Universitat Internacional de Catalunya
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# Tesis doctoral

*Social determinants of Health in Europe: precarious employment and new forms of work.*

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PhD program in health sciences
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Workers of the world, unite!

To the workers of the past, present and future

## ACKNOWLEDGEMENTS

# ACKNOWLEDGEMENTS

*agradecer.*

*1. tr. Sentir gratitud.*

*2. tr. Mostrar gratitud o dar gracias.*

*3. tr. Dicho de una cosa: Corresponder al trabajo empleado en conservarla o mejo rarla.*

Gracias a mi compañero de vida, Hamed. Por apoyar todas mis ideas, acompañarme allí donde vaya, transmitirme energía positiva, ánimos, fuerza y espíritu luchador. Por creer en mí. Y a efectos más prácticos, dar su toque artístico a la tesis.

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# ABSTRACTS OF THE THESIS IN DIFFERENT LANGUAGES

# ABSTRACT

Even though the health effects of precarious employment (PE) have been studied in the past recent years, data from years after the Great Recession has not yet been explored using a multidimensional approach in Europe. Further, digitalization of the labour market is happening, and new forms of work are appearing. But, its potential implications for the worker's health are unknown. Given the similar characteristics of PE and gig work, the health impact of platform work could be huge. The main aim of this thesis is to describe the health status and occupational safety of precariously employed and gig workers, years after the Great Recession in Europe. The thesis was performed using two European surveys (Flash Eurobarometer 398 on Working Conditions and the Sixth European Working Conditions Survey) and occupational safety data obtained through direct observation in Barcelona (Spain). The results found in the thesis show that years after the Great Recession, PE is present in the European workforce. PE is more common among women, young workers and individuals with lower educational level. Moreover, as PE quartiles increase, so did the prevalence of declaring to suffer any health problem. The most precarious employees and unemployed individuals declare in similar magnitude health problems. In addition, to be precariously employed is not associated to exercise the right of sick leave shorter than 15 days. Instead, it is related to long sick leave (more than 15 days). Further, precariously employed workers are

more exposed to violence and harassment, stress and repetitive movements or painful positions in the workplace than workers not precariously employed. Similarly, delivery gig workers do have an irregular use of personal protective equipment and frequently violate traffic regulations. Based on the results and conclusions obtained in the thesis, some recommendations from public health are pointed out. First of all, current labour market regulations should be reconsidered in order to achieve the 8th sustainable development goal of decent work and economic growth by 2030. Second, Public Health agencies should monitor precarious employment as another determinant of health. Third, it is necessary to solve the probable misclassification of gig workers as dependent self-employed in order to protect them from occupational risks. Finally, new approaches for addressing occupational safety at work in platform digital work should be carefully reviewed.

# RESUMEN

A pesar de que los efectos en la salud del empleo precario (EP) se han ido estudiando durante los últimos años, ésta no se ha explorado en años posteriores a la Gran Recesión en Europa utilizando un enfoque multidimensional. Además, el mercado laboral se está digitalizando y se están originando nuevas formas de trabajo, como el trabajo 'gig'. Las posibles implicaciones de éstas para la salud de los trabajadores son aún desconocidas. Dado que las características del EP y el trabajo 'gig' son muy similares, el impacto en salud de este tipos de trabajos podría ser enorme. El objetivo principal de esta tesis es describir el estado de salud y la seguridad laboral de los trabajadores con EP y trabajo 'gig' años después de la Gran Recesión en Europa. Para ello, se utilizaron dos encuestas europeas ('Flash' Eurobarómetro 398 sobre Condiciones de trabajo y la Sexta Encuesta Europea sobre Condiciones de trabajo), además de datos obtenidos sobre uso de equipamiento de protección individual y cumplimiento de las normas de tráfico mediante observación directa en Barcelona (España). Los resultados de la tesis muestran que años después de la Gran Recesión, el EP está presente en los trabajadores de Europa. Siendo éste más común entre las mujeres, los trabajadores jóvenes y las personas con un nivel educativo más bajo. Además, conforme incrementan los cuartiles de EP, también lo hace la prevalencia de declarar sufrir cualquier problema de salud. Los trabajadores empleados altamente precarios y las personas recién desempleadas declaran, en similar magnitud, problemas de salud. Además,

el EP no se asocia con ejercer el derecho a baja por enfermedad inferior a 15 días. En cambio, sí está relacionado con una baja por enfermedad larga (más de 15 días). Asimismo, los trabajadores con EP están más expuestos a violencia y/o acoso, estrés, movimientos repetitivos y/o posiciones dolorosas en el lugar de trabajo, respecto a trabajadores no empleados de manera precaria. De manera similar, se observa que una mayoría de los trabajadores 'gig' no utilizan equipo de protección personal y violan las normas de tráfico. En base a éstos resultados, se señalan algunas recomendaciones desde salud pública. En primer lugar, las reglamentaciones actuales del mercado laboral deberían reconsiderarse para alcanzar el octavo objetivo de desarrollo sostenible sobre trabajo decente y crecimiento económico para 2030. En segundo lugar, las agencias de salud pública deberían monitorear el EP como cualquier otro factor determinante de la salud. En tercer lugar, es necesario resolver la probable mala clasificación de los trabajadores 'gig' como autónomos dependientes, con el objetivo de conseguir una mayor y mejor protección frente a los riesgos laborales. Finalmente, nuevos enfoques para abordar la seguridad laboral en los trabajos ligados a plataformas digitales deben ser revisados cuidadosamente.

# RESUM

Tot i que els efectes de la precarietat laboral (PL) en la salut s'han anat estudiant en els darrers anys, fins al moment, no s'ha explorat l'evidència sobre anys posteriors a la Gran Recessió, utilitzant un enfocament multidimensional i a nivell europeu. A més a més, el mercat laboral s'està digitalitzant i s'estan originant noves formes de treball, com el treball 'gig'. Però, les possibles implicacions per a la salut del treballadors són desconegudes. Atès que les característiques de la PL i el treball 'gig' són molt semblants, l'impacte en salut d'aquest tipus de treballs podria ser enorme. L'objectiu principal d'aquesta tesi és descriure l'estat de salut i seguretat laboral dels treballadores amb PL i treball 'gig' anys després de la Gran Recessió a Europa. Per a això, es van utilitzar dues enquestes europees ('Flash' Eurobaròmetre 398 sobre Condicions Laborals i la Sisena Enquesta Europea sobre Condicions de Treball), a més de dades d'ús d'equipament de protecció individual i compliment de les normes de tràfic, obtingudes mitjançant observació directa a Barcelona (Espanya). Els resultats descrits en la tesis mostren que anys posteriors a la Gran Recessió, la PL és present en els treballadors d'Europa. La PL és més comuna entre les dones, els treballadors joves i les persones amb un nivell educatiu més baix. A més, conforme augmenten els quartils de PL, també ho fa la prevalença de declarar patir qualsevol problema de salut. Els treballadors altament empleats precàriament i les persones recent aturades declaren, en magnitud similar, problemes de salut. A més, la PL no s'associa amb exercir el dret a

baixa per malaltia inferior a 15 dies. En canvi, sí que està relacionada amb una baixa per malaltia llarga (més de 15 dies). A més, els treballadors amb PL estan més exposats a la violència i l'assetjament, l'estrès i els moviments repetitius o les posicions doloroses en el lloc de treball, pel que fa als treballadors no empleats de manera precària. De manera similar, els treballadors 'gig' mostren un baix ús de l'equip de protecció personal i freqüentment violen les normes de trànsit. En base als resultats i conclusions obtingudes en la tesi, s'assenyalen algunes recomanacions des de salut pública. En primer lloc, les reglamentacions actuals del mercat laboral haurien de reconsiderar-se per assolir el vuitè objectiu de desenvolupament sostenible del treball decent i creixement econòmic de l'any 2030. En segon lloc, les agències de salut pública haurien de monitoritzar la PL com un altre factor determinant de la salut. En tercer lloc, cal resoldre la probable mala classificació dels treballadors 'gig' com a autònoms dependents, amb l'objectiu d'aconseguir una major i millor protecció dels riscos laborals. Finalment, nous enfocaments per abordar la seguretat laboral en els treballs lligats a plataformes digitals, han de ser revisats acuradament.

# چکیده

اگرچه تاثیرات سلامتی اشتغال بی ثبات (کار زیان آور) (PE) در سال‌های اخیر مورد مطالعه قرار گرفته است، اطلاعاتی از سال‌های پس از رکود بزرگ مالی هم، تاکنون با استفاده از یک رویکرد چند بعدی در اروپا مورد بررسی قرار نگرفته است. علاوه بر آن، عامل دیجیتال سازی بازار کار در حال رخ دادن است و شکل‌های جدید کار پدیدار می گردند. اما پیامدهای بالقوه آن برای سلامت کارگران ناشناخته است. با توجه به ویژگی‌های مشابه کار و کار موقت، تاثیرپذیری بهداشت بر برنامه کاری می‌تواند بسیار گسترده باشد. هدف اصلی این پایان‌نامه، توصیف وضعیت سلامت و ایمنی شغلی کارکنان شاغل و دارای شغل موقت، سال‌ها پس از رکود اقتصادی بزرگ در اروپا می‌باشد. این پایان‌نامه با استفاده از دو نظرسنجی اروپایی ( Flash Eurobarometer 398 بر شرایط کاری و همچنین ششمین بررسی شرایط کاری اروپا) و داده‌های ایمنی شغلی به دست آمده از طریق مشاهدات مستقیم در بارسلونا (اسپانیا) انجام شد. نتایج بدست‌آمده در این پایان‌نامه نشان می‌دهد که سال‌ها بعد از رکود بزرگ مالی، PE در نیروی کار اروپایی وجود دارد. PE بیشتر در میان زنان، کارگران جوان و افراد با سطح تحصیلات پایین‌تر رایج است. علاوه بر این، به عنوان افزایش آمار PE، شیوع اعلام ابتلا به هر گونه مشکل بهداشتی نیز افزایش یافت. بیشتر کارکنان دارای اشتغال بی ثبات و افراد فاقد اشتغال، دارای مشکلات سلامتی و بهداشتی می باشند. علاوه بر این، به طور بالقوه، برای مشاغل بی ثبات، حق مرخصی استعلاجی کم‌تر از ۱۵ روز نمی باشد ولی در عوض، اگر بیماری (بیش از 15 روز طول

بکشد) طبیعتا حق مرخصی استعلاجی هم بیشتر خواهد شد. علاوه بر این، کارگران به طور بالقوه برای مشاغل بی ثبات بیشتر در معرض خشونت و آزار، استرس و همچنین موقعیت‌های سخت و دشوار در محیط کار نسبت به کارگرانی که فاقد اشتغال زیان آور می باشند نیز هستند. به طور مشابه، کارگران در حال کار از تجهیزات حفاظتی شخصی استفاده می‌کنند و اغلب مقررات ترافیکی را نقض می‌کنند. براساس نتایج به‌دست‌آمده در این پایان‌نامه، پیشنهاداتی از سلامت عمومی ارائه شده‌است. اول از همه، مقررات بازار کار فعلی باید برای دستیابی به هدف توسعه پایدار و رشد اقتصادی تا سال ۲۰۳۰ مورد بازبینی قرار گیرد. دوم اینکه، سازمان‌های بهداشت عمومی باید بر اشتغال به عنوان عامل تعیین‌کننده سلامت و بهداشت نظارت داشته باشند. سوم، لازم است که طبقه بندی‌های نادرست کارگران دارای کار موقت به عنوان افراد بیکار به منظور حفاظت از آن‌ها در برابر خطرات شغلی را حل کنیم. در پایان، رویکردهای جدیدی برای پرداختن به ایمنی شغلی در رابطه با کارهایی در باب پلتفرم های دیجیتالی باید به دقت مورد بررسی قرار گیرند.

# PREFACE

# PREFACE

In the last decades the world of work has suffered many transformations. From the flexibilization of the workforce in the mid-80s (1), the decline in the union membership (2), the increase in non-standard arrangements highlighted by the Great Financial Crisis of the 2007-09 (3), to later emergence of work linked to online digital labour platforms (4). Recently, there was a call for the research of the health status among precariously employed workers (5), as well as, the urge to address the needs of workers in the gig economy (6).

The present PhD thesis gives insight into the quality of the employment conditions, including the new forms of work (gig work), exposure and use of protection against occupational risks, and health status of the European workforce. Considering the current state of evidence in this field of research, the findings of this thesis contribute to: i) elucidate the proportion of precariously employed workers in Europe years after the Great Recession, ii) show the prevalence of health problems and sick leave among precariously employed workers, iii) compare the health status of the individuals in different employment conditions (unemployment, precarious employment and other employment relationships), iv) characterize the occupational safety and exposure to occupational risks in precariously employed workers and gig workers.

The document is structured as follows: first, the thesis' abstracts in English, Spanish, Catalan, and Persian are enclosed. Next, an introduction providing

a general view of important aspects of social epidemiology linked to this project is enclosed. Following the introduction, there is a rationale justifying the research scope. Further, the aims and hypotheses of the project are stated. Also, a brief description of the populations and designs used for the purposes of the thesis is provided. The compilations of the four papers (2 published and 2 under review) that form the thesis are enclosed. Subsequently, there is a general discussion of main findings, and strengths of this thesis project. Final conclusions of the thesis are provided. Based on the conclusions, recommendations from public health and future research suggestions are also enclosed. The Annex includes the supplementary material of the papers, the editorial process and responses to reviewers' comments of the published papers, and also, other articles done during the thesis by the PhD candidate as a first author.

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**Annexes**

# 1

# INTRODUCTION

## 1.1. Portrait of the labour market in Europe

> "*Like all Faustian bargains, the orgy had to end, which duly happened in 2007-9. But while the media focused on the greed of bankers and financial markets, attention was diverted from the structural features of the global market system and the released 'crises' that had been nurtured by the neo-liberalist strategy.*" *Guy Standing.*

### 1.1.1. **Origin of non-standard employment relationships**

In the post-World War II era, the pressure of trade unionists and the creation of new legislation to protect workers' bargaining rights, gave rise to specific labour-market norms. Stable employment relationships, called Standard Employment Relationships (SER) became the norm. SER is characterized by permanent, full-time, full-year, based at the employer's location and providing a range of benefits employment. Although, this was just the case for male and native workers (7). In the 1970s new forces began to erode labour-market norms. There was an important economic downturn driven by the oil shocks. The productivity rates decreased, and the firms had to find new ways to improve performance and competiveness. The international trades together with technological advancements intensified international

competition. Employer's needed an *ad hoc* system for adjust to market shifts; to avoid the burden of fixed costs in periods of reduced demands (8). So organizational restructuring resulted in the elimination of a large proportion of permanent positions, and their replacement with 'flexible' ones. This phenomenon is frequently called as 'casualization of the workforce'. The casualization of the workforce, implied that employees were more frequently excluded from trade union representation. Therefore, workers were less able in advancing for their interests and being protected. That's how non-standard employment (NSE) erode and increased in the European Labour Market (9). The increase in NSE happened at different times according to the countries. For instance, in France and Spain, temporary employment increased between 1985-1995, in Sweden in the early 1990s and in Germany in the early 2000s. Poland went from 4.6% in 1999 to 28.2% by 2007 (10).

NSE arrangements are all the employment forms that can not be classified as SER, such as temporary employment, part-time work or dependent self-employment. All of them share many features which are low earnings, reduced social security coverage, poor working conditions, few prospects for personal development and low trade union representation (11).

