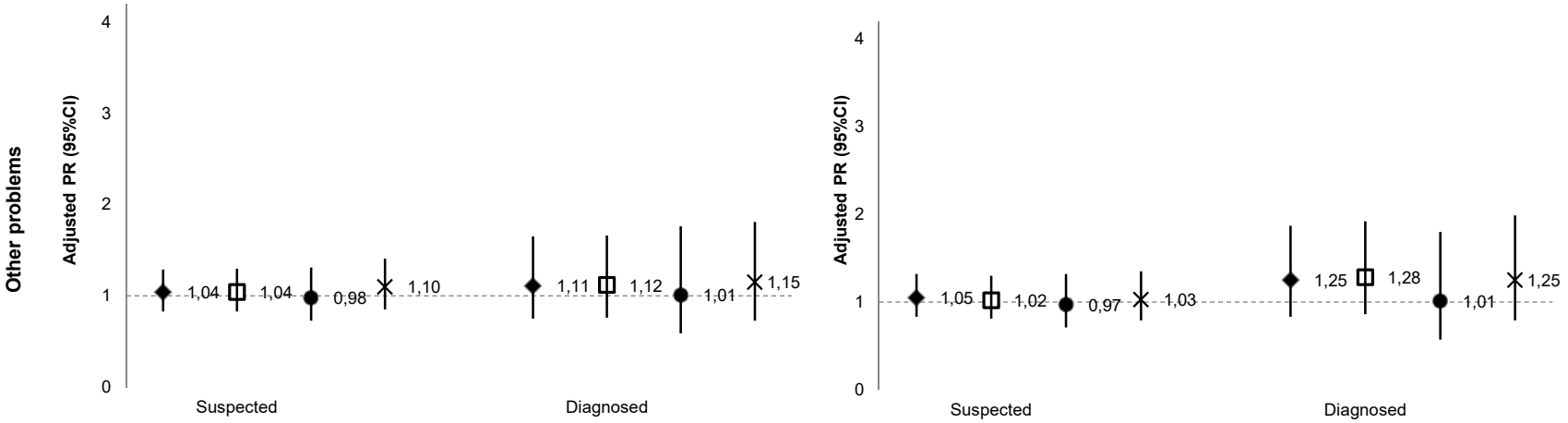
[a] Includes socialization problems, anxiety problems, depression, fear, lack of self-confidence and shyness.

Figure 2. Sensitivity analysis: adjusted prevalence ratios (95% CI) for associations between child neurodevelopmental and behavioural problems and maternal unemployment at child age 7 and 10 years.




Language problems
Externalizing behaviours
Adjusted PR (95%CI)
0
1
2
3
4
1,07
1,06
1,01
1,12
0,97
0,97
0,93
0,98
1,09
1,08
1,07
1,17
1,06
1,06
1,03
1,17
1,11
1,11
1,14
1,13
1,07
1,08
0,99
1,01
1,27
1,25
1,19
1,32
1,23
1,25
1,09
1,24
Suspected
Diagnosed


Developmental delay
Autism
Adjusted PR (95%CI)
0
1
2
3
4
1,33
1,31
1,69
1,55
1,39
1,36
1,72
1,54
1,54
1,50
1,50
1,78
1,42
1,34
1,52
1,43
1,20
1,21
1,55
1,45
0,75
0,74
0,77
0,86
1,69
1,61
1,50
2,21
1,66
1,67
1,29
2,10
Suspected
Diagnosed



The prevalence ratios and 95% confidence intervals presented are estimated by robust Poisson regression models.

Estimates were adjusted for maternal age (in years), maternal educational level (in years), single mother household, singleton/multiple pregnancy, having children with less than 6 years of age in household, monthly household income and maternal history of a diagnosed mental disorder.

Diamond: whole sample (n=5754)

Square: only participants with monthly household income of EUR 3000 or less (n=5253)

Circle: only participants who were not unemployed at baseline (n=4759)

Cross: only participants with children with no organic disease diagnosis (n=4467)

Supplemental table 1. Associations between child neurodevelopmental and behavioural problems and maternal unemployment at child age 7 and 10 years, after excluding families with household income of more than EUR 3000 (prevalence ratio, PR, and respective 95% confidence interval, CI)