It is therefore, of major interest for the public health research, to understand how NSE affects the health. The available evidence shows that workers in NSE have higher poorer health than workers in SER. NSE has been associated with non-optimal health status, psychological morbidity, work-

related psychosocial problems, nutritional-related outcomes, musculoskeletal disorders, psychosomatic disorders and cardiovascular diseases (12).

### 1.1.2. **The Great Recession of 2008**

Failures in financial regulation and supervision, and a combination of excessive borrowing, risky investments, and little transparency devastated the stability of financial markets. These were the drivers of a financial crisis that led to economic crises. In the 2009 the gross domestic product (GDP) fell in real terms in the entire EU (13). Between 2007 and 2010 there was a rapid increase in unemployment rates in Europe. For example, in Portugal, Slovakia and Bulgaria increased by a 3%, in Denmark, Hungary and Greece by a 4%, in Iceland by a 5%, in Ireland by a 9%, in Spain and Estonia by a 12%, in Latvia by a 13% and in Lithuania by a 14% (13). The unemployment rates increased more among men than for women. This has been described as the feminization of the labour market (14).

Austerity policies were imposed by the so-called Troika (the International Monetary Fund, European Commission, and the European Central Bank). Importantly, these were imposed as a pre-condition for financial rescue packages (15). Consequently, many countries engaged in a number of labour market reforms, as well as, employment policies. In the initial phases of the crises (2007-10), countries adopted measures for maintaining employment and providing a safety net for the vulnerable. For example,

some of the measures to maintain employment were ‘short-time work’ (in the case of Belgium, Germany, Ireland and Luxembourg) and employment subsidies (Austria, Luxembourg, the Netherlands, Romania and Slovakia). As the crisis progressed (2010-13), more in-depth reforms were adopted for making labour markets more ‘efficient’ and increase competitiveness (16). For instance, one measure was the simplification of procedures for collective lay-offs. The intensity and timing of the crisis differed across European countries. The largest and most wide-ranging changes occurred in the southern European countries (Greece, Italy, Portugal and Spain) and Ireland (16).

The quality of work was severely affected by the crisis. European workers declared that their training opportunities decreased, as the work intensity, job insecurity and work-family conflicts increased (17). Moreover, the working life expectancy was importantly affected; in the case of Spain, men working in unskilled manual jobs lost close to 14 years of working life expectancy (18).

The years following the crisis, jobseekers accepting non-standard arrangements increased in Europe (19). This may be explained because high unemployment rates would diminish the workers’ power and they may accept poorer employment and working conditions (20). Further, between 2007 and 2014 the proportion of self-employed working part-time in the EU because of not being able to find full-time work increased by six percentage points (21).

Even though the research of the health implications of the austerity era is starting, the few studies available point that austerity had important consequences for health and health services; such as worsening of the mental health and increase in suicides (22). Possibly, these consequences were mediated through the employment conditions.

### 1.1.3. **The present time**

At the present time, the world of work is changing. The globalisation, the technological progress and digitalisation, the ageing population and new organisational business models have brought new challenges into the work (23).

Globally, a median pay gap of 12.5 per cent is still pervasive; the hourly wages of men are higher than those of women. Moreover, the women's participation in the labour force was 48% while for men was 75% in 2018. Youth are three times more likely to be unemployed than adults. In 2018 around 172 million people worldwide were without work (5%), and it is projected to increase by 1 million each year (24). It is estimated that over 600 million new jobs need to be created by 2030, that is around 40 million per year (25). In some countries, part-time or temporary workers, gig workers or other forms of non-standard arrangements are 40-50% less likely to receive benefits when out of work than those who have a full-time, permanent job with one employer (23).

In the case of Europe, according to data from the Organisation for Economic Co-Operation and Development (OECD), trade union density has decreased overall in Europe in the last years, from a 41% in 1998 to a 29% in 2015. In the EU-28, the number of involuntary part-time workers had doubled from 5 million (2000) to 10 million by 2018. Further, temporary employed individuals increased from 20 million in 2000 to 27 million in 2018. The unemployed individuals decreased from nearly 20 million in 2000 to 16 million in 2018 (26). Moreover, 4.3% of total employment in the EU28 in 2015 was dependent self-employment (employees falsely classified as self-employed by employers) (27).

Therefore, it is clear that new challenges are raising, and others still remain.

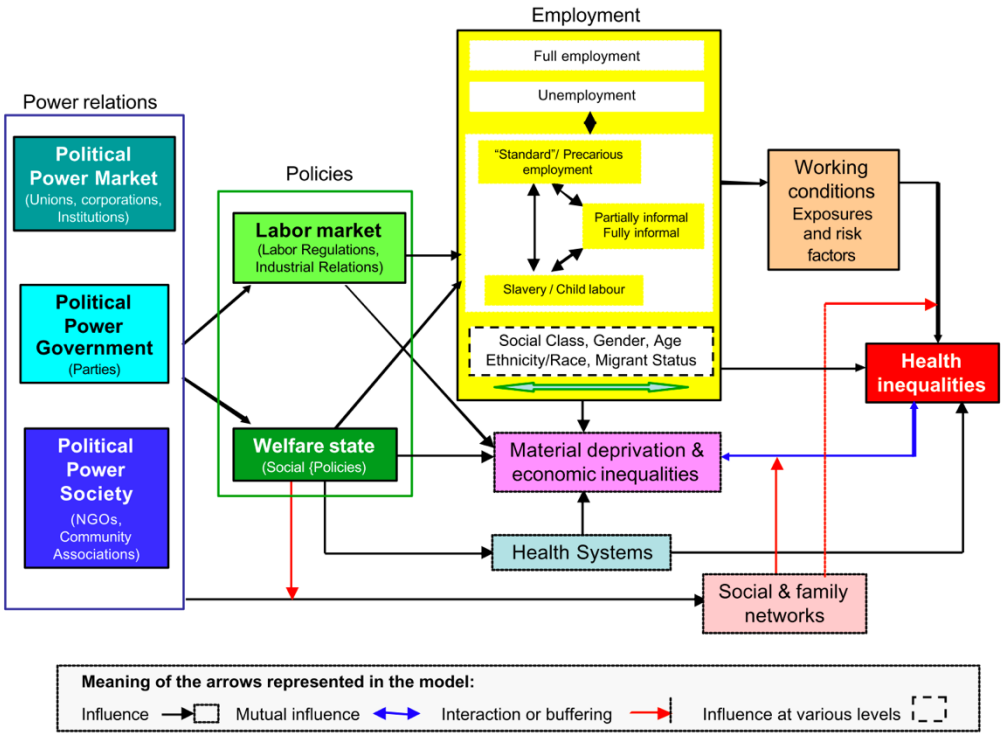
## 1.2. Employment conditions as a social determinant of health

> *"The logical answer to the question as how conditions similar to those unfolded before our eyes in Upper Silesia can be prevented in the future is, therefore, very easy and simple: education, with its daughters, liberty and prosperity." Rudolf Virchow (1821-1902)*

Social determinants of health, also known as the causes of the causes, are defined by the World Health Organization (WHO) as "the conditions in which people are born, grow up, live, work and age. These circumstances are shaped by the distribution of money, power and resources at global, national and local levels. These conditions influence a person's opportunity to be healthy, his/her risk of illness and life expectancy."(28). The social

determinants of health are mostly culpable for the social inequities in health; the unfair and avoidable differences in health status across groups in society (29). Employment and working conditions are social determinants of health (30). Although both concepts are highly correlated, it is important to differentiate them for understanding their role in the workers' health. On one hand, employment conditions are related to the terms of contract, rewards, and other mutual expectations between workers and employers. On the other hand, working conditions are related to the physical and chemical work environment, ergonomics and the psychosocial work environment (31). For example, two individuals working as teachers in the same school, sharing the same working conditions and facing the same exposure to risks, can be under different employment conditions. One teacher may be a permanent employee in the school, while the other is a temporary employee hired for the summer season. Therefore, their employment conditions differ completely and possibly, the way they affect the health.

**Figure 1. Macro-theoretical framework of employment relations and health inequalities**.

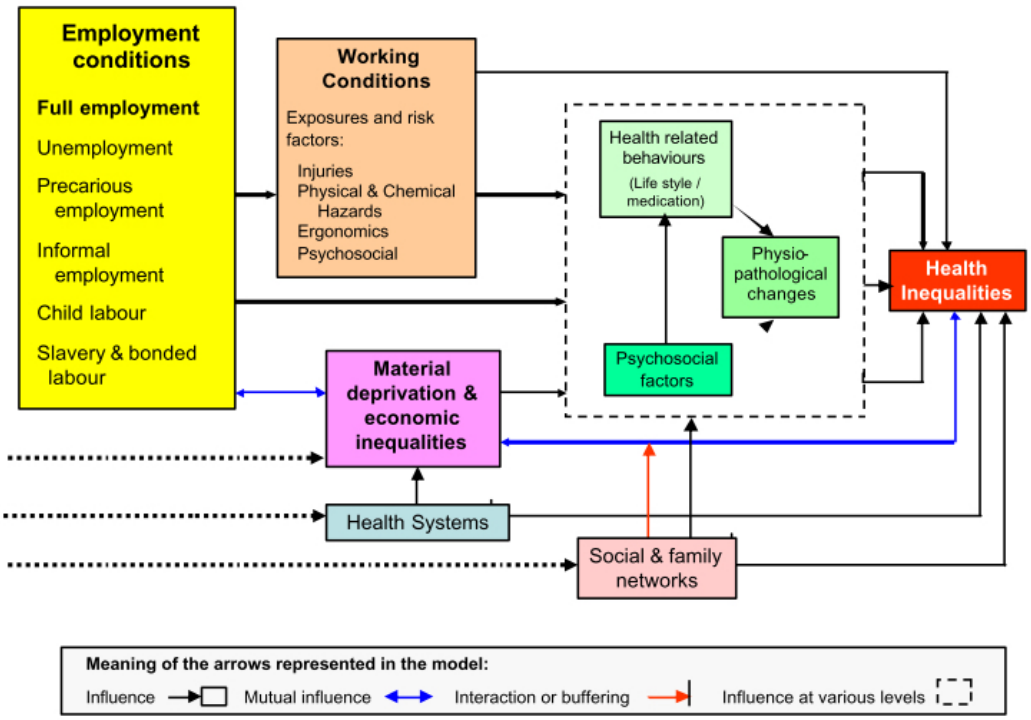



Source: EMCONET report to the WHO on Employment Conditions and Health Inequalities (30)

A framework for assessing the employment conditions and health inequalities is already available in the literature (30). The figures 1 and 2 show the macro-theoretical and micro-theoretical framework. Employment conditions are placed on a social, economic and political context, so are their health effects. The power relations (political power market, government and society) affect the employment conditions through their influence over policies (labour market and welfare state). The employment conditions are shaped by the axes of inequality: social class, gender,

ethnicity/race, age, migrant status, and geographical location. Further, material deprivation and economic inequalities (access to healthy diet, poverty, housing, etc.), health systems, and social and family networks may interact with the effect of employment conditions on worker's health and health inequalities. Employment conditions may influence the worker's health directly or through the exposure and risk factors faced at work.

**Figure 2. Micro-theoretical framework of employment conditions and health inequalities**.




Source: EMCONET report to the WHO on Employment Conditions and Health Inequalities (30)

## 1.3. Precarious employment

*"It is unethical and short-sighted business practice to compromise the health of workers for the wealth of enterprises."*
*Evelyn Kortum, WHO*

Precarious employment (PE) has its origins in the flexibilization of the labour markets and casualization of the workforce (32). Precarious 'jobs' were first defined from the sociology field as those that combine the following factors: uncertainty of continuing work, low control over work, poor protected (by law or through collective organization and social protection), and low income (33) Since then, many definitions and adaptations have been proposed (34–39). It is well acknowledged that PE is a social determinant of health. For the purposes of this thesis, the definition used is the one that states; PE is an employment condition characterized by employment insecurity, individualized bargaining relations between workers and employers, low wages and economic deprivation, limited workplace rights and social protection, and powerlessness to exercise workplace rights (36).

Just as it was important to differentiate between employment and working conditions, it is also necessary to differentiate between the concepts that most of times are interchangeably used: PE and precarious work. While PE refers to low quality employment (such as, temporary employment and low wages), precarious work refers to poor working conditions (physically or

psychologically hazardous, source of dissatisfaction, lacks training and career advancement opportunities) (40).

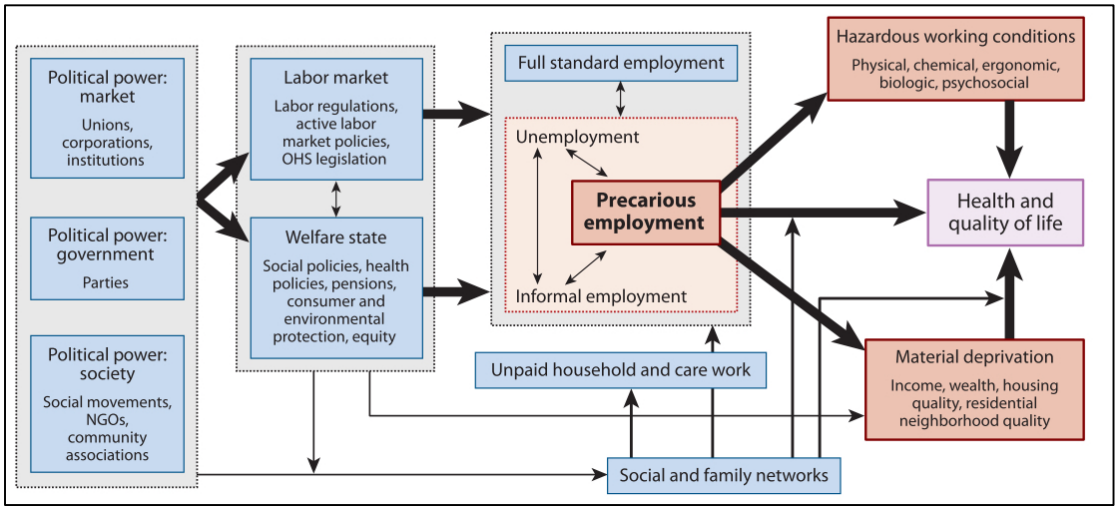
To date, several multidimensional approaches have been proposed for measuring PE or employment quality. A summary of the dimensions included in each of the operationalization is provided in the Table 1. For the purpose of this thesis, the measurement of PE was done by proxy indicators available in the existing surveys. The variable was constructed based on the validated scale in Spanish salaried workers (EPRES) (41).