		Model 1		Model 2		Model 3		Model 3
	N (%) (n=5253)	Child age 7	Child age 10	Child age 7	Child age 10	Child age 7	Child age 10	7 and 10
Suspected								
Learning problems								
No	4720 (90.0)	1	1	1	1	1	1	1
Yes	525 (10.0)	1.52 (1.31-1.76)	1.53 (1.30-1.79)	1.26 (1.09-1.47)	1.26 (1.07-1.49)	1.22 (1.05-1.42)	1.24 (1.05-1.46)	1.30 (1.03-1.64)
Attention problems								
No	4118 (78.6)	1	1	1	1	1	1	1
Yes	1118 (21.4)	1.11 (0.98-1.27)	1.01 (0.88-1.17)	1.04 (0.91-1.18)	0.96 (0.83-1.10)	1.02 (0.90-1.16)	0.95 (0.83-1.10)	1.08 (0.88-1.31)
Language problems								
No	4395 (83.8)	1	1	1	1	1	1	1
Yes	848 (16.2)	1.14 (0.99-1.31)	1.16 (0.99-1.34)	1.06 (0.92-1.22)	1.07 (0.93-1.25)	1.06 (0.92-1.22)	1.08 (0.93-1.25)	1.07 (0.86-1.33)
Externalizing behaviours								
No	4633 (88.6)	1	1	1	1	1	1	1
Yes	597 (11.4)	1.28 (1.10-1.50)	1.45 (1.24-1.70)	1.14 (0.98-1.33)	1.30 (1.12-1.52)	1.11 (0.95-1.29)	1.25 (1.07-1.46)	1.41 (1.13-1.75)
Developmental delay								
No	5106 (97.6)	1	1	1	1	1	1	1
Yes	125 (2.4)	1.54 (1.17-2.03)	1.83 (1.40-2.39)	1.33 (1.01-1.75)	1.56 (1.19-2.05)	1.31 (0.99-1.72)	1.50 (1.14-1.98)	1.61 (1.09-2.37)
Autism								
No	5172 (99.0)	1	1	1	1	1	1	1
Yes	51 (1.0)	1.11 (0.66-1.88)	1.47 (0.92-2.36)	1.26 (0.74-2.13)	1.67 (1.02-2.74)	1.21 (0.71-2.06)	1.61 (0.98-2.65)	1.45 (0.67-3.15)
Other problems[a]								
No	4917 (93.8)	1	1	1	1	1	1	1
Yes	323 (6.2)	1.07 (0.86-1.34)	1.08 (0.85-1.36)	1.06 (0.85-1.32)	1.07 (0.84-1.35)	1.04 (0.83-1.30)	1.02 (0.81-1.30)	1.10 (0.79-1.54)

Diagnosed								
Learning problems								
No	5023 (95.9)	1	1	1	1	1	1	1
Yes	217 (4.1)	1.51 (1.21-1.87)	1.44 (1.13-1.83)	1.28 (1.04-1.59)	1.22 (0.96-1.55)	1.26 (1.02-1.55)	1.18 (0.93-1.51)	1.27 (0.91-1.78)
Attention problems								
No	4958 (94.8)	1	1	1	1	1	1	1
Yes	270 (5.2)	1.11 (0.88-1.41)	1.28 (1.01-1.61)	1.03 (0.82-1.29)	1.19 (0.94-1.49)	1.01 (0.80-1.27)	1.15 (0.91-1.45)	1.28 (0.93-1.76)
Language problems								
No	4633 (88.6)	1	1	1	1	1	1	1
Yes	598 (11.4)	1.03 (0.87-1.23)	1.15 (0.97-1.37)	0.97 (0.82-1.14)	1.07 (0.90-1.27)	0.97 (0.82-1.14)	1.06 (0.89-1.26)	0.95 (0.73-1.24)
Externalizing behaviours								
No	5037 (96.6)	1	1	1	1	1	1	1
Yes	177 (3.4)	1.26 (0.97-1.65)	1.45 (1.12-1.89)	1.12 (0.87-1.46)	1.31 (1.02-1.68)	1.08 (0.83-1.41)	1.25 (0.96-1.62)	1.45 (1.01-2.07)
Developmental delay								
No	5134 (98.2)	1	1	1	1	1	1	1
Yes	94 (1.8)	1.60 (1.18-2.18)	1.67 (1.21-2.31)	1.38 (1.02-1.87)	1.42 (1.02-1.97)	1.36 (1.00-1.84)	1.34 (0.96-1.88)	1.62 (1.05-2.51)
Autism								
No	5192 (99.4)	1	1	1	1	1	1	1
Yes	29 (0.6)	0.71 (0.29-1.76)	1.59 (0.88-2.88)	0.77 (0.31-1.93)	1.73 (0.94-3.18)	0.74 (0.30-1.86)	1.67 (0.89-3.14)	1.21 (0.40-3.62)
Other problems[a]								
No	5142 (98.2)	1	1	1	1	1	1	1
Yes	92 (1.8)	1.12 (0.76-1.66)	1.32 (0.90-1.94)	1.16 (0.79-1.72)	1.39 (0.95-2.03)	1.12 (0.76-1.66)	1.28 (0.86-1.92)	1.23 (0.68-2.24)
Nr. of suspected problems								
0	3199 (62.0)	1	1	1	1	1	1	1
1	1097 (21.2)	1.11 (0.96-1.27)	1.07 (0.92-1.24)	1.06 (0.92-1.21)	1.03 (0.89-1.19)	1.06 (0.93-1.22)	1.04 (0.89-1.20)	1.10 (0.89-1.37)
2+	867 (16.8)	1.34 (1.17-1.54)	1.31 (1.13-1.52)	1.16 (1.01-1.33)	1.15 (0.99-1.33)	1.13 (0.98-1.30)	1.13 (0.97-1.31)	1.28 (1.04-1.58)
Nr. of diagnosed problems								
0	4333 (84.5)	1	1	1	1	1	1	1
1	492 (9.6)	0.92 (0.75-1.12)	1.10 (0.90-1.34)	0.87 (0.72-1.06)	1.05 (0.86-1.27)	0.87 (0.72-1.06)	1.05 (0.86-1.27)	0.79 (0.57-1.09)
2+	303 (5.9)	1.28 (1.05-1.58)	1.37 (1.11-1.70)	1.13 (0.92-1.38)	1.21 (0.98-1.49)	1.10 (0.90-1.35)	1.17 (0.94-1.45)	1.32 (0.98-1.77)

Model 1 - crude associations

Model 2 - Adjusted for maternal age and educational level, in years.

Model 3 - Adjusted for maternal age (in years), maternal educational level (in years), single mother household, singleton/multiple pregnancy, having children with less than 6 years of age in household and maternal history of a diagnosed mental disorder.

[a] Includes socialization problems, anxiety problems, depression, bipolar disorder, fear, lack of self-confidence and shyness.

Supplemental table 2. Associations between child neurodevelopmental and behavioural problems and maternal unemployment at child age 7 and 10 years after excluding mothers who were unemployed at baseline (prevalence ratio, PR, and respective 95% confidence interval, CI)

		Model 1		Model 2		Model 3		Model 3
	N (%) (n=4759)	Child age 7	Child age 10	Child age 7	Child age 10	Child age 7	Child age 10	7 and 10
Suspected								
Learning problems								
No	4337 (91.3)	1	1	1	1	1	1	1
Yes	415 (8.7)	1.68 (1.39-2.02)	1.74 (1.43-2.11)	1.39 (1.15-1.67)	1.39 (1.15-1.69)	1.34 (1.11-1.61)	1.35 (1.11-1.65)	1.47 (1.10-1.96)
Attention problems								
No	3762 (79.3)	1	1	1	1	1	1	1
Yes	983 (20.7)	1.17 (1.00-1.36)	1.00 (0.84-1.19)	1.07 (0.92-1.25)	0.93 (0.78-1.10)	1.06 (0.91-1.24)	0.92 (0.78-1.10)	1.14 (0.89-1.45)
Language problems								
No	4024 (84.7)	1	1	1	1	1	1	1
Yes	725 (15.3)	1.08 (0.90-1.30)	1.17 (0.97-1.41)	1.01 (0.85-1.21)	1.08 (0.90-1.29)	1.01 (0.85-1.21)	1.07 (0.89-1.29)	1.00 (0.76-1.33)
Externalizing behaviours								
No	4226 (89.2)	1	1	1	1	1	1	1
Yes	514 (10.8)	1.34 (1.11-1.62)	1.44 (1.18-1.74)	1.17 (0.97-1.42)	1.25 (1.04-1.51)	1.14 (0.94-1.38)	1.19 (0.98-1.44)	1.37 (1.03-1.81)
Developmental delay								
No	4634 (97.8)	1	1	1	1	1	1	1
Yes	104 (2.2)	2.06 (1.53-2.77)	1.97 (1.43-2.73)	1.72 (1.28-2.32)	1.59 (1.13-2.22)	1.69 (1.26-2.28)	1.50 (1.07-2.11)	1.89 (1.21-2.95)
Autism								
No	4701 (99.2)	1	1	1	1	1	1	1
Yes	37 (0.8)	1.42 (0.77-2.63)	1.36 (0.70-2.66)	1.62 (0.88-2.98)	1.56 (0.78-3.12)	1.55 (0.84-2.87)	1.50 (0.75-2.99)	2.27 (0.98-5.27)
Other problems[a]								
No	4474 (94.2)	1	1	1	1	1	1	1
Yes	274 (5.8)	1.01 (0.76-1.34)	1.03 (0.76-1.39)	1.00 (0.75-1.33)	1.02 (0.75-1.37)	0.98 (0.73-1.31)	0.97 (0.71-1.32)	0.89 (0.55-1.42)