**Table 1. Different multidimensional approaches used in the literature for measuring employment quality or/and PE.**

| Authors | Construct | Dimensions |
|---|---|---|
| **Eurofound, 2013** (42) | Employment quality score (summation approach) | - Type of employment contract<br>- Low-wage jobs<br>- Non-wage benefits<br>- Uncompensated flexible working times<br>- The availability of information on occupational health and safety<br>- Involuntary part-time jobs<br>- Long working hours<br>- Regular working hours<br>- Training paid or provided by the employer<br>- Availability of an employee representative<br>- Possibilities for communication and participation with superiors<br>- Self-determination over the work schedule |
| **Lewchuk, et al , 2008** (38) | Employment Strain Model | - Employment relationship uncertainty<br>- Employment relationship effort<br>- Employment relationship support |
| **Lozano, et al 2019** (43) | Precarious employment indicator (summation approach) | - Temporariness<br>- Full or part-time work<br>- Satisfaction with current job |
| **PEPSO, 2013** (44) | EPI (Employment Precarity Index) | - Employment type<br>- Standard employment relationship<br>- Benefits<br>- Getting paid if you miss work<br>- Income variability<br>- Hours of paid employment reduced in the future<br>- Working on call<br>- Knowing schedule in advance<br>- Paid in cash<br>- Health and safety rights |

| Authors | Construct | Dimensions |
|---|---|---|
| **Puig-Barrachina, et al 2014** (45) | Proxy indicators available in existing surveys (based on EPRES) | - Employment instability<br>- Low income level<br>- Lack of rights and social protection<br>- Incapacity to exercise rights<br>- Absence of collective bargaining (or formal relations)<br>- Imbalanced interpersonal power relations (or vulnerability)<br>- Lack of training<br>- Low control over working time |
| **Quinlan, et al 2004** (46) | Pressures, Disorganization and Regulatory (PDR) model | - Income insecurity<br>- Disorganization at the workplace<br>- Regulatory failure |
| **Tompa et al, 2008** (39) | Dimensions of work-related Precarious experiences (based on Rodgers's four dimensions) | - Degree of certainty of continuing work<br>- Control over work processes<br>- Legal and institutional protection<br>- Income and benefits adequacy<br>- Work-role status<br>- Socio-cultural environment at work<br>- Risk of exposure to physical hazards<br>- Training and career advancement opportunities |
| **Van Aerden, et al 2014** (47) | Typological approach (Latent Class Cluster Analysis) | - Employment instability<br>- Low material rewards<br>- Erosion of workers' rights and social protection<br>- De-standarized working time arrangements<br>- Limited employability opportunities<br>- Collective disorganisation<br>- Imbalanced interpersonal power relations |
| **Vives, et al, 2010** (41) | Employment Precariousness Scale (EPRES) | - Temporariness<br>- Disempowerment<br>- Vulnerability<br>- Wages<br>- Rights<br>- Exercise Rights |

**Figure 3. Conceptual model linking PE and health and quality of life.**




Source: Benach et al 2016. What should we know about precarious employment and health in 2025? Framing the agenda for the next decade of research. (36)

Mechanisms and pathways in which PE affects the health has been described previously (36) and can be observed in the figure 3. Three main mechanisms have been proposed. First, precariously employed individuals could experience higher exposures to hazardous working conditions (i.e. physically demanding workloads, working intensity, inadequate occupational health safety) with harmful health effects. Second, PE would affect the social and material living conditions. PE may limit the workers' ability to make decisions related to their personal life (family formation), the housing and neighbourhood conditions, access to health care and healthy lifestyles, etc. Third, PE would directly produce negative psychosocial experiences and thus, psychosocial stress. While observing these mechanisms, it is important to bear in mind that precarious employment, as employment relations, is affected by the political, economic and social context. And these by the axes of social inequality: social class, gender,

race, age, level of education, etc. (48). PE has been described to be more prevalent among women, younger workers, immigrant, workers from lower educational level and from manual social classes (7,37,49,50).

The study of PE and its health effects from a multidimensional perspective has increased in the past years (51). Still, much of the available evidence comes from one-dimensional approaches (that is, analysing one of the multiple characteristics that construct the precariousness) (52–61). Further, most of studies use data from years before or years during the Great Recession. Although one-dimensional approaches are showing the effect on the health, they are not studying at the same time all the features of an employment relation, thus limiting the mechanisms through which precariousness affect health. Moreover, most of studies explore mental health and self-perceived health, and few have explored sickness absence, or social consequences. Some examples of studies analysing the health effects of PE, using a one- or multi-dimensional approaches, available before, during and after the Great Recession are described in table 2.

**Table 2. Description of some studies analysing the health effects of PE before and after the Great Recession.**

| | Authors | Study Population and Design | One or multi-dimensional approach to PE | Outcome(s) | Main results |
|---|---|---|---|---|---|
| **Before the Great Recession** | Scherer, et al 2009 (62) | Cross-sectional study. ESS data, Western European Countries, 2004, n ≈10500 | One-dimensional (based on contract) | Problematic social and family situations | Insecure employment is accompanied by more problematic 'social and family' situations. |
| | Clarke, et al 2007(63) | Qualitative study. Interview data, Toronto, 2006, n=82 | Multi-dimensional (Employment Strain) | Stress related health issues | Unsustainable precarious employment relationships reported high levels of stress, anxiety and various health problems. |
| | Vives, et al 2013 (64) | Cross-sectional study. Psychosocial Work Environmental Survey, Spain, 2004-05, n=5679 | Multi-dimensional (EPRES) | Mental health (SF-36) | Gradient association between PE and poor mental health, being stronger among women. |
| | Canivet, et al 2016 (60) | Cohort study. Sweden, follow ups 1999/2000, 2005, 2010, n=1135 | Multi-dimensional (indicators) | Mental health (GHQ-12) | PE situation is an important risk factor for subsequent development of mental health problems among previous mentally healthy young adults. |
| | Virtanen, et al 2005 (65) | Review of 27 studies, 1979-2001 | One-dimensional (based on contract) | Psychological, physical/global health, musculoskeletal disorders, occupational injuries, mortality and sickness absence | Higher psychological morbidity, risk of occupational injuries, lower sickness absence. |

| | Authors | Study Population and Design | One or multi-dimensional approach to PE | Outcome(s) | Main results |
|---|---|---|---|---|---|
| **Before the Great Recession** | Virtanen, et al 2005 (55) | Cohort study. Finland, 1998-2002, n=1670 | One-dimensional (labour market trajectories based on contract) | Self-rated health and psychological distress (GHQ-12) | Trajectories directed toward the periphery of the labour markets were associated with poorer health. |
| | Nätti, et al 2009 (54) | Cohort study, Finland, 1984-2000, n=8004 | One-dimensional (based on contract) | Mortality | Temporary employees who felt the insecure situation unsatisfactory or who worked in temporary work involuntarily had higher risk of mortality than permanent. |
| | Kachi, et al 2014 (66) | Cohort study. Japan, 2005-2009, n=15222 | One-dimensional (based on contract) | Risk of serious psychological distress (K6 scale) | PE is associated with double the risk of psychological distress incidence. |
| | Samuelsson, et al 2012 (67) | Cross-sectional study. Sweden, 2007, n=877 | One-dimensional (based on type of employment) | Work characteristics (job demands, control, social support) and health status (general and emotional exhaustion) | No direct associations between type of employment and health were found for women and men. |
| | Benach, et al 2004 (68) | Repeated cross-sectional studies. European Union, 1995 (n=15146), 2000 (n=21703). | One-dimensional (based on type of employment) | Job dissatisfaction, stress, fatigue and backache | Non-permanent employment reported high percentages of job dissatisfaction but low levels of stress. |
| | Min, et al 2015 (69) | Cross sectional study. South Korea, 2008, n=52161 | One-dimensional (based on contract) | Suicidal thoughts and attempts | PE is associated to suicidal ideation and attempts. |

| | Authors | Study Population and Design | One or multi-dimensional approach to PE | Outcome(s) | Main results |
|---|---|---|---|---|---|
| **Before the Great Recession** | Minelli, et al 2014 (58) | Repeated cross-sectional studies. Italy, 2006-10, n=37782 | One-dimensional (based on type of employment) | Self-reported health status | Temporary workers, first-job seekers and unemployed individuals all experience a worse health conditions than permanent workers. |
| | Virtanen, et al 2003 (70) | Cross-sectional. Finland, 1998, n=15468 | One-dimensional (based on contract) | Self-rated health, diseases diagnosed by a doctor, depression (BDI) | Health inequalities prevail across different labour market groups within the employed and the unemployed. |
| **During the Great Recession** | Van Aerden, et al 2017 (71) | Cross-sectional study. Generations & Gender Survey, Belgium, 2008-2010, n=4377 | Multi-dimensional (latent class cluster analysis) | Self-perceived general health and self-rated mental health | Unemployment and precarious job type are related to poor general and mental health. |
| | Julià, et al 2017 (72) | Cross-sectional study. Psychosocial Work Environmental Survey, Spain, 2010, n=4430 | Multi-dimensional (EPRES-2010) | Mental health (SF-36) | PE is associated with poor mental health, being stronger in permanent than temporary workers. |
| | Jang, et al 2015 (52) | Longitudinal study. Korean Welfare Panel Study, Korea, 2007-2013, n=3490 | One-dimensional (other than full-time and waged by their employers) | Severe depressive symptoms (CES-D-11) | Depending on head of household status and sex, PE is associated with the development of new-onset severe depressive symptoms. |
| | Oke, et al 2016 (73) | Cross-sectional study. European Working Conditions Survey, Denmark, Finland, Sweden, Norway, 2010, n=4186 | Multi-dimensional (proxy indicators) | Sickness absence | PE indicators predicted sickness absence. |

| | Authors | Study Population and Design | One or multi-dimensional approach to PE | Outcome(s) | Main results |
|---|---|---|---|---|---|
| **During the Great Recession** | Koranyi, et al 2018 (61) | Review of 17 articles, 1988-2014 | One-dimensional (based on single dimensions of PE) | Occupational accidents and injuries | Association between some PE dimensions (multiple jobholders and employees of temp agencies) and occupational injuries. |
| | Benach, et al 2015 (74) | Cross-sectional study. II Catalan Working Conditions Survey, Catalonia, 2010, n=970 | Multi-dimensional (EPRES) | Mental health (GHQ-12), self-perceived health | Positive gradient in the association between PE and poor health |
| | Bacci, et al 2017 (56) | Cross-sectional study. EU-SILC survey, 26 European countries, 2009-12, n=26898 | One-dimensional (based on contract) | Self-evaluated health status | Material deprivation and economic strain are able to partly account for the negative effects on health from PE. |
| | Van Aerden, et al 2016 (75) | Cross-sectional study. European Working Conditions Survey, EU-27, 2010, n=27325 | Multi-dimensional (latent class cluster analysis) | Self-perceived general health and job dissatisfaction | Precarious intensive jobs are associated with the worst health and well-being situation. |
| **After the Great Recession** | Lewchuk, et al 2016 (51) | Two cross-sectional studies, Greater Toronto and Hamilton area, 2011 and 2014, n= 8328 | Multi-dimensional (employment precarity index) | Social consequences (social isolation, starting a family, forming a relationship) | The precarity disadvantages in establishing healthy households and being engaged in one's community. |
| | Bentley, et al 2019 (57) | Cohort study. Australia, 2002-2014, n=24201 | One-dimensional (based on contract) | Mental health | Causal relationship between PE and mental health, mediated by changing housing cost and onset of affordability stress. |

## 1.6. New forms of work: digital labour platforms

> *"It is the perfect exploitation system: the worker is forced to exploit himself. You do not need an angry boss to tell you how much you have to work, you already entrust yourself." Ken Loach.*

One of the major transformations in the labour market over the past decade has been the emergence of online digital labour platforms. The digital platform work is based on labour platforms that use technology to connect workers with consumers for one-off tasks, or jobs that are completed either virtually or in person by an on-demand workforce (76). 40% of jobs created between 2005 and 2016 were in digitally intensive sectors (23).

The first companies considered to be part of the gig economy started appearing on 2005, being the first one Amazon's Mechanical Turk (77). Since its start, thousands of digital platforms for commercial coordination of digital labour have emerged in recent years (78). Digital labour platforms can be classified accordingly to the place and responsible for the task as 'crowd work' (web-based and less frequent location-based, the tasks are given to a crowd) and 'gig work' (location-based, the tasks are given to individuals) (77).

Gig work companies, are mostly dedicated to accommodation, transportation, delivery and household services. Some examples of gig work companies are Uber, Deliveroo or Glovo. It is difficult to estimate the share of workers in the gig economy. This is because companies are reluctant to disclose the data, or it is difficult to draw reliable estimates (the movement

of workers in and out from one platform to another one) (79). Uber, one of the companies for which data are available, had about 2,000 employees but more than 160,000 ‘driver-partners’ (gig workers) in the United States on 2014 (80).

Gig work main characteristics are: the work is paid by tasks, tasks are often on demand or completed immediately after a customer/client request the work, tasks are short term and small scale, workers have only a short-term relationship with their client, and workers are classified as independent contractors (81). Based on these characteristics, it is clear that gig work is not based on the sharing of common goods, and therefore the use of terms such as ‘sharing economy’ or ‘collaborative’ economy’ is wrong for referring to gig economy (82).

Further, because gig workers are not considered employees, they are denied from having an employer-employee relationship. Therefore, platforms do not have the responsibility to follow labour laws, or to provide benefits such as workers’ compensation insurance (6). Moreover, the gig workers remain in a grey zone as dependent self-employed between the self-employment and the salaried work, suffering the disadvantages of being self-employed (such as economic insecurity) and dispensing of the benefits (such as control over work) (27). This situation has provoked a debate over whether the dependent self-employed need to be reclassified as dependent employees or whether there is a need for a new, third category of workers, so that such workers enjoy protections typically associated with traditional employment

relationships (27). It is evident that gig work shares some features with precarious employment, such as low labour organization, temporariness and low social protection (83). Because of these poor employment features, some authors describe gig workers as a new potential social class, similar to the 'Precariat' (83), or a new class of precarious workers named 'Cybertariat' (84).

From the occupational health field, the understanding of this potential social determinant of health is limited. The search results from PubMed of papers that contain "gig economy" in their title are just 5, and none of them discuss empirical data. Given their employment condition as self-employed, the regulatory framework for prevention does not cover them (80). Moreover, they have to provide their own tools or equipment and they have limited opportunities for training (6,81). Next, unionization among gig workers is specially weak (76). Therefore, all of these characteristics may contribute to silence their demands for occupational safety and health needs.

# 2

# RATIONALE

*"Digital platform capitalism, as exemplified by companies like Uber or Lyft has the potential to transform employment and working conditions for an increasing segment of the workforce."*
*Carles Muntaner*

Work and employment are important policy domains globally. The 2030 Agenda for Sustainable Development encompasses the Goal 8 "decent work and economic growth". Its aim is to promote decent work for all men and women, productive, high-quality employment and for inclusive labour markets (25). In the case of the European Union, this has been also pinpointed. One of the aims of the European Employment Strategy at the Lisbon summit 2000 was improving the quality of jobs (85). Also, 'An Agenda for new skills and jobs', which forms part of the Europe 2020, was set aiming better functioning labour markets, more skilled workforce, better job quality and working conditions and promotion of job creation (86).

The importance of employment and working conditions on health is clear. 30 years after the foundation of the International Labour Organization (ILO), the first Joint ILO/World Health Organization (WHO) Committee on Occupational Health convened on 1950 (87). Years later, in 1980 the Black

Report was published. The report showed that the causes of differences in health status between the social classes were due to many social inequalities influencing health; being two of them the employment and conditions of work (88). In the further years, the Commission on Social Determinants of Health (CSDH) was set up by the WHO on 2005 (89) and many efforts are still ongoing (90).

While working conditions have attracted much attention from occupational epidemiologists, the study of employment conditions has been much more neglected. Even though the health effects of PE has been studied in the past recent years, data from years after the crisis has not been yet explored using a multidimensional approach in Europe. Different measures and reforms were undertaken during the economic crisis within the labour market (employment protection legislation, unemployment benefits, wage setting) and welfare regime (social and health policies) (16). This may have had an impact in the health effect of PE.

Further, technological development and digitalization of the labour market has happened (77). The European Foundation for the Improvement of Living and Working Conditions (EUROFOUND), acknowledged that the most relevant NSE forms will be related to digitalisation (91). The trends for the gig work are growing. But, its potential implications for the worker's health are unknown. The available evidence is scarce, mostly based on grey literature and qualitative studies from Canada (81). Gig work shares many

characteristics with PE, a well-known social determinant of health. Therefore, the health impact of gig work could be huge (83).

Consequently, it is necessary to shed light on these new forms of work and to study the impact of PE on the workers' health years after the Great Recession.

# 3

# AIMS AND HYPOTHESES

## 3.1. Aims

- To describe the proportion of PE in Europe through a multidimensional construct time after the Great Recession.

- To analyse the association of PE and health status in Europe.

- To compare the health status of the precariously employed individuals with those recently unemployed in Europe.

- To explore the association of PE and sick leave in Europe.

- To examine the relationship between PE and exposure to occupational hazards in Europe.

- To describe the protection against occupational hazards of delivery gig workers in Barcelona.

- To report the compliance with traffic regulations of delivery gig workers in Barcelona.

## 3.2. Hypotheses

- PE is higher among women, young workers, those with lower level of education and from Eastern and Southern welfare regimes.

- Precariously employed workers have higher prevalence of health problems caused by the work than those not precariously employed.

- Precariously employed workers and recently unemployed individuals report similar health status.

- Precariously employed workers have lower prevalence of sick leave than those not precariously employed.

- Precariously employed workers have higher prevalence of exposure to occupational hazards than those not precariously employed.

- Delivery gig workers are poorly protected against occupational hazards.

- Delivery gig workers have low compliance of the traffic regulations.

# 4

# METHODS

A general overview of datasets used and data collection is provided in this section. For the purposes of the doctoral thesis, cross-sectional studies, based on secondary analysis of data and direct observation, were designed. On one hand, data from different European surveys was used: the flash Eurobarometer 398 survey and the 6th European Working Conditions Survey (EWCS). The table 3 shows the main differences among the two European surveys used. On the other hand, data obtained from a structured direct observation in Barcelona was used.

The data analyses and variables description are described in detail in the methods section of each paper.

## 4.1. European surveys

Flash Eurobarometer 398 survey about "Working Conditions"

The main characteristics of the Flash Eurobarometer 398 are shown in Table 3. This survey was requested by the European Commission, Directorate-General for Employment, Social Affairs and Inclusion. It was carried out by TNS Political & Social, a consortium created between TNS political &

social, TNS UK and TNS opinion between the 3rd and 5th April 2014 (92). Around 27000 European Union (EU-28) citizens were interviewed via telephone (landline and mobile phone). In each country, a multistage random sampling design was used.

The Flash Eurobarometer 398 includes questions regarding trends of working conditions, satisfaction with working conditions, access to paid holidays, rest periods and flexibility at work, information and health and safety at work.

Given the aims of the thesis, this data survey was used for measuring PE and describing the health problems related to work, sick leave and occupational risk exposure of the precariously employed workers in the EU-28.

6th European Working Conditions Survey (EWCS) 2015

The main characteristics of the 6th EWCS are shown in Table 3. This survey aims to monitor working conditions across European countries, identify groups at risk, highlight issues of concern and contribute to develop EU policy. The Eurofound has been carrying out the EWCS every 5 years since 1990. Given that the thesis is contextualized years after the economic crisis, we used the sixth EWCS carried out between February and December 2015 (93). Nearly 44000 workers were interviewed in 35 European countries; the 28 EU Member States, the five EU candidate countries (Croatia, the Former Yugoslav Republic of Macedonia, Turkey, Albania, Montenegro and

Kosovo) and Norway and Switzerland. In each country, a multistage stratified random sampling design was used. The survey interviews were carried out face to face using computer-assisted personal interviewing (CAPI) at respondents' homes. The overall response rate was 42.5%

The sixth EWCS includes questions regarding employment status, work organisation, learning and training, working time duration and organisation, physical and psychosocial risk factors, health and safety, work-life balance, worker participation, earnings and financial security, as well as work and health.

Given the aims of the thesis, the survey data was used for measuring PE and comparing the health problems of the precariously employed workers with the unemployed individuals in Europe.

**Table 3. Main differences of the European Surveys used in the thesis project.**

| | Flash Eurobarometer (2014) | 6th EWCS (2015) |
|---|---|---|
| **Methodology** | Telephone (fixed-line and mobile phone). | Face-to-face interviews. |
| **Countries surveyed** | EU-28 (N=26571) | EU-28 + 5 candidates countries + Norway and Switzerland (N= 43850) |
| **Age range** | Aged 15 or older | Aged 15 or older, except Bulgaria, Norway, Spain and the UK that are aged 16 or older |
| **Unemployed individuals** | Not included | Included, but just those that are recently unemployed (individuals included may have been working at least one hour in the previous week of answering the questionnaire) |
| **Health problems related to work** | Available for over the last 12 months and related to work | Available for over the last 12 months and not necessarily related to work |
| **Educational level** | Not available, instead age at the end of studies | Available |
| **Construction of Precarious employment (PE) as a proxy of indicators** | The prevalence of PE was defined as the presence of one or more dimensions of precariousness. The variable PE had two possible categories: to be precariously employed or not. | The prevalence of PE was defined as having an average mean of precariousness higher than 0. Further, quartiles of precariousness were calculated, ranging from lower precariousness (quartile 1) to higher precariousness (quartile 4). |

## 4.2. Local observation

Direct observation consists on observe the individuals without altering the environment. According to whether individuals know they are being observed or not, the direct observation is open or covert, respectively. Further, the observation can be structured or not according to the use or not of an observation template. We designed a structured covert direct observational study, because delivery gig workers are a hard to reach population. Two observers did the observation in the city of Barcelona, from the months of September to December 2018. The observers walked the a priori designed routes twice; during the midday and at evening. The observation consisted on waiting approximately for 15 minutes in each corner or traffic light of the routes, and wrote down the observed variables in the data collection sheet. The data collection sheet included items related to (i) socio-demographics characteristics of the gig workers, (ii) use of protective equipment, and (iii) compliance with traffic regulations.

Given the aims of the thesis, direct observation was used for describing the use of protective equipment and traffic behaviour of the delivery gig workers in Barcelona.

# 5

# RESULTS

The thesis consists of a compilation of 4 papers (2 published and 2under review) in journals indexed in the Web of Science. The supplemental material of the papers can be found in the Annex (I, II and III). Also, the replies to reviewers' comments of the accepted papers can be found in the Annexes IV and V. The table 4 shows the aims, study design and population, main variables and results of the papers included in the doctoral thesis.

The papers that include the doctoral thesis are:

Paper I. Matilla-Santander N, Lidón-Moyano C, González-Marrón A, Bunch K, Martín-Sánchez JC, Martínez-Sánchez JM. Measuring precarious employment in Europe 8 years into the global crisis. J Public Health (Oxf). 2018; fdy 114. J Public Health (Oxf) is included in the Journal Citation Report of ISI-Web of Science with and impact factor of 1.648 (position 81/162 in the category of Public, Environmental & Occupational Health) in 2018.

Paper II. Matilla-Santander N, González-Marrón A, Martín-Sánchez JC, Lidón-Moyano C, Cartanyà-Hueso A, Martínez-Sánchez JM. Precarious

employment and Health-related outcomes in the European Union: a cross-sectional study. Crit Public Health. 2019; doi: 10.1080/09581596.2019.1587385. Critical Public Health is included in the Journal Citation Report of ISI-Web of Science with an impact factor of 2.742 (position 27/162 in the category of Public, Environmental & Occupational Health) in 2018.

Paper III. Matilla-Santander, N, Martín-Sánchez JC, González-Marrón A, Cartanyà-Hueso A, Lidón-Moyano C, Martínez-Sánchez JM. "Precarious Employment, recent Unemployment and their association with health-related outcomes in 35 European countries: a cross-sectional study." (under review).

Paper IV. Matilla-Santander N, Jovell L, Emre Dogan Y, Martín-Sánchez JC, González-Marrón A, Cartanyà-Hueso A, Sánchez-Martínez N, Bodin T, Martínez-Sánchez JM. Gig economy delivery workers: use of protective equipment and driving behaviour in Barcelona (Spain), 2018. (under review).

**Table 4. The aims, study design and population, main variables and results of the papers included in the doctoral thesis.**

| Paper | Aim | Study design | Study population | Main variables | Main results |
|---|---|---|---|---|---|
| **I** | To describe the prevalence of Precarious Employment (PE) in the EU-28 using a multidimensional approach, 8 years into the economic crisis. | Cross-sectional (secondary data analysis); Flash Eurobarometer 398 (2014). | EU-28 salaried workers (n=7702). Exclusion criteria: unemployed, self-employed, to be <16 years old or >70 years old, to have a missing value in any dimension of PE. | Exposure: PE<br>Covariates: individual characteristics and welfare regime. | (i) 2 out of 3 workers had a PE.<br>(ii) PE was higher among young workers (77.5%), those with lower educational level (71.7%) and working in countries with Eastern (72.6%) and Continental (69.3%) welfare regimes.<br>(iii) The most prevalent dimension was not having the ability to exercise rights (42.4%). |
| **II** | To evaluate the associations between PE and health-related outcomes in salaried workers from the EU-28 using a multidimensional approach. | Cross-sectional (secondary data analysis); Flash Eurobarometer 398 (2014). | EU-28 salaried workers (n=7702). Exclusion criteria: unemployed, self-employed, to be <16 years old or >65 years old. | Exposure: PE<br>Outcomes: self-reported health problems caused or worsened by the work, days of sick leave, main health and safety risks faced in the workplace. | (i) PE is associated to suffer health problems caused or worsened by work.<br>(ii) PE is associated to sick leave of more than 15 days [aPR: 1.43, CI95%:1.09;1.87].<br>(iii) PE is associated to being exposed to violence or harassment [aPR: 1.82, CI95%: 1.42;2.34]. |

| Paper | Aim | Study design | Study population | Main variables | Main results |
|---|---|---|---|---|---|
| **III** | To compare the health status of highly precarious employees with that of recently unemployed people in 35 European countries. | Cross-sectional (secondary data analysis); European Working Conditions Survey (2015). | 35 European countries (n= 33938). Exclusion criteria: self-employed, unable to work due to disability, at work on child-care leave, retired, full time homemaker, in full time education, to be <16 years old or >65 years old. | Exposure: PE and unemployment. Outcomes: bad health status, health problems. | (i) Quartiles 3 and 4 of precariousness are associated to declare bad health status, headache, skin and hearing problems, anxiety, fatigue, backache, upper and lower muscular pain and injuries. (ii) CI95% of the aPR for most of health-related outcomes overlapped between the highest quartiles of precariousness and unemployment. |
| **IV** | To describe the use of personal protection equipment (PPE) and vehicle protection equipment (VPE) and the compliance with traffic regulations of delivery gig workers. | Cross-sectional based on structured covert direct observation (2018). | Delivery gig workers in Barcelona, Spain (n=803). Inclusion criteria: to be identified as a worker of the companies Deliveroo, Glovo, Stuart, Uber Eats or Just Eat by the visible brand on their backpacks. | Compliance with traffic regulations (respect of traffic signals, driving in the correct lane). Use or proper use of PPE (use of helmet, full-face helmet, gloves and mask). Use of VPE (reflective in bicycle, front light in bicycle, phone holder). | (i) Most of workers were men (98%), aged 18 to 25 years (56.9%) and used the bicycle as working vehicle (64.4%). (ii) Only 41% of the bicycle riders respected the traffic signals and 46% drove in the correct lane. (iii) The use of helmet was much lower among bicycle (13%) than motorcycle riders (99%). (iv) 31% had bicycle refractors and 15% had bicycle front light. |

# 5.1. Paper I

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# Measuring precarious employment in Europe 8 years into the global crisis

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## ABSTRACT

**Background** The objective of this study is to describe the prevalence of precarious employment in the European Union (EU) using a multidimensional approach, 8 years into the economic crisis (2014).

**Methods** We use data from the Flash Eurobarometer 398 among salaried workers ($n$ = 7702). We calculated the proportion and its 95% confidence intervals (CI 95%) for each of the precarious employment dimensions (not having the ability to exercise rights, vulnerability, disempowerment and temporariness), the prevalence of precarious employment (presenting at least one dimension) and the proportion of workers presenting one, two, three or four dimensions.

**Results** Two out of three workers had a precarious employment. The prevalence of precariousness was higher in Eastern (72.64%; CI 95%: 61.78; 81.34) than in Nordic European countries (51.17%; CI 95%: 44.30; 58.00). The most prevalent dimension was not having the ability to exercise rights (42.39%).

**Conclusions** Precarious employment is an important social determinant of health. Therefore, the EU policy-makers should take into consideration the new forms of employment and legislate accordingly.

**Keywords** economic crisis, employment conditions, European Union, non-standard employment, precarious employment

## Introduction

Precarious employment has its origins in the mid-1970s, when changes in capitalist economies transformed the relationship between employers and workers,[1] known as standard employment relationship (full-time and stable employment in which employees have collective bargaining power, social rights and protections), and derived into the proliferation of flexible employment forms.[2,3]

Precarious jobs are those in which the risk of job loss is high and with a short time horizon. Further, the control over working conditions, wages and pace of work is low, the extent to which workers are protected is poor (by law or through collective organizations) and workers suffer from poverty and insecure social insertion.[4] Therefore, precarious employment is understood as a sociological construct[5] that takes into account several dimensions such as employment insecurity (uncertainty regarding the continuity of employment), minimal worker control (powerlessness to take in part in wages, pace of work and working conditions), low wages and limited social protection (work not protected by law or collective agreements).[4,6–8] Since neoliberal systems may have global consequences,[1] precarious employment is growing in industrialized countries,[1] as in the so-called 'developing countries'. Precarious employment, whose study remains in its infancy,[6] is considered an emerging social determinant of

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health[9] and an important employment condition related to health inequities.[1]

The prevalence of precarious employment in the European Union (EU) before the economic crisis was of 48% (study conducted in 2005). Women, workers with fewer credentials and living in Eastern and Southern European countries had higher levels of precarious employment in the EU before the start of the crisis.[8] However, the prevalence of precarious employment after the economic crisis is still unknown in the EU. This prevalence may be substantial as the economic crisis increased the unemployment rates and deteriorated employment and working conditions, which are positively associated with precarious employment.[10]

Recently, there was a call for researchers to study precarious employment from a multidimensional perspective.[6] In the literature, several studies have described the associations between poor employment conditions (i.e. temporary work, dispatched work, part-time work, contingency work and fixed-term work) and workers' health related outcomes as a unidimensional approach of precarious employment.[11–20] However, several dimensions define precarious employment. Thus, analyzing it from only one dimension may limit the mechanisms by which it affects health and the magnitude of the associations found.[6,21] So, the study of precarious employment as a multidimensional construct may reflect the role of employment relationships taking into account all factors that make employment precarious.[21]

Therefore, the objective of this study is to describe the precarious employment in the EU through a multidimensional approach 8 years into the economic crisis (2014).

## Methods

### Study population and data collection

This is a cross-sectional study. The flash Eurobarometer 398 survey, based on 'Working Conditions' was carried out by TNS Political & Social network between 3 and 5 April 2014, on behalf of the European Comission, DG Employment, Social Affairs and Inclusion.[22] The survey covers the resident population in each of the 28 Member States aged 15 years and over. To complete the questionnaire, trained personnel interviewed the respondents via telephone (landline and mobile phone) in their mother tongue. In each country, the sampling method used was a multi-stage random sampling design. The survey includes information of 26 571 EU citizens.