Diagnosed								
Learning problems								
No	4571 (96.3)	1	1	1	1	1	1	1
Yes	176 (3.7)	1.77 (1.37-2.29)	1.73 (1.31-2.28)	1.49 (1.16-1.92)	1.41 (1.07-1.86)	1.46 (1.13-1.87)	1.35 (1.02-1.79)	1.51 (1.01-2.24)
Attention problems								
No	4509 (95.2)	1	1	1	1	1	1	1
Yes	228 (4.8)	1.16 (0.87-1.55)	1.21 (0.90-1.64)	1.05 (0.79-1.38)	1.08 (0.80-1.44)	1.02 (0.77-1.35)	1.03 (0.76-1.39)	1.25 (0.84-1.87)
Language problems								
No	4222 (89.1)	1	1	1	1	1	1	1
Yes	519 (10.9)	0.99 (0.80-1.23)	1.14 (0.92-1.42)	0.93 (0.75-1.15)	1.05 (0.85-1.30)	0.93 (0.75-1.15)	1.03 (0.83-1.27)	0.86 (0.61-1.22)
Externalizing behaviours								
No	4576 (96.8)	1	1	1	1	1	1	1
Yes	149 (3.2)	1.20 (0.85-1.70)	1.37 (0.97-1.92)	1.03 (0.73-1.45)	1.16 (0.84-1.61)	0.99 (0.70-1.39)	1.09 (0.78-1.52)	1.40 (0.89-2.20)
Developmental delay								
No	4658 (98.4)	1	1	1	1	1	1	1
Yes	78 (1.6)	2.14 (1.54-2.97)	2.06 (1.44-2.96)	1.75 (1.26-2.44)	1.62 (1.11-3.36)	1.72 (1.24-2.39)	1.52 (1.04-2.23)	1.87 (1.13-3.09)
Autism								
No	4718 (99.6)	1	1	1	1	1	1	1
Yes	18 (0.4)	0.73 (0.20-2.69)	1.20 (0.43-3.38)	0.82 (0.23-2.98)	1.34 (0.46-3.87)	0.77 (0.21-2.80)	1.29 (0.45-3.71)	1.80 (0.48-6.70)
Other problems[a]								
No	4673 (98.5)	1	1	1	1	1	1	1
Yes	72 (1.5)	1.00 (0.58-1.74)	1.10 (0.64-1.91)	1.07 (0.62-1.85)	1.18 (0.69-2.02)	1.01 (0.59-1.76)	1.01 (0.57-1.80)	1.04 (0.45-2.40)
Nr. of suspected problems								
0	2955 (63.1)	1	1	1	1	1	1	1
1	1012 (21.6)	1.15 (0.98-1.36)	1.16 (0.97-1.38)	1.08 (0.92-1.27)	1.09 (0.92-1.29)	1.09 (0.93-1.29)	1.10 (0.93-1.30)	1.15 (0.89-1.50)
2+	716 (15.3)	1.34 (1.12-1.60)	1.33 (1.11-1.61)	1.15 (0.97-1.37)	1.13 (0.94-1.36)	1.12 (0.94-1.33)	1.10 (0.91-1.32)	1.23 (0.93-1.61)
Nr. of diagnosed problems								
0	3966 (85.2)	1	1	1	1	1	1	1
1	441 (9.5)	0.86 (0.67-1.11)	1.14 (0.90-1.44)	0.83 (0.65-1.06)	1.08 (0.87-1.36)	0.83 (0.65-1.06)	1.08 (0.86-1.35)	0.75 (0.50-1.13)
2+	249 (5.3)	1.26 (0.97-1.64)	1.31 (0.99-1.73)	1.09 (0.84-1.41)	1.10 (0.83-1.45)	1.06 (0.81-1.37)	1.05 (0.79-1.39)	1.20 (0.81-1.76)

Model 1 - crude associations

Model 2 - Adjusted for maternal age and educational level, in years.

Model 3 - Adjusted for maternal age (in years), maternal educational level (in years), single mother household, singleton/multiple pregnancy, having children with less than 6 years of age in household, monthly household income and maternal history of a diagnosed mental disorder.

[a] Includes socialization problems, anxiety problems, depression, bipolar disorder, fear, lack of self-confidence and shyness.

Supplemental table 3. Associations between child neurodevelopmental and behavioural problems and maternal unemployment at child age 7 and 10 years after excluding mothers of children with an organic disease diagnosis (prevalence ratio, PR, and respective 95% confidence interval, CI)

		Model 1		Model 2		Model 3		Model 3
	N (%) (n=4467)	Child age 7	Child age 10	Child age 7	Child age 10	Child age 7	Child age 10	7 and 10
Suspected								
Learning problems								
No	4085 (91.6)	1	1	1	1	1	1	1
Yes	375 (8.4)	1.51 (1.26-1.82)	1.60 (1.32-1.93)	1.24 (1.03-1.48)	1.30 (1.08-1.57)	1.20 (1.00-1.44)	1.25 (1.03-1.52)	1.33 (1.01-1.75)
Attention problems								
No	3523 (79.1)	1	1	1	1	1	1	1
Yes	930 (20.9)	1.09 (0.94-1.27)	1.03 (0.88-1.21)	1.01 (0.87-1.17)	0.97 (0.83-1.13)	1.01 (0.87-1.17)	0.96 (0.82-1.13)	1.10 (0.88-1.39)
Language problems								
No	3773 (84.6)	1	1	1	1	1	1	1
Yes	687 (15.4)	1.20 (1.02-1.41)	1.27 (1.08-1.50)	1.12 (0.95-1.30)	1.18 (1.00-1.38)	1.12 (0.96-1.31)	1.17 (1.00-1.38)	1.17 (0.92-1.50)
Externalizing behaviours								
No	3978 (89.5)	1	1	1	1	1	1	1
Yes	469 (10.5)	1.31 (1.09-1.56)	1.54 (1.29-1.83)	1.15 (0.96-1.38)	1.37 (1.15-1.63)	1.13 (0.94-1.36)	1.32 (1.11-1.58)	1.29 (0.98-1.68)
Developmental delay								
No	4372 (98.3)	1	1	1	1	1	1	1
Yes	75 (1.7)	1.89 (1.36-2.61)	2.28 (1.69-3.08)	1.55 (1.12-2.13)	1.85 (1.34-2.55)	1.55 (1.13-2.13)	1.78 (1.28-2.48)	1.52 (0.90-2.59)
Autism								
No	4404 (99.1)	1	1	1	1	1	1	1
Yes	38 (0.9)	1.33 (0.75-2.36)	2.07 (1.32-3.23)	1.49 (0.84-2.63)	2.29 (1.42-3.69)	1.45 (0.81-2.58)	2.21 (1.35-3.61)	1.74 (0.74-4.10)
Other problems[a]								
No	4194 (94.1)	1	1	1	1	1	1	1
Yes	262 (5.9)	1.14 (0.89-1.46)	1.10 (0.85-1.44)	1.11 (0.87-1.43)	1.08 (0.83-1.40)	1.10 (0.85-1.41)	1.03 (0.79-1.35)	1.06 (0.72-1.58)

Diagnosed								
Learning problems								
No	4318 (96.9)	1	1	1	1	1	1	1
Yes	138 (3.1)	1.48 (1.11-1.98)	1.74 (1.32-2.28)	1.23 (0.94-1.62)	1.44 (1.11-1.89)	1.22 (0.93-1.59)	1.39 (1.06-1.82)	1.28 (0.84-1.94)
Attention problems								
No	4256 (95.7)	1	1	1	1	1	1	1
Yes	189 (4.3)	1.04 (0.76-1.41)	1.39 (1.06-1.82)	0.93 (0.70-1.25)	1.26 (0.97-1.65)	0.93 (0.70-1.25)	1.23 (0.94-1.62)	1.24 (0.83-1.85)
Language problems								
No	3986 (89.6)	1	1	1	1	1	1	1
Yes	465 (10.4)	1.05 (0.85-1.28)	1.28 (1.06-1.55)	0.98 (0.80-1.19)	1.19 (0.98-1.43)	0.98 (0.81-1.19)	1.17 (0.97-1.42)	0.98 (0.72-1.33)
Externalizing behaviours								
No	4313 (97.3)	1	1	1	1	1	1	1
Yes	120 (2.7)	1.17 (0.82-1.67)	1.46 (1.06-2.02)	1.03 (0.73-1.46)	1.31 (0.96-1.79)	1.01 (0.71-1.43)	1.24 (0.90-1.72)	1.16 (0.69-1.93)
Developmental delay								
No	4391 (98.7)	1	1	1	1	1	1	1
Yes	56 (1.3)	1.92 (1.32-2.78)	1.95 (1.32-2.87)	1.54 (1.07-2.20)	1.53 (1.01-2.31)	1.54 (1.08-2.20)	1.43 (0.93-2.20)	1.45 (0.78-2.69)
Autism								
No	4420 (99.5)	1	1	1	1	1	1	1
Yes	20 (0.5)	0.84 (0.30-2.38)	2.11 (1.16-3.84)	0.87 (0.31-2.47)	2.15 (1.14-4.04)	0.86 (0.30-2.47)	2.10 (1.07-4.12)	1.20 (0.31-4.73)
Other problems[a]								
No	4379 (98.3)	1	1	1	1	1	1	1
Yes	74 (1.7)	1.14 (0.72-1.79)	1.30 (0.84-2.02)	1.17 (0.75-1.84)	1.36 (0.88-2.10)	1.15 (0.73-1.81)	1.25 (0.79-1.99)	1.03 (0.48-2.23)
Nr. of suspected problems								
0	2762 (63.0)	1	1	1	1	1	1	1
1	952 (21.7)	1.11 (0.95-1.30)	1.03 (0.87-1.22)	1.06 (0.91-1.24)	1.00 (0.85-1.18)	1.07 (0.92-1.25)	1.01 (0.86-1.19)	1.12 (0.88-1.43)
2+	671 (15.3)	1.36 (1.15-1.60)	1.41 (1.19-1.66)	1.17 (0.99-1.37)	1.22 (1.03-1.44)	1.15 (0.98-1.35)	1.19 (1.00-1.41)	1.29 (1.01-1.66)
Nr. of diagnosed problems								
0	3739 (85.8)	1	1	1	1	1	1	1
1	415 (9.5)	0.86 (0.68-1.09)	1.12 (0.90-1.40)	0.83 (0.66-1.04)	1.08 (0.87-1.34)	0.83 (0.66-1.04)	1.07 (0.86-1.32)	0.71 (0.48-1.04)
2+	205 (4.7)	1.31 (1.01-1.69)	1.55 (1.21-1.98)	1.12 (0.88-1.44)	1.33 (1.04-1.70)	1.11 (0.87-1.43)	1.30 (1.01-1.67)	1.29 (0.90-1.87)