For the purpose of the present study, we excluded people who declared not to be working and to be self-employed (due to lack of variables regarding employment quality) and <16 years old or >70 years old ($n$ = 18 362). Moreover, we excluded all the workers that had any missing value in any of the four dimensions of precarious employment ($n$ = 507), so the final sample for this study accounted for 7702 salaried EU workers. Of those, the average age was 41 years, 59.75% were men and more than a half had finished their studies at the age of 20 years.

### Study variables

The precarious employment variable was conceptualized as a multidimensional construct.[8,23,24] We constructed the variable based on four dimensions: (1) 'not having the ability to exercise rights' (constructed from presenting at least one of the following four items: not having a break after 6 h of work, working days that exceed a total of 13 h, not having a day off every week, not having 4 weeks of paid holidays every year); (2) 'vulnerability' (constructed from presenting at least one of the following two items: not using the rights because it might have a negative impact on the career, not using the rights because it might lower the salary); (3) 'disempowerment' (constructed from presenting at least one of the following two items: unable to influence your work schedule, not satisfied with how the opinion about their own work is taken into account); and (4) 'temporariness' (constructed when any of these response options were responded: temporary employment agency contract, fixed-term contract, apprenticeship or other training scheme). Given the available data in the Eurobarometer 398, we could not include the dimensions 'low wages' and 'limited social protection or rights' for the construction of the variable precariousness. The prevalence of precarious employment was defined as the presence of one or more dimensions of precariousness (as described previously by Vives *et al.*[7]). Vives *et al.*[7] measured precarious employment through an instrument that had been previously validated in salaried Spanish working population. A more detailed description of the construction of the variable precarious employment is in Table 1.

The covariates used for the study were sex (men/women), age (16–24 years, 25–39 years, 40–54 years, ≥55 years old), country typologies based on the welfare regime type[25] as follows: Continental area (Austria, Belgium, Germany, France, the Netherlands and Luxembourg), Anglo-Saxon area (Ireland and the United Kingdom), Eastern European area (Croatia, Czech Republic, Estonia, Hungary, Lithuania, Latvia, Poland, Rumania, Bulgaria, Slovenia and Slovakia), Southern European area (Cyprus, Greece, Spain, Italy, Malta and Portugal) and Nordic area (Denmark, Finland and Sweden). We also included age at the end of the studies (still studying, <15 years, 16–19 years, >20 years), as a proxy of

**Table 1** The four dimensions taken into account for construct the variable precarious employment

| | *Item* | *Question* | *Variable treatment* |
|---|---|---|---|
| Dimension 1: Not having the ability to exercise rights | Not one break after 6 h of work | 'In practice, at work do you generally benefit from:'<br>Answer: at least one break after 6 h of work. | When the answer is no is considered as an item of precariousness |
| | Working days that exceed a total of 13 h | 'In practice, at work do you generally benefit from:'<br>Answer: working days that do not exceed a total of 13 h. | When the answer is no is considered as an item of precariousness |
| | Not one day off every week | 'In practice, at work do you generally benefit from:'<br>Answer: at least 1 day off every week. | When the answer is no is considered as an item of precariousness |
| | Not 4 weeks of paid holidays every year | 'In practice, at work do you generally benefit from:'<br>Answer: at least 4 weeks of paid holidays every year. | When the answer is no is considered as an item of precariousness |
| Dimension 2: Vulnerability | Do not use the options (special leave, work part time, flexible hours, work from home) because it might have a negative impact on the career | 'In some companies, employees are able to take special leave, to work part time or with flexible hours or to work from home. Does your company or organization offer any of those options?'<br>Answer: Yes, but you don't use any of them because it might have a negative impact on your career. | When the answer is yes is considered as an item of precariousness |
| | Do not use the options (special leave, work part time, flexible hours, work from home) because it might lower the salary | 'In some companies, employees are able to take special leave, to work part time or with flexible hours or to work from home. Does your company or organization offer any of those options?'<br>Answer: Yes, but you don't use any for other reasons. | When the answer is yes is considered as an item of precariousness |
| Dimension 3: Disempowerment | Unable to influence your work schedule | 'Which of the following are the main reasons for your dissatisfaction with working hours?'<br>Answer: Unable to influence your work schedule (e.g. when you start and finish, or annual leave). | When the answer is yes is considered as an item of precariousness |
| | Not satisfied how the opinion about its own work is taken into account | 'More precisely, how satisfied are you with each of the following aspects in your current job?'<br>'The way in which your opinion is taken into account when decisions are made about your work'.<br>Answer: very satisfied, fairly satisfied, not very satisfied, and not at all satisfied. | When the answer is 'not very satisfied' and 'not at all satisfied' is considered as an item of precariousness |
| Dimension 4: Temporariness | Temporariness | 'What type of contract do you have?'<br>Answer: permanent contract, fixed-term contract (long or short term), temporary employment agency contract, apprenticeship or other training scheme, other. | When the answers are 'temporary employment agency contract', 'fixed-term contract', 'apprenticeship or other training scheme' is considered as an item of precariousness |

level of education (i.e. the higher the age is at the end of the studies, the higher the level of education is).

### Statistical analysis

We calculated the proportion and the 95% confidence intervals (95% CI) for each of the precarious employment dimensions (exercise rights, vulnerability, disempowerment and temporariness). Next, we calculated the proportion and the 95% CI of workers presenting only one, two, three or four dimensions of precarious employment. We stratified all analyses by age, sex, age at the end of the studies and country typologies. We tested the differences between proportions in each co-variable using the $Chi^2$ test. Moreover, all analyses included sampling weights for each country (population size weighting). The level of statistical significance was set to a two-sided *P*-value <0.05. We did all analyses using Stata 14.0 statistical software.

## Results

Table 2 shows the proportion of precarious employment and of workers presenting one, two, three or four dimensions of precariousness. Of the salaried EU workers, 67.08% (CI 95%: 61.59, 72.13) had a precarious employment. Of those, 40.78% presented one, 21.03% presented two, 5.01% presented three and 0.25% presented four dimensions. There were statistically significant differences in the prevalence of presenting three dimensions of precariousness according to age, with a tendency of higher prevalence at lower age. We also found statistically significant differences in the prevalence of presenting two dimensions of precariousness according to country typologies. The highest prevalence was in Eastern European countries and the lowest was in Nordic welfare regime countries. We did not find statistically significant differences in the prevalence of precarious employment according to sex and age at the end of the studies of the workers.

Table 3 shows the proportion of each of the four dimensions taken into account to measure precarious employment. The most prevalent dimension was not being able to exercise their rights (42.39%), followed by disempowerment of the workers (31.44%), temporariness (12.64%) and vulnerability (12.41%). Statistically significant differences were found in the proportion of the dimension 'temporariness' according to age and age at the end of the studies, being higher in the youngest (38.58%) and those still studying (39.32%). Moreover, we found differences according to the welfare regime countries classification. The dimension 'not have the ability to exercise rights' (53.18%; CI 95%: 42.07, 63.99) was more prevalent in Eastern European countries, while the dimension 'vulnerability' was more frequent among Continental countries (16.16%; CI 95%: 9.49, 26.17).

## Discussion

### Main finding of this study

Two out of three workers had a precarious employment in the EU by 2014. The most prevalent dimension of precariousness was 'to not have the ability to exercise the rights'. This is the first study that describes the proportion of precarious employment from a multidimensional approach among salaried workers in the EU 8 years into the economic crisis.

### What is already known and what this paper adds on this topic

Previous studies have studied the precarious employment from a multidimensional approach in the EU[8] before the economic crisis and in Spain[10] during the economic crisis. The prevalence of precarious employment shown by these studies was of 48% in 2005 (measured through the working conditions survey and using eight dimensions) and 49% in 2010 (measured through a validated Employment Precariousness scale; EPRES, and using six dimensions). Both studies showed a high prevalence of precarious employment, which is in concordance with the high prevalence we show in our study using four dimensions (67.08%). We can observe an increase in the prevalence of precariousness from 2005 (48%)[8] to 2014 (67.08%) in the EU, according to the results obtained in our study. Since 2005, there have been important changes in the labor markets of the EU countries that could explain the increase seen in the prevalence of precariousness. First, increases in unemployment rates are correlated to a deterioration in working conditions,[10] and in the EU the unemployment rates increased from 21 million persons (2005) to 25 million persons (2014).[26] Further, there has been an increase in new forms of poorly regulated employment, such as casual work or crowd employment,[27] which could represent new risks for deteriorating the employment conditions. Moreover, the economic crisis has been associated with an increase in job insecurity among workers,[28] which would be related to precarious conditions of employment. However, it is important to keep in mind that the measurement of precariousness differs between the different studies. Therefore, precariousness estimates could be slightly different.

The studies conducted before[8] and during the crisis[10] showed a higher prevalence of precarious employment among women, younger and lower educational level salaried workers. In our study, we found a higher prevalence of

**Table 2** Proportion of precarious employment and of workers with one, two, three or four dimensions of precarious employment by sex, age, age at the end of the studies and country typologies of EU (2014)

| | *Precarious employment*[a] | | *One dimension* | | *Two dimensions* | | *Three dimensions* | | *Four dimensions* | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *% (CI 95%)* | P-*value*[b] | *% (CI 95%)* | P-*value*[b] | *% (CI 95%)* | P-*value*[b] | *% (CI 95%)* | P-*value*[b] | *% (CI 95%)* | P-*value*[b] |
| Overall | 67.08 (61.59;72.13) | | 40.78 (38.33;43.28) | | 21.03 (18.63;23.66) | | 5.01 (3.85;6.48) | | 0.25 (0.13;0.49) | |
| Sex | | 0.8707 | | 0.658 | | 0.378 | | 0.369 | | 0.416 |
| Men | 66.98 (61.52;72.02) | | 41.17 (38.07;44.34) | | 20.44 (17.29;23.99) | | 5.20 (4.04;6.66) | | 0.17 (0.04;0.79) | |
| Women | 67.22 (61.18;72.74) | | 40.02 (36.75;43.76) | | 21.92 (19.66;24.37) | | 4.72 (3.40;6.53) | | 0.37 (0.16;0.86) | |
| Age | | 0.078 | | 0.420 | | 0.637 | | **0.002** | | 0.486 |
| 16–24 years | 77.51 (64.66;77.85) | | 45.07 (38.04;52.30) | | 23.57 (16.52;32.46) | | 8.49 (5.40;13.12) | | 0.37 (0.04;3.10) | |
| 25–39 years | 66.30 (59.79;72.25) | | 40.10 (36.18;44.14) | | 20.14 (16.79;23.95) | | 5.89 (4.20; 8.21) | | 0.18 (0.05;0.63) | |
| 40–54 years | 66.95 (60.50;72.82) | | 41.27 (38.03;44.60) | | 21.12 (18.24;24.31) | | 4.17 (3.37;5.17) | | 0.39 (0.15;0.99) | |
| ≥55 years | 64.35 (59.19;69.14) | | 39.07 (35.77;42.48) | | 21.97 (17.71;26.92) | | 3.31 (1.99;5.45) | | 0 | |
| Age at the end of the studies | | 0.659 | | 0.569 | | 0.504 | | 0.414 | | 0.831 |
| <15 years | 71.72 (64.66;77.85) | | 45.34 (37.12;55.83) | | 22.80 (18.38;27.91) | | 3.44 (1.56;7.43) | | 0.13 (0.01;1.21) | |
| 16–19 years | 66.52 (61.96;70.78) | | 40.66 (39.41;41.93) | | 20.06 (17.42;22.97) | | 5.57 (4.05;7.62) | | 0.22 (0.03;1.44) | |
| >20 years | 66.95 (60.53;72.79) | | 40.21 (36.78;43.75) | | 21.59 (18.94;24.49) | | 4.85 (3.15;7.41) | | 0.29 (0.14;0.63) | |
| Still studying | 65.21 (29.17;89.51) | | 48.59 (20.18;77.95) | | 16.43 (5.54;39.76) | | 0.19 (0.02;1.63) | | 0 | |
| Country typologies | | **0.027** | | 0.099 | | **<0.001** | | 0.243 | | 0.894 |
| Continental | 69.30 (62.85;75.08) | | 42.26 (41.94;42.58) | | 21.26 (17.97;24.98) | | 5.44 (3.10;9.36) | | 0.34 (0.16;0.71) | |
| Anglo-Saxon | 58.51 (58.00;59.01) | | 36.52 (36.51;36.52) | | 16.60 (15.89;17.34) | | 5.39 (5.17;5.62) | | 0 | |
| Eastern European | 72.64 (61.78;81.34) | | 43.23 (37.20;49.47) | | 24.10 (20.93;27.59) | | 5.13 (4.05;6.49) | | 0.17 (0.05;0.58) | |
| Southern European | 67.01 (59.34;73.87) | | 38.81 (36.38;41.31) | | 22.86 (20.23;25.72) | | 4.85 (2.99;7.76) | | 0.48 (0.28;0.82) | |
| Nordic | 51.17 (44.30;58.00) | | 38.59 (31.55;46.13) | | 11.83 (11.00;12.71) | | 0.75 (0.45;1.27) | | 0 | |

Note: Bold *P*-values are those under 0.05.

[a]Precarious employment: defined as having at least one factor.

[b]$Chi^2$ test.

**Table 3** Description of the precarious employment dimensions by sample characteristics of EU (2014)

| | | *Dimension 1: Exercise rights* | | *Dimension 2: Vulnerability* | | *Dimension 3: Disempowerment* | | *Dimension 4: Temporariness* | |
|---|---|---|---|---|---|---|---|---|---|
| | n[a] | *% (CI 95%)* | P-*value*[b] | *% (CI 95%)* | P-*value*[b] | *% (CI 95%)* | P-*value*[b] | *% (CI 95%)* | P-*value*[b] |
| Overall | 7702 | 42.39 (36.46;48.54) | | 12.41 (9.07;16.76) | | 31.44 (27.04;36.21) | | 12.64 (10.10;15.71) | |
| Sex | | | 0.335 | | 0.840 | | 0.588 | | 0.5747 |
| Men | 4602 | 42.00 (35.94;48.32) | | 12.26 (9.23;16.12) | | 31.86 (26.60;37.62) | | 12.21 (9.64;15.34) | |
| Women | 3100 | 42.96 (37.07;49.06) | | 12.63 (8.27;18.79) | | 30.83 (26.93;35.02) | | 13.29 (9.70;17.95) | |
| Age | | | 0.293 | | 0.427 | | 0.133 | | **<0.001** |
| 16–24 years | 537 | 43.74 (34.07;53.92) | | 11.98 (6.66;20.62) | | 24.88 (19.24;34.33) | | 38.58 (29.78;48.20) | |
| 25–39 years | 2928 | 40.26 (32.98;48.00) | | 12.85 (8.68;18.62) | | 29.92 (25.86;34.33) | | 15.73 (12.08;20.22) | |
| 40–54 years | 3161 | 44.34 (38.56;50.28) | | 12.89 (10.01;16.45) | | 32.97 (27.53;38.91) | | 7.38 (5.68;9.53) | |
| ≥55 years | 1076 | 41.79 (35.47;48.38) | | 10 (6.52;15.04) | | 34.38 (26.42;43.32) | | 6.78 (4.32;10.47) | |
| Age at the end of the studies | | | 0.506 | | 0.402 | | 0.053 | | **0.005** |
| <15 years | 380 | 43.21 (35.37;51.40) | | 11.33 (6.93;17.99) | | 27.46 (22.21;33.41) | | 19.81 (13.25;28.53) | |
| 16–19 years | 3044 | 41.70 (35.41;48.28) | | 11.82 (9.59;14.48) | | 31.22 (27.80;34.86) | | 13.64 (10.26;17.91) | |
| >20 years | 4149 | 42.78 (36.63;49.17) | | 13.19 (8.41;20.08) | | 32.33 (26.79;38.40) | | 10.82 (8.50;13.69) | |
| Still studying | 72 | 28.93 (12.40;53.92) | | 2.24 (0.54;8.80) | | 11.54 (3.74;30.46) | | 39.32 (14.68;70.93) | |
| Country typologies | | | **0.009** | | **0.029** | | 0.106 | | 0.093 |
| Continental | 2801 | 42.27 (39.29;45.31) | | 16.16 (9.49;26.17) | | 33.31 (24.19;43.87) | | 10.73 (8.46;13.51) | |
| Anglo-Saxon | 1208 | 32.79 (32.73;32.85) | | 14.37 (14.23;14.51) | | 27.69 (26.87;28.52) | | 11.04 (10.92;11.16) | |
| Eastern European | 1896 | 53.18 (42.07;63.99) | | 7.87 (6.35;9.72) | | 29.62 (26.88;32.52) | | 16.83 (11.77;23.49) | |
| Southern European | 1398 | 38.67 (29.17;49.12) | | 11.74 (8.39;16.19) | | 36.90 (30.78;43.48) | | 13.72 (8.69;20.98) | |
| Nordic | 398 | 34.02 (26.75;42.14) | | 4.01 (3.11;5.15) | | 19.25 (17.37;21.29) | | 7.23 (2.86;17.09) | |

Note: Bold *P*-values are those under 0.05.