Model 1 - crude associations

Model 2 - Adjusted for maternal age and educational level, in years.

Model 3 - Adjusted for maternal age (in years), maternal educational level (in years), single mother household, singleton/multiple pregnancy, having children with less than 6 years of age in household, monthly household income and maternal history of a diagnosed mental disorder.

[a] Includes socialization problems, anxiety problems, depression, bipolar disorder, fear, lack of self-confidence and shyness.

5. OVERALL DISCUSSION

With this thesis, we were able to take a step towards a more comprehensive portrait of women's work-related health in Portugal. In particular, we looked into two important outcomes that have a major effect on health, enterprises and society – work-related health problems and injuries (Papers I and II). An increasing number of countries is recognizing Occupational Safety and Health as a higher priority; many stakeholders are now accepting the growing evidence showing that the social, economic and health-related burden of occupational accidents and diseases is much greater than previously thought (18). Moreover, one of the goals of the National Strategy for Safety and Health at Work 2015-2020 is to reduce injuries incidence rates, decrease the risk factors associated with occupational diseases and improve the worker's quality of life at work. Among the several proposed measures are: developing a more effective information system for occupational diseases and injuries; promoting the statistical analysis of occupational diseases figures; and developing research projects in priority areas (81).

National data on occupational injuries and diseases is scarce and it either follows a more traditional occupational epidemiology approach by restricting research to a particular sector of activity, occupational group or type of injury/disease (82-85), or relies on routine government statistics (6). Routine assessment of the burden of occupational injuries and diseases depends on the completeness of national reporting systems, which is known to vary according to company and system-level characteristics; this calls for a bottom-up understanding of the occupational burden. Hence, by using a large population-based cohort, this study provided us with women's perspective outside the workplace while also taking into account women's embeddedness in a family and social context. The setting in which this thesis takes place is not only important due to the scarcity of large-scale occupational information in Portugal, but also due to its less favourable ergonomic and psychosocial profile compared to Europe.

Furthermore, Portuguese workers report more frequently that work negatively affects their health as well as more symptoms such as musculoskeletal pain (6).

With this thesis, we were also able to provide more insight into the interplay between occupation and the worker's family context, thus turning the focus towards women who are mothers (Papers III and IV). This consist of a particularly interesting group to study once the birth of children, in particular the birth of the first child, may consist of a key point for the reinforcement of gender asymmetries. And the use of a birth cohort, particularly a large birth cohort such as the one used, constitutes a privileged setting that covers from gestation into maternal adulthood, while also incorporating work life prevalence of health outcomes with occupation as a contributing cause. However, researchers have often framed their questions and generated information around the cost-related concerns of employers and insurers, but cost is not the only issue in a system that fundamentally involves human costs. Only recently, as a result of a joint effort between the ILO and the United Nations Entity for Gender Equality and the Empowerment of Women (UN Women), indicators of household type were included in ILOSTAT, namely marital status, household composition and the presence of children, in order to produce a global dataset that allows for the analysis of labour market outcomes from a family perspective. Until then, reliable and consistent global data needed to explore the links between gender gaps in labour force participation and family context were lacking (44).

5.1. Methodological considerations

Using data from a large population-based birth cohort, such as Generation XXI, to study occupational health comes with its own methodological issues. Considering that only women giving birth at public maternities were invited to participate at baseline, thus excluding women giving birth in private settings, selection bias at recruitment is a possibility. Although it has been estimated that, at the time, public maternities where recruitment took place

encompassed 91.6% of deliveries occurring in the whole catchment population, an overrepresentation of women from lower socioeconomic background, or who were not willing or capable to pay for private health care could be expected. Also, since level III public maternity units with differentiated pre and perinatal support are the preferential referral centres for high risk pregnancy cases, which are also at greater risk of obstetric complications, an overrepresentation of women with complicated pregnancies is also expected. Additionally, not all eligible mothers were invited to participate in the cohort study due to logistic constraints, namely human resources availability, and 70% of the eligible mothers were invited on a first come first served basis (86).

When compared to all the mothers who gave birth in 2005 and 2006 within the catchment area (87), cohort participants were slightly younger but similar in marital status. The prevalence of caesarean section was slightly higher than the prevalence in Portugal in 2004. Both samples showed a similar sex distribution but the cohort had a higher proportion of multiple foetuses as compared to the national percentages. The cohort also showed a higher proportion of preterm and low birth weight newborns, when compared to the Portuguese deliveries in 2005 and 2006, probably due to the highly differentiated perinatal support of all the maternities enrolled, thus reflecting the overrepresentation of complicated pregnancies. It is difficult to speculate whether these differences may have biased our effect estimates. However, since the selection of public maternities was not related to the objectives of this thesis, we expect that these selection criteria have not largely biased our associations.

The potential for participation bias also constitutes a source of attention within any cohort study, which may occur due to nonparticipation at baseline or attrition throughout follow-up. At baseline, 91.4% of the invited mothers accepted to take part in the evaluations. Although mothers who refused to participate are likely to be systematically different from those who accepted to take part in the evaluations, it was not possible to collect information on those

who refused to participate and therefore to estimate the scope of such differences. Nevertheless, we believe that nonparticipation at baseline had a minor impact on our estimates due to Generation XXI's high participation proportion at baseline - even though they are not directly linked. Also, previous evidence on the effects of nonparticipation in a cohort study of pregnant women showed small effects on the relative risk estimates regarding perinatal outcomes (88).

Another important issue to be considered in cohort studies is the extension of differential losses to follow-up. In addition to baseline, our analyses used data from the 7- and 10-year-old re-evaluations, in which 79.7% and 76.0% of the entire cohort, respectively, participated in the evaluation. Previous research on a longitudinal study of mothers of an 18-month-old child has shown that even when subjects who stay differ from those who drop out of a study, estimates of associations tend to remain robust to such differences and are only minimally affected by attrition rates (89). In each of the present studies, comparisons between mothers who were and were not included in the analyses revealed differences in sociodemographic characteristics - mothers participating in follow-up studies were slightly older and higher educated. However, the magnitude of those differences was generally small, which supports our belief that our effect estimates were not largely biased due to selective loss to follow-up, and if they were biased, using a sample with a lower socioeconomic position would have probably underestimated our results and/or provided less precise estimates. Overall, although differential losses to follow-up are a major concern for the generalizability of findings from birth cohorts, these studies are still a valuable approach to assess associations between risk or protective factors and later health outcomes.

A key concern regarding our findings is the potential for misclassification of occupations. Generation XXI was established as a multi-purpose prospective population-based birth cohort that aims to better understand health in childhood and later in adolescence and adulthood,

thus focusing primarily on the child. Nevertheless, as many birth and pregnancy cohorts throughout the world, it collects information on employment and health of parents (especially mothers) before and during pregnancy, at birth, and at several assessment waves. During recruitment, mothers were asked to describe their occupation as well as the tasks performed, while the following evaluations only inquired about occupation. And the fact that these were open-ended questions, occasionally resulted in insufficient information. Ideally, a more comprehensive assessment of occupations, including not only information on occupation but also on tasks, economic activity and employment status, would allow for a more accurate occupation characterization and thus a better understanding of occupational-related exposures, which we were not able to fully assess. However, since occupations were categorized into broader groups – at the 1-digit level of the International Standard Classification of Occupations – we do not expect a major problem of misclassification of occupations.

Another consideration to be taken into account is the self-reported nature of the data source used. We relied on self-reported information to define both work-related health problems in mothers and child neurodevelopmental or behavioural problem, without clinical validation, which may introduce some degree of misclassification. We also relied on self-reported sick leave information. However, some research has shown there is no relevant difference between data stemming from self-reported and recorded information in regards to certain problems such as depression and anxiety and information on sickness absence (90-92). On the other hand, musculoskeletal problems have been shown to be often accurately self-reported while underrepresented in clinical records (90). This suggests that our population-based approach may have some degree of misclassification regarding the presence of some, but probably not all, conditions.

5.2. Future research

A number of major issues remain to be addressed in future studies. Disentangling the impact of social, demographic and work-related agents on work-family balance warrants further study; particularly when it comes to fathers since research on the bidirectional relationship and complex interactions among parenthood, work and health in parents are mainly focused on mothers. It is important to highlight the bi-directionality of this relationship. Work is more commonly used as a determinant of health, thus research that takes into consideration how health status – whether individual or at family-level, like for instance children's health – affects working life trajectories (i.e., work participation, employment and working conditions) needs also to be addressed more often. Focusing on the interplay between work, family and health is particularly relevant in this day and age where telework is expected to increase, thus potentially increasing the number of households where the lines between work and personal life get blurred. Research on these topics is usually provided by more affluent economies, but one should not extrapolate the results to other settings with different contexts. For example, Portugal combines high rates of maternal full-time employment with less developed state-supported care services when compared to other European countries, as well as labour market factors that generally increase female employment (39), such as low wages and lack of availability of part-time jobs (69).