[a]The total observations by covariates can be lower than 7702 due to missing values.

[b]$Chi^2$ test.

precariousness in the youngest, being statistically significant when presenting three dimensions of precariousness. Moreover, even though the differences were not statistically significant, we found a relationship between a higher prevalence of precariousness and having studied fewer years. We also describe a higher prevalence of temporariness among younger workers, which has been described previously and has been associated with a poor health status.[12] Workers that were still studying had the lowest prevalence of precariousness, which we should interpret with caution, as the sample size for this subgroup is lower. We did not find differences in the prevalence of precariousness according to sex. This may be explained because our construct of 'precarious employment' did not consider the two dimensions 'rights' and 'wages' which could have increased the prevalence of precariousness among women.[29,30]

We found differences in the proportion of precarious employment according to welfare regimes. The previous study measuring the precariousness in the EU found that the highest rates of precarious employment dimensions were in Eastern and Southern European workers.[8] Our results are in the same line, as we found a higher prevalence of precarious employment among Eastern, Continental and Southern welfare regime countries. Moreover, studies done in European workforce have shown that precarious job types (low quality employment) are more prevalent in Southern and Eastern European countries, while SER-like and portfolio job types (high level quality employment) are more strongly present in Nordic and Central European countries.[31] Therefore, our results are coherent with the welfare regime of these countries: while Nordic welfare regimes are characterized by active labor policies and reliable social protection measures, in Southern, Eastern and Continental welfare regimes the social protection regulations are weak or highly fragmented, and labor policies follow principles of neo-liberalism.[32] Further, austerity policies in these countries after the crisis and the low quality of new employment forms[32] may have exacerbated the precariousness in those regimes.

Furthermore, it is important to take into account the increase of new companies based on digital platforms.[33] Digital platforms have several strengths for companies, as they facilitate the exchange of products and services. However, they have very important implications for working conditions, as they have been associated with relatively lower wages and employ fewer people.[33] Moreover, this kind of employment, which would represent a new form of non-standard poorly regulated employment, may increase precariousness. Therefore, even though with our study design we cannot describe the prevalence of precarious workers that work through digital platforms, future studies may incorporate this information.

Epidemiological evidence supports that non-standard employment forms[2] and flexible labor markets[34] have a negative health effect in the employees. Precarious employment has been previously associated with lower job satisfaction and worse general and mental health in EU salaried workers.[31] Besides, we have described differences in the prevalence of precariousness according to age, age at the end of studies and welfare regime. Therefore, the high prevalence of precariousness described in our study may have important consequences in the health of the working population and, further, it may create health inequalities.

Key policies and interventions for reducing precarious employment and its health inequalities have already been described elsewhere.[35] Given that the dimensions 'to not have the ability to exercise rights' and 'vulnerability' were the most prevalent, an objective of the policies may be to decrease the prevalence of each of these dimensions. Some examples of those policies would include limiting temporary contracts, creating incentives and sanctions for reduction of employment violations, providing incentives for unionization and collective bargaining and defining integrated minimum labor standards. As we show in this study, the prevalence of precarious employment is very high in the EU and it is increasing dramatically years after the start of the crisis in comparison with previous studies.[8,10] For this reason, it would be highly recommended for policy-makers from the EU to take into account this social determinant of health and to legislate accordingly to reduce the prevalence of precariousness. In this line, a report was recently sent to the European Parliament for its discussion, and in the case it is approved it will be sent to the European Commission to guarantee good working conditions and same rights for the different kinds of employment.[36]

## Limitations of this study

This study has some limitations. First, we cannot rule out the recall bias as the data was obtained from a questionnaire. Next, we could not consider all the six dimensions described of precarious employment.[7] We were not able to take into account the factors 'rights or limited social protection' and 'wages', as there are no questions in the questionnaire referring to that dimensions, and that may have underestimated the prevalence shown in the study. On the contrary, using the definition of precariousness when having just one dimension may have overestimated its prevalence. Moreover, we could not account for the levels of intensity of precariousness, as we constructed our variable from dichotomous

answers to several questions. Instead, we constructed the variable precarious employment from many items given by the questionnaire, so we could describe the prevalence of precarious employment from a multidimensional approach. Further, we measured precarious employment in individuals with a formal employment contract only, thus, excluding self-employment, because the available data from the dataset was not enough to measure precariousness in other forms of employment. It is important to consider that the use of an approach for measuring precariousness based on indicators (with the available information) has some data limitations, such as not being able to include self-employed workers or not having information about the salaries or wages. However, it enables to create large-scale evidence using existing data sources. Moreover, we believe the results obtained through this approach are complementary to previous studies.[37] Nevertheless, a validated scale like the one used in Spanish salaried workers,[7] but that took into account non-salaried workers as well, may be useful and necessary for the rest of Europe, in order to monitor the prevalence of precariousness and to disentangle the causes of increases in precariousness.

## Conclusions

Our study shows that two out of three EU salaried workers in 2014 had a precarious employment. Since precarious employment is a social determinant of health and a serious public health issue, the EU policy-makers should take into consideration the new forms of employment and legislate accordingly.

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# 5.2. Paper II

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# Precarious employment and health-related outcomes in the European Union: a cross-sectional study

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# Precarious employment and health-related outcomes in the European Union: a cross-sectional study

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**ABSTRACT**

In this cross-sectional study, we evaluated the associations between precarious employment and health-related outcomes in salaried workers from 28 countries in Europe (2014). We used data from the Flash Eurobarometer 398 among salaried workers (n = 7,702). We fitted multilevel generalized linear models (GLMM) using the Poisson family and country as the random effect, to calculate the crude (cPR) and adjusted (aPR) prevalence ratios with their 95%CI of health-related outcomes (health problems, sick leave, health and safety risks in the workplace) according to precarious employment. We found significant associations between having a precarious employment and health problems caused or worsened by the work (stress/depression/anxiety, musculoskeletal problems, infectious diseases, respiratory problems, accidents/injuries and allergies), sick leave of more than 15 days [aPR: 1.43, (CI95%: 1.09;1.87)] and exposure to violence or harassment [aPR: 1.82, (CI95%: 1.42;2.34)]. Our study shows an association of precarious employment, understood as a multidimensional construct, and negative health-related outcomes and sick leave of more than 15 days. Therefore, we recommend prioritizing legislative measures for reducing non-standard arrangements and for improving the conditions of workers in non-standard arrangements.

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## Introduction

In the mid-1970s there was an economic downturn driven by oil economics, which resulted in important political and economic changes (Scott, 2004), followed by a shift from Keynesianism (generous welfare states, strong labour unions and strong regulation of employment relations) toward neoliberal economic policies in most industrialized countries, including those belonging to the European Union (EU-28) (Palley, 2005). These policies fostered changing labour markets, to make them more flexible, prioritizing a casual workforce, because employers 'needed' to ease the movement of the workers into and out of jobs (Standing, 2014). This transformed standard employment relationships (full-time and stable employment where employees have collective bargaining power, social rights and protections) to non-standard and atypical employment relationships (Bosch, 2004; Quinlan, Mayhew, & Bohle, 2001). It is in this major social transformation that precarious employment has its origin. Precarious employment has been defined as an employment condition that includes several characteristics such as employment insecurity (uncertainty

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Supplementary data can be accessed here

regarding the continuity of employment), minimal worker control (powerlessness to take in part in wages, pace of work and working conditions), low wages and limited social protection (work not protected by law or collective agreements) (Benach et al., 2014; Hadden, Muntaner, Benach, Gimeno, & Benavides, 2007).

The economic crisis released by the bank failures of 2008 has been one of the most severe. With the experience and evidence of past recessions (Peters, 2008), a deterioration of employment quality would be expected. Results from the European Social Surveys (19 European countries), suggested that the quality of work was affected by the crisis through a decline in the opportunities for training, and a rise in work intensity, job insecurity and work-family conflict among workers from 2004 to 2010 (Gallie, 2013). Further, there is evidence that the proportion of jobseekers accepting atypical employment arrangements (temporary agency work, fixed-term work, zero hours contracts) increased in Europe the years following the crisis (Committee on Employment and Social Affairs, 2016).

So, the impact of the global financial crisis (Horton, 2009), with the increasing trends in non-standard work contracts (Aronsson, 2001), such as those related to digital platforms (Eurofound, 2016), together with global unemployment (driven by increases in emerging economies) and the projected growth by 11 million per year of total number of workers in vulnerable employment forms (ILO, 2017), seems to predict an increment in the incidence of the precariousness. It has been estimated that two out of three salaried workers from the EU-28 had a precarious employment in 2014 (Matilla-Santander et al., 2018).

Non-standard employment forms have been associated with non-optimal health status, psychological morbidity, work-related psychosocial problems, nutritional-related outcomes, musculoskeletal disorders, psychosomatic disorders and cardiovascular disease (Benach, Muntaner, & Santana, 2007). Given that epidemiological evidence suggests that flexible labour markets have a negative health effect on employees (Ferrie, Westerlund, Virtanen, Vahtera, & Kivimki, 2008), an increasing trend in precariousness may have important health consequences.

Furthermore, employment relations are affected by power relations within society, thus by axes of social inequality such as social class, gender, race, age, level of education, etc. (Muntaner et al., 2010), and by political and economic determinants such as labour market policies and welfare regimes (Dragano, Siegrist, & Wahrendorf, 2010). Non-standard arrangements and precariousness are more common among the most vulnerable labour market individuals; women, younger, immigrants, with lower educational level and from manual social classes (Benach et al., 2014; Committee on Employment and Social Affairs, 2016).

Recently, there was a call for researchers to study precarious employment from a multidimensional perspective (Benach, Vives, Tarafa, Delclos, & Muntaner, 2016). That is, studying the multiple dimensions that characterize precariousness (employment insecurity, minimal worker control, low wages or limited social protection) at the same time and not individually, through a multidimensional construct. In the literature, several studies have described the associations between precarious employment from an unidimensional approach (that is, analysing one of the multiple characteristics that construct the precariousness) and health outcomes (Jang, Jang, Bae, Shin, & Park, 2015; Kim, Park, Lee, & Kim, 2016; Steele, Giles, Davies, & Moore, 2017). Although they are showing the effect on the health, they are not studying at the same time all the features of an employment relation, thus limiting the mechanisms through which precariousness affect health.

Therefore, this study aimed to evaluate the associations between precarious employment and health-related outcomes in salaried workers from the EU-28 using a multidimensional approach. We hypothesize that individuals with precarious employment will have a higher prevalence of health-related problems, and will be more frequently exposed to risks at the workplace. Regarding sick leave, we suggest that the associations could be in two different directions: those individuals with a precarious employment will have more health problems and therefore higher proportion of sick leave, or, it could be possible that due to the job insecurity arising from the precariousness, they would not ask for sick leave unless the illness is really severe. Further, we expect that the

prevalence of health-related outcomes among individuals with precarious employment will be higher in the most vulnerable groups (women, younger and those with lower educational level) and also, among those individuals living in countries with poorer social policies regimes.

## Methods

### Study population and data collection

This is a cross-sectional study based on secondary data from the flash Eurobarometer 398 survey, based on 'Working Conditions'. The survey was carried out between the 3 and 5 April 2014 by the TNS Political & Social, a consortium created between TNS political & social, TNS UK and TNS opinion. It was requested by the European Commission, Directorate-General for Employment, Social Affairs and Inclusion (European Comission, 2014). The survey covers the resident population in each of the 28 Member States aged 15 years or over. In each country, a multi-stage random sampling design was used. To complete the questionnaire, the respondents were interviewed via telephone (landline and mobile phone) in their mother tongue. Therefore, the survey covers the population of citizens of all the EU-28 Member States that are residents in these countries in 2014 and have a sufficient command of the national languages to answer the questionnaire. The survey includes information of 26,571 European Union citizens. The data are anonymous and publicly available at GESIS Data Archive (European Commission, 2014).

For the purpose of the present study, we excluded people who declared not to be working, self-employed, and to be 15 years old or >70 years old (n = 18,362). We excluded all workers that had any missing value in any of the four factors of precarious employment (n = 507), leaving a final sample for this study of 7,702 salaried European workers. The average age was 41 years, 59.75% were men, and more than half had finished their studies at the age of 20 years.

### Study variables

#### Precarious employment

The precarious employment variable was conceptualized as a multidimensional construct. We defined the variable based on the validated scale in Spanish salaried workers for measuring precarious employment (EPRES) (Vives et al., 2010), based on several indicators obtained through the questions as follows and classified in four dimensions; (1) 'do not exercise rights' (constructed from having at least one of the following four items: not having a break after six hours of work, working days that exceed a total of 13 hours, not having a day off every week, not having four weeks of paid holidays every year); (2) 'vulnerability' (constructed from having at least one of the following two items: not using the rights because it might have a negative impact on the career, not using the rights because it might lower the salary); (3) 'disempowerment' (constructed from having at least one of the following two items: unable to influence your work schedule, not satisfied how the opinion about its own work is taken into account); and (4) 'temporariness' (constructed from having at least one of the three items: temporary employment agency contract, fixed term contract, apprenticeship or other training scheme). The prevalence of precarious employment was defined as the presence of one or more dimensions of precarious employment (as described previously by (Vives et al., 2010)).

#### Health-related variables

*Health problems caused or worsened by the work* were obtained from the question: 'In the last twelve months, have you experienced any of the following health problems caused or worsened by your work?', with the possible answers: (i) stress, depression or anxiety, (ii) bone, joint or muscle problems, (iii) infectious diseases, (iv) breathing or lung problems, (v) accident or injuries, (vi)

allergies, (vii) another health problem caused by your work, (viii) none. Multiple answers could be given; we calculated those who declared more than one health problem.

*Days of sick leave due to health problems caused or worsened by the work* were obtained from the question: 'During the last twelve months, how many days were you on sick leave due to health problems caused or made worse by your work or due to an accident at work?', with the possible answers: none, 1 to 3 days, 4 to 15 days, 16 days to 2 months, 2–6 months, more than 6 months to 1 year, you are currently on sick leave and you are not expected to work again. For the purposes of the analysis, we recoded the variable into the categories: (i) none, (ii) 1–3 days, (iii) 4–15 days, (iv) more than 15 days (including the rest of the possible answers).

*Main health and safety risks faced in the workplace* were obtained from the questions: 'In your opinion, what are the main health and safety risks that you face in your workplace?', with the possible answers: (i) exposure to violence or harassment, (ii) exposure to stress, (iii) risks of accidents or serious injuries, (iv) lifting, carrying or moving loads on a daily basis, (v) repetitive movements or tiring or painful positions, (vi) exposure to infectious materials or substances, (vii) exposure to potentially dangerous chemicals, (viii) exposure to noise or vibrations, (ix) other. Multiple answers could be given. We also calculated those who declared more than one health problem.

### Covariates

The covariates used for the study were sex (men/women), age (16–24 years, 25–39 years, 40–54 years, ≥55–70 years), age at the end of education (<15 years, 16–19 years, >20 years, still studying), as a proxy of level of education, and country typology classification based on the welfare regime type (Thevénon, 2011) as follows: Continental area (Austria, Belgium, Germany, France, the Netherlands and Luxembourg), Anglo-Saxon area (Ireland and the United Kingdom), Eastern European area (Croatia, Czech Republic, Estonia, Hungary, Lithuania, Latvia, Poland, Rumania, Bulgaria, Slovenia and Slovakia), Southern European area (Cyprus, Greece, Spain, Italy, Malta and Portugal) and Nordic area (Denmark, Finland and Sweden).

### Statistical analysis

We calculated the percentages of salaried workers with precarious employment according to sex, age, age at the end of the studies and country welfare regime. We compared those percentages using the chi-squared test. Next, we calculated the percentages of non-precarious and precarious employees with health-related outcomes. We fit a multi-level generalized linear model (GLMM) using the Poisson family and country as the random effect, to calculate the crude (cPR) and adjusted (aPR) prevalence ratios with their 95%CI of health-related outcomes according to precarious employment. Moreover, we stratified the adjusted analysis by sex and welfare regime. All analyses included sampling weights for each country (according to the population size). We constructed a directed acyclic graph (DAG) for drawing the associations between precarious employment and health-related outcomes and the relations with the covariates (Figure S1) using DAGitty (Textor, Hardt, & Knüppel, 2011). The confounding variables were obtained from the DAG and were sex, age, age at the end of education, and welfare regime. In order to understand if the exclusion of those with missing values (n = 3,825) may have introduced any bias, we compared the characteristics of the included and excluded individuals. All analyses were conducted using Stata 14.0 statistical software.

## Results

Among those included in the sample, 59.7% were men, 41% were 40–54 years old, 54.3% were aged more than 20 years when finishing their studies and 36.4% were from Continental welfare regime. The proportion of women, younger workers, those with lower ages by the end of the

studies, and the prevalence of infectious diseases, allergies and exposure to carrying or moving loads daily was higher in the participants excluded due to missing values than those included. The prevalence of exposure to stress and noise was higher in the included than excluded individuals (Table S1).

The prevalence of precarious employment in the EU-28 was of 67.1% (Table 1). We found significant differences in the precariousness prevalence according to welfare regime classification, with Eastern European countries with the highest prevalence (72.6%) compared with Nordic countries (51.2%). The prevalence of precarious employment was higher among young workers and among those with fewer years studied, although the differences were not statistically significant (Table 1).

Table 2 shows the associations between precarious employment and health problems caused or worsened by the work. The prevalence of not declaring any health problem was higher in the group without a precarious employment (60.9%) *vs*. the precarious group (43.6%), as was the prevalence of declaring more than one health problem (38.8% *vs*. 55.9%). The association was statistically significant for the entire sample and for men and women (Figure S2). Significant associations were found between having a precarious employment and health problems caused or worsened by the work (stress/depression/anxiety, musculoskeletal problems, infectious diseases, respiratory problems, accidents/injuries and allergies), between 50% and 111% higher, after adjustment for confounder variables (Table 2). When stratifying by welfare regime, the results were in the same line (Table S2). The highest magnitude of the associations for more than one health problem was in the Continental welfare regime [aPR: 1.6, (CI95%: 1.4;1.8)], and the lowest was in Nordic welfare regime [aPR: 1.2, (CI95%: 1.1;1.2)]. When stratifying by sex; the associations for respiratory problems, other health-related problems and allergies were significant for women but not for men (Figure S2).

**Table 1.** Proportion of precarious employment in the EU-28 (2014) salaried workers by sex, age, age at the end of the studies, and country typologies.

| | | No precarious employment (n = 2536) | Precarious employment (n = 5166) | |
|---|---|---|---|---|
| | n | % (CI95%) | % (CI95%) | p-value[a] |
| **Overall** | 7702 | 32.92 (27.87;38.41) | 67.08 (61.59;72.13) | |
| **Sex** | | | | 0.871 |
| *Men* | 4602 | 33.02 (27.98;38.48) | 66.98 (61.52;72.02) | |
| *Women* | 3100 | 32.78 (27.26;38.82) | 67.22 (61.18;72.74) | |
| **Age** | | | | 0.078 |
| *16–24 years* | 537 | 22.49 (14.39;33.38) | 77.51 (66.62;85.61) | |
| *25–39 years* | 2928 | 33.7 (27.75;40.21) | 66.30 (59.79;72.25) | |
| *40–54 years* | 3161 | 33.05 (27.18;39.50) | 66.95 (60.5;72.85) | |
| *55–70 years* | 1076 | 35.65 (30.86;40.74) | 64.35 (59.26;69.14) | |
| **Age at the end of the studies** | | | | 0.659 |
| *<15 years* | 380 | 28.28 (22.14;35.34) | 71.72 (64.66;77.85) | |
| *16–19 years* | 3044 | 33.48 (29.22;38.03) | 66.52 (61.96;70.78) | |
| *>20 years* | 4149 | 33.05 (27.21;39.47) | 66.95 (60.53;72.79) | |
| *Still studying* | 72 | 34.78 (10.48;70.83) | 65.22 (29.17;89.51) | |
| **Country typologies** [b] | | | | 0.027 |
| *Continental* | 2801 | 30.70 (24.92;37.15) | 69.30 (62.85;75.08) | |
| *Anglo-Saxon* | 1208 | 41.49 (40.99;42.00) | 58.51 (58.00;59.01) | |
| *Eastern European* | 1896 | 27.36 (18.66;38.22) | 72.64 (61.78;81.34) | |
| *Southern European* | 1398 | 32.99 (26.13;40.66) | 67.01 (59.34;73.87) | |
| *Nordic* | 398 | 48.83 (42.00;55.70) | 51.17 (44.30;58.00) | |

Note: there are missing values in the variable 'age at the end of the studies'. Precarious employment: defined as the presence of one or more of the following factors: temporariness, do not exercise their rights, vulnerability and disempowerment. [a] p-value obtained with Chi-squared test. [b] Country typologies based on Welfare regime: Continental area (Austria, Belgium, Germany, France, the Netherlands and Luxembourg), Anglo-Saxon area (Ireland and the United Kingdom), Eastern European area (Croatia, Czech Republic, Estonia, Hungary, Lithuania, Latvia, Poland, Rumania, Bulgaria, Slovenia and Slovakia), Southern European area (Cyprus, Greece, Spain, Italy, Malta and Portugal) and Nordic countries (Denmark, Finland and Sweden).

**Table 2.** Association between precarious employment and health problems caused or worsened by the work in the EU-28 (2014).

| | No precarious employment (n = 2536) n (%) | Precarious employment (n = 5166) n (%) | cPR (CI95%) | aPR (CI95%) |
|---|---|---|---|---|
| None | 1543 (60.86%) | 2255 (43.65%) | 0.72 (0.68;0.76) | 0.72 (0.67;0.76) |
| Stress/depression/anxiety | 493 (19.45%) | 1648 (31.90%) | 1.64 (1.29;2.09) | 1.71 (1.38;2.11) |
| Musculoskeletal problems | 508 (20.02%) | 1588 (30.74%) | 1.49 (1.35;1.65) | 1.50 (1.33;1.69) |
| Infectious diseases | 49 (1.95%) | 187 (3.62%) | 2.05 (1.30;3.23) | 2.11 (1.34;3.31) |
| Respiratory problems | 50 (1.97%) | 204 (3.94%) | 2.00 (1.14;3.51) | 2.04 (1.17;3.57) |
| Accidents/injuries | 91 (3.61%) | 361 (6.99%) | 1.98 (1.18;3.35) | 1.95 (1.16;3.28) |
| Allergies | 77 (3.03%) | 266 (5.15%) | 1.66 (1.28;2.16) | 1.68 (1.32;2.14) |
| Others | 105 (4.15%) | 341 (6.61%) | 1.57 (0.91;2.71) | 1.58 (0.93;2.71) |
| One or more | 983 (38.8%) | 2890 (55.94%) | 1.44 (1.33;1.56) | 1.44 (1.34;1.55) |

Abbreviations: cPR: crude Prevalence Ratio, aPR: adjusted Prevalence Ratio. Adjustment variables: sex, age, age at the end of the studies, country typologies.

Note: The 'n' do not sum to 2536 nor 5166 due to multiple answers. Precarious employment: defined as the presence of one or more of the following factors: temporariness, do not exercise their rights, vulnerability and disempowerment.

**Table 3.** Association between precarious employment and sick leave due to health problems caused or worsened by the work in the EU-28 (2014).

| | No precarious employment (n = 2536) n (%) | Precarious employment (n = 5166) n (%) | cPR (CI95%) | aPR (CI95%) |
|---|---|---|---|---|
| None | 671 (68.61%) | 1730 (60.17%) | 0.88 (0.78;1.01) | 0.89 (0.79;1.01) |
| 1–3 days | 95 (9.75%) | 314 (10.90%) | 1.16 (0.58;2.31) | 1.16 (0.63;2.11) |
| 4–15 days | 127 (12.99%) | 441 (15.32%) | 1.18 (0.77;1.79) | 1.16 (0.75;1.77) |
| >15 days | 84 (8.64%) | 391 (13.60%) | 1.46(1.11;1.91) | 1.43 (1.09;1.87) |

Abbreviations: cPR: crude Prevalence Ratio, aPR: adjusted Prevalence Ratio. Adjustment variables: sex, age, age at the end of the studies, country typologies.

Note: The 'n' do not sum to 2536 nor 5166 due to missing values in the variable sick leave. The category '>15 days' include four individuals that declare not being able to work again. Precarious employment: defined as the presence of one or more of the following factors: temporariness, do not exercise their rights, vulnerability and disempowerment.

Table 3 shows the associations between precarious employment and sick leave due to health problems caused or worsened by the work. A significant association was found between having a precarious employment and sick leave of more than 15 days [aPR: 1.4, (CI95%: 1.1;1.9)], being statistically significant for women but not for men (Figure S3). Non-significant associations were found between precarious employment and any kind of sick leave of less than 15 days. When stratifying by welfare regime, the highest magnitudes of the association for sick leave of more than 15 days was in Nordic welfare regime compared to the continental (Table S2).

Table 4 shows the associations between precarious employment and the main health and safety risks faced in the workplace. The prevalence of declaring exposure to more than one health and safety risks was higher in the precarious group (93.5%) than in the non-precarious group (87.7%). Precarious employment was significantly associated with exposure to violence or harassment [aPR: 1.8, (CI95%: 1.4;2.3)]. Borderline associations were found between precarious employment and exposure to stress [aPR: 1.1, (CI95%: 0.9;1.4)], being significant among women (Figure S4) and exposure to repetitive movement or painful positions [aPR:1.1, (CI95%: 0.9;1.1)], being significant among men (Figure S4). When stratifying by welfare regime, the highest magnitudes of the association for exposure to violence was in Southern welfare regimes compared to the Anglo-Saxon (Table S2).

## Discussion

### *What this study adds*

To our knowledge, this is one of the largest studies describing the association between precarious employment using a multidimensional approach and health-related outcomes in the European

**Table 4.** Association between precarious employment and the main health and safety risks faced in the workplace in the EU-28 (2014).

| | No precarious employment (n = 2536) n(%) | Precarious employment (n = 5166) n(%) | cPR (CI95%) | aPR (CI95%) |
|---|---|---|---|---|
| Exposure to violence | 217 (8.55%) | 723 (13.99%) | 1.75 (1.33;2.30) | 1.82 (1.42;2.34) |
| Exposure to stress | 1287 (50.77%) | 2999 (58.04%) | 1.15 (0.97;1.35) | 1.15 (0.98;1.37) |
| Risk of accidents or serious injuries | 479 (18.88%) | 1077 (20.86%) | 1.11 (0.88;1.41) | 1.08 (0.87;1.36) |
| Carrying or moving loads daily | 531 (20.96%) | 1274 (24.66%) | 1.19 (0.97;1.47) | 1.11 (0.94;1.32) |
| Repetitive movement or painful positions | 670 (26.42%) | 1444 (27.96%) | 1.04 (0.97;1.12) | 1.07 (0.99;1.15) |
| Exposure to infectious materials | 182 (7.18%) | 523 (10.12%) | 1.47 (1.23;1.75) | 1.46 (0.88;1.25) |
| Exposure to chemicals | 268 (10.55%) | 596 (11.54%) | 1.06 (0.93;1.21) | 1.05 (0.88;1.25) |
| Exposure to noise | 457 (18.03%) | 1082 (20.94%) | 1.14 (0.91;1.42) | 1.15 (0.94;1.41) |
| Others | 143 (5.64%) | 415 (8.04%) | 1.45 (0.94;2.25) | 1.47 (0.95;2.26) |
| One or more | 2223 (87.66%) | 4832 (93.54%) | 1.07 (1.01;1.13) | 1.03 (1.01;1.13) |

Abbreviations: cPR: crude Prevalence Ratio, aPR: adjusted Prevalence Ratio. Adjustment variables: sex, age, age at the end of the studies, country typologies.

Note: The 'n' do not sum 2536 neither 5166 due to multiple answers. Precarious employment: defined as the presence of one or more of the following factors: temporariness, do not exercise their rights, vulnerability and disempowerment.

Union. We found that precarious employment is associated with several health problems caused or worsened by the work, with sick leave of more than 15 days and with being exposed to violence or harassment.

The associations found in our study are in the same direction as previous scientific evidence. Previous studies have described that precarious employment is associated with poor physical (Keuskamp, Ziersch, Baum, & LaMontagne, 2013) and mental health (Canivet et al., 2016), depressive symptoms (Jang et al., 2015; W. Kim et al., 2016), psychological distress (Kachi, Otsuka, & Kawada, 2014), women remaining childless until the age 35 (Steele et al., 2017), suicidal ideation (Min, Park, Hee, & Min, 2015) and lower use of annual health check-ups (Inoue, Tsurugano, Nishikitani, & Yano, 2012). The main difference between those studies and our study is the way precarious employment was measured. We have used a multidimensional approach that accounts for almost all the precariousness characteristics, in contrast to studies that have used a unidimensional approach to define precariousness (having a part-time job, contingent job, fixed-term job, dispatched workers, casual job, other job than waged by their employers, temporary agency contract). Therefore, the magnitude of the associations described in the previous studies could be underestimated.