It can be argued that parental occupational data collected in birth cohorts is an under-utilized resource to study work-family balance issues and more. Existing information could be exploited to study risk factors and outcomes typically understudied in occupational epidemiology (such as work-life balance), adopting a life course approach. The idea is to study work/employment and health of parents in birth cohorts, which are typically used as determinants of children's health (Fig. 6a), not merely as confounders in the relation between a risk factor and children's health (Fig. 6b), but aimed at a better understanding of the causal

and intertwined relationships between work and health of parents also in relation to the children's health (Fig. 6c) (62).

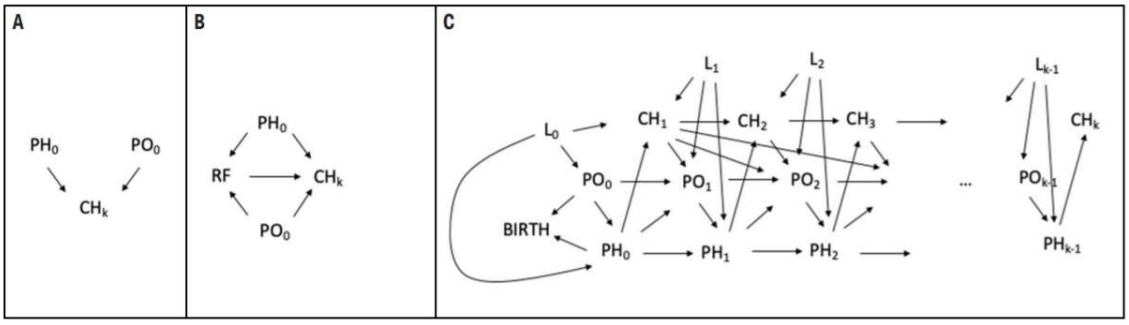


Figure 6. Conceptual framework for investigating causal relationships between work and health of parents also in relation to the children's health. [PH_i=parents' health at time i (i=0: baseline, i.e., during pregnancy or at birth); PO_i=parents' occupation at time i; RF=risk factor; CH_i=child's health at time i; L_i=confounders at time i.] (Reproduced from Ubalde-Lopez *et al.* (62)).

A. Occupation and health of parents at baseline as possible determinants of child's health.

B. Causal relationship between a risk factor and child's health, controlling for occupation and health of parents at baseline.

C. Possible more complex causal relationship between occupation and health of parents, and health of the child at different time points, including confounders

Furthermore, there is also the ecological argument. Repurposing existing resources to allow for original research, i.e. improving the value of data that are already available as a result of a serious investment in both human and material resources (such as in cohorts), is aligned with current moves towards improving research efficiency and reducing waste (93), a theme of increasing importance to funders and peer reviewers (94). Thus, in the future, using cohort studies to address the bidirectional relationship and complex interactions among parenthood, work and health in parents will allow for not only a cost-effective way of gathering the data, but it will also allow for the inclusion of the different sociocultural settings as well as leave

entitlements and child care services and labour market characteristics of the different countries.

6. CONCLUSIONS

By using a population-based sample, this thesis provided a working women's perspective on both occupational injuries and non-traumatic work-related health problems, including the identification of groups of health problems with specific characteristics. Also, there was a clear association between mothers' and partners' history of occupational injuries and work-related health problems, which may pose a double challenge for family and child well-being. These findings point towards a broadened understanding of work-related outcome consequences and research focusing on family-level factors that account for the embeddedness of workers in households.

Regarding maternal work participation, we found that, independently of occupational group, being self-employed or having low job autonomy and decision authority at work were major determinants in the decision to work during pregnancy, even in healthier pregnancies. Moreover, our findings suggested that having a child with a developmental or behavioural problem or an autism spectrum disorder at age seven was associated with maternal unemployment up to age ten. This thesis showed that the analysis of work and health should take into account the complex interactions between gender, family roles, employment status and social class. In a family setting, women often assume a central role in caring for dependents, and parental leave schemes are essential for working parents. Accessible, affordable and quality childcare services are key not only to enhance children's cognitive development, educational achievement and health outcomes, but also to allow parents (although more often women) the opportunity to remain in the labour force. A more comprehensive depiction of employment patterns of mothers, including flexible work arrangements, needs also to be addressed and developed, in order for mothers, families and companies to prosper. The inherent complexity of the problem of work participation suggests

that a worker-centred approach consists of a valuable tool once it takes into account the person's context, including their social and family context, while identifying vulnerable groups.

With this thesis, we were able to take a step towards a more comprehensive portrait of work-related health in women in Portugal, where large-scale information on the subject is scarce. By looking into the interplay between employment and health among working mothers and their offspring, we will be better able to understand and convey how women work, as well as better inform interventions and support evidence-based policymaking, so that inequalities between women and men in occupational attainment, lifetime earnings, and economic independence will improve and we can ultimately improve women's livelihoods, as well as those of their families and communities.

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