### *Precarious employment and health-related outcomes*

We found that the prevalence of suffering stress/depression/anxiety, musculoskeletal problems, infectious diseases, respiratory problems, accidents/injuries and allergies was higher in precarious employees. Few studies have previously described the association between precarious employment measured from a multidimensional construct and poor-self rated health (Benach et al., 2015) and mental health (Julià, Vives, Tarafa, & Benach, 2017). Although precarious employment is a social determinant of health, the mechanisms through it affects the health of the workers are not clearly understood. However, we know that precariousness is defined by job insecurity, feelings of powerlessness, low wages and limited social protection, characteristics that have been described previously to increment the risk of developing negative health-related behaviours, as well as producing detrimental psychological and physio-pathological changes leading to poorer health status (Ferrie et al., 2008; Virtanen et al., 2013). Moreover, precarious employees would suffer from social deprivation which is linked with other social determinants of health such as access to health care, adverse

lifestyles, or detrimental housing conditions (Benach et al., 2014). Therefore, the mechanisms through which precariousness could affect the health are multiple, and further studies are needed to understand better this social determinant of health.

We found an association between precarious employment and sick leave of more than 15 days. Our results are in line with one previous cross-sectional study that used data from Denmark, Finland, Norway and Sweden from 2010 (n = 4186) (Oke, Braithwaite, & Antai, 2016). This study found that three precarious employment indicators were positively associated with sickness absence (absence from work due to illness 7 days or more within the last 12 months) (Oke et al., 2016). Therefore, the association found in our study supports the evidence that precarious employees suffer from a poorer health status. Furthermore, we did not find any association between precarious employment and sick absence of less than 15 days. This could be explained because precarious employees do not have access to collective bargaining (limited social protection) and suffer from job insecurity, and therefore they would just have considered sickness absence when the illness is severe. Therefore, we hypothesize that presenteeism (an employee attending to work even when they fell too ill to work effectively) (Eurofound, 2010) would be common among precarious jobs. For these reasons, we believe that the leave of less than 15 days could be underestimated among precarious employment workers. Moreover, in our study, we describe that precarious employees have in absolute terms 5% more sick leave of more than 15 days than non-precarious employees. Thus, taking into account that 66% of the salaried working population in the European Union (355 million) is precarious, 11.7 million of precarious employees in the EU would take a sick leave of more than 15 days. This may have direct (salary of the absent employee) and indirect (productivity, administration, quality of service, social security) costs (Eurofound, 2010).

We describe that the prevalence of being exposed to violence and harassment, stress and repetitive movements or painful positions in the workplace was higher among precarious employees. Our results provide epidemiological evidence for one of the theoretical pathways that would link the precariousness with poor health; to be exposed to hazardous working conditions (Benach et al., 2014). It has been hypothesized that precarious employees would be exposed to detrimental physical (e.g. high physical workload, toxic substances) and psychosocial (low social support and low control) working conditions and weaker safety measures (Benach et al., 2014; Kachi et al., 2014) and that may have health consequences.

### *Prevalence of health-related outcomes by gender*

Some of the associations were significant for women and borderline or not significant for men. This suggests that precarious employment might affect women and men, but when employment conditions interact with gender, those would be more damaging for women (Menéndez, Benach, Muntaner, Amable, & O'Campo, 2007). That may be explained by the low level of trade union involvement in the 'feminized fields' and the lack of representation of women's interests in the labour movement (Ledwith, 2012). Also, driven by the patriarchy and the breadwinner model, and according to the 'human capital theory', women bear greater burden of household responsibility and housework than men, and that may push them to accept non-standard arrangements to facilitate their work–life balance (Artazcoz, Cortès-Franch, Escribà-Agüir, López, & Benavides, 2018; Hašková & Dudová, 2016), and possible by gendered divisions in the labour market (occupational gender segregation), which tend to exclude women from jobs characterized by better working conditions and greater prestige (Bettio & Verashchagina, 2009).

### *Prevalence of health-related outcomes by welfare regime*

Finally, we compared the proportion of precariousness according to welfare regime; being higher among Eastern, Southern and Continental welfare regimes. Further, the prevalence of health problems and exposure to some risks was more strongly associated to precarious employment in

Continental, Anglo-Saxon and Eastern European welfare regimes, while the prevalence of sick leave of more than 15 days was more strongly associated with precariousness in Nordic welfare regimes. That may be explained because in Nordic welfare regimes, active labour policies, and reliable social protection are the norm, while in the other welfare regimes, social protection regulation is weak or highly fragmented, and labour policies follow principles of neoliberalism (Artazcoz et al., 2018; Dragano, Siegrist, & Wahrendorf, 2010). More specifically, welfare regime may protect the health damage of hazardous work conditions through sickness absence compensation, active labour market policies, generous out-of-work benefits, higher minimum wages, taxation-financed service provision (care for children and the elderly to reduce the work–life balance conflicts) and greater power for labour unions (Bambra, Lunau, Van Der Wel, Eikemo, & Dragano, 2014). Based on previous research of the impact of liberalization of the markets, in the case of post-socialist EU member states (classified as Eastern European Welfare regimes), the transition resulted in a decline in unionization and in higher levels of perceived job insecurity (Dixon, Fullerton, & Robertson, 2013). Given that different measures/reforms were undertaken during the economic crisis (employment protection legislation, unemployment benefits, wage setting) in some of the countries of the European Union, this may have exacerbated the proportion of precariousness and its health effects (Escribà-Agüir & Fons-Martinez, 2014). Specifically, the largest changes occurred in the southern European countries, which suffered the most severe shocks in terms of GDP (Gross Domestic Product) and unemployment, and therefore adopted more structural measures (employment protection, criteria for unemployment benefits and structure of the collective bargaining system). Also, Ireland suffered from structural measures, but, as it can be observed through the OECD's employment protection index, the index from southern European countries declined considerably between 2008 and 2013, and instead, for Ireland there was almost no change, because the labour markets were already flexible before the crisis for this country (Izquierdo et al., 2017). Changes in the time of adoption of measures for the economic crisis according to each country may explain also the differences found. During the initial phases of the crises (2007–10) many countries adopted measures to maintain employment, but as the crisis progressed, some countries had to apply more in-depth reforms. As in this study, we are using data from 2014, we could be observing the possible effects of the applied reforms by some countries during the initial phases of the crises, but not those that were undergone subsequently.

### *Measures for reducing precarious employment and its impact on society*

Precarious employment has a negative impact on society in several ways. Precarious employment would have an impact on the health status of the workers and in their relatives and in the economy of the country, derived from the costs from health assistance and sick leaves. Hence, we recommend to prioritize some of the legislative measures proposed by the ILO (ILO, 2016). On one hand, measures to reduce the non-standard arrangements through preventing abuses in its use (seen as cheaper alternatives or for evading responsibilities), that address employment status misclassification (the classification defines the protection of the worker), and limit the renewals or overall duration of the contracts. On the other hand, measures are also needed to improve the quality of the jobs with non-standard arrangements through removing the legal barriers for equal treatment between non-standard and standard employment arrangements, according to minimum hours and other safeguards, and ensuring the freedom of association and collective bargaining.

### *Limitations of this study*

This study has some limitations. First, we cannot rule out the self-report bias as the data was obtained from a questionnaire. Next, the variable precariousness did not account for the dimensions 'rights' and 'wages', and that may have underestimated the precariousness prevalence and partially the magnitude of the associations found. Moreover, previous studies have suggested that

suffering from health problems may reduce the chance of achieving a good position in the labour market, thus leading into higher probabilities of being a precarious employee (Virtanen et al., 2005). Therefore, as this is a cross-sectional study, the direction of the association cannot be determined. To identify the direction of any causal relationships, longitudinal studies are needed. The proportion of those excluded due to missing values was higher in women, younger workers and those with lower educational level. This may have underestimated the proportion of precarious employment, as those groups have been described the most vulnerable for suffering from precarious employment (Committee on Employment and Social Affairs, 2016). However, we did not find a clear pattern of differences in the proportions of health-related outcomes between the excluded and included individuals, so the magnitude of the associations shown would not be biased. Further, we used the variable age at the end of the education as a proxy of level education which could have misclassified those individuals that interrupted their education as 'higher level of education' being not necessarily the case. Nevertheless, this study accounts for a huge sample size in comparison with previous studies (Oke et al., 2016; Vives et al., 2013), using data from salaried workers of the 28 European Union countries and using a multidimensional construct of precarious employment. Similar efforts for monitoring employment conditions may be at play in other regions of the world (Rodríguez-Loureiro, Vives, Franzoni Franzoni, & López-Ruiz, 2019). We believe that the use of a validated scale for measuring precariousness, for the entire European Union and other regions is necessary to monitor employment quality.

## Conclusion

In conclusion, our study shows an association of precarious employment, understood as a multidimensional construct, and negative health-related outcomes and sick leave of more than 15 days. Therefore, we recommend prioritizing legislative measures for reducing non-standard arrangements and for improving the conditions of workers at non-standard arrangements.

## Disclosure statement

No potential conflict of interest was reported by the authors.

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# 5.3. Paper III

**Precarious Employment, Unemployment and their association with health-related outcomes in 35 European countries: a cross-sectional study.**

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**Abstract**

Though work and paid employment are generally beneficial, and unemployment is frequently harmful, precarious employment relations are also health damaging. This study compared the health status of workers high precariously employed with unemployed individuals in 35 European countries. We used data from the 6th European Working Conditions Survey (2015) (n=33938). We fitted a multi-level generalized linear model (GLMM), using the Poisson family and country as the random effect, to calculate the adjusted prevalence ratios (aPR) of health related outcomes according to quartiles of precariousness and unemployment, having as reference the not precariously employed workers. In addition, we calculated the aPR of health related outcomes in high precariously employed (quartile 4 of precariousness), having as reference the unemployed individuals. We found associations of higher prevalence of bad health status, headache, skin and hearing problems, anxiety, fatigue, backache, upper and lower muscular pain and injuries among quartiles 3 and 4 of precariousness compared with not precariously employed workers. The confidence intervals of the aPR for most of health-related outcomes overlapped between the highest quartiles of precariousness and recent unemployed individuals. We conclude that unemployment and higher degrees of precariousness could be similarly health damaging. Therefore, we propose that employment conditions should be better monitored. This is an essential first step in order to document, and identify interventions to prevent the health damaging consequences of growing levels of precarious employment. This will be essential for achieving the 8th sustainable development goal of decent work and economic growth by 2030.

**Keywords:** Employment conditions; Social determinants of health; Precarious Employment; Europe.

## INTRODUCTION

Work meets important psychosocial needs in societies where employment is the norm. It is central to individual identity, social roles and social status, and it is essential for material well-being (Waddell & Burton, 2007). Unemployment has been consistently correlated to poor health. It has been linked with all-cause mortality risk in men (Clemens, Popham, & Boyle, 2015), stomach cancer mortality (Maruthappu et al., 2014), mortality before the age of 70 years (Nylén, Voss, & Floderus, 2001) and suicide (Cylus, Glymour, & Avendano, 2014; Milner, Page, & LaMontagne, 2014; Milner, Page, & LaMontagne, 2013; Norström & Grönqvist, 2014). Also, the health effects of unemployment follow a social gradient; individuals from low social class declare worse poorer self-reported health (Norström, Virtanen, Hammarström, Gustafsson, & Janlert, 2014). Further, to be unemployed has been associated with poverty and social exclusion (Bambra, 2011). The prevalence of unemployment (defined by Eurostat as someone aged 15/16 to 74 years, without work during the reference week, available to start work within the next two weeks and actively having sough employment at some time during the last four weeks) in the European Union (EU) in 2017 was 8.7% (Eurostat, 2018). Decent work is productive, delivers a fair income, security in the workplace, social protection for families, and freedom for people to express their concerns, organize and participate in the decisions and ensures equality of opportunity and treatment for all women and men (ILO, 2019). Though work and paid employment are generally beneficial for physical and mental health and well-being, and unemployment is frequently harmful, employment relations that deviate from 'decent work' also are harmful (Benach, Muntaner, & Santana, 2007).

Since the mid-1970s, there have been changes in the structure of the labour markets of most industrialized neoliberal countries. Driven by an economic downturn, labour markets required a flexible work-force and transformed standard employment relationship (full-time and stable employment, where employees have collective bargaining power) to non-standard and atypical employment relationships (Bosch, 2004). Precarious employment has its origin in the flexibilization of the labour market (Standing, 2014). Precarious employment has been defined as an employment condition that includes characteristics such as employment insecurity (uncertainty regarding the continuity of employment), minimal worker control (powerlessness to influence wages, pace of work and working conditions), low wages and limited social protection (work not protected by law or collective agreements) (Benach, Vives, Tarafa, Delclos, & Muntaner, 2016). Precariousness has been associated previously with poor mental health and poor self-rated health, following a positive dose-response pattern (the higher the precariousness, the worse the health status) (Julià, Vanroelen, Bosmans, Van Aerden, & Benach, 2017). A study using a multidimensional approach for measuring precariousness estimated that two out of three salaried workers from the EU were precariously employed in 2014, eight years into the global crisis (Matilla-Santander et al., 2018). Furthermore, precariousness is socially distributed, disproportionately affecting those with vulnerable labour market profiles, such as women, youth, immigrants, those in lower social classes and less-educated workers, both in its prevalence and in its health damage (Julià et al., 2017).

The great recession of 2008 had important consequences for labour markets and worsened trends in non-standard employment relationships (Standing, 2014). For instance,

unemployment rates (people unemployed as a percentage of the labour force) in the EU increased from 7.2 in 2007 to 10.22 in 2014 (Eurostat, 2018). Further, jobseekers accepting atypical employment arrangements such as temporary agency work, fixed-term work, zero hours contracts increased in the years following the crisis (Committee on Employment and Social Affairs., 2016). The crisis was followed by the austerity era, which worsened the consequences of market flexibilization (Standing, 2014). Several austerity measures were implemented in Europe for making their markets more 'competitive', such as changes in employment protection legislation, unemployment benefits, etc. (Izquierdo et al., 2017).

Previous studies have already questioned whether a "bad quality" job or being unemployed is more damaging for health. Poor psychosocial working conditions, particularly perceived job insecurity, have been associated with several health outcomes. In most of cases, only moderate differences were found in the magnitude of the associations between health outcomes and either unemployment or bad quality jobs (Broom et al., 2006; Butterworth, Leach, McManus, & Stansfeld, 2013; Kim & Knesebeck, 2015; Mohammad Ali & Lindström, 2006; Rueda et al., 2015). However, these studies analysed poor quality jobs through a unidimensional approach, and employment relations are far more complex. Therefore, to facilitate understanding how the employment characteristics affect the health, we propose using a multidimensional approach for measuring precariousness (J. Benach et al., 2016). Evidence from unidimensional approaches states that low quality jobs are similarly health damaging to being unemployed. Therefore, we hypothesize that the health status of highly precarious employed workers (taking into account many employment characteristics) and

unemployed individuals will be similar or even worst among the precariously employed workers. Our aim is to compare health-related outcomes in high precariously employed and unemployed individuals in 35 European countries in 2015.

## METHODS

### Study population and data collection

This is a cross-sectional study based on a secondary analysis from the 6th European Working Conditions Survey (EWCS). The 6th EWCS was carried out by the European Foundation for the Improvement of Living and Working Conditions (Eurofound) between February and December 2015 (Eurofound, 2017). The survey included 43,850 individuals in 35 European countries: the EU28; the five candidate countries for EU membership (Albania, the Former Yugoslav Republic of Macedonia (FYROM), Montenegro, Serbia and Turkey); Norway; and Switzerland. In each country, a multistage stratified random sampling design was used. The survey interviews were carried out face-to-face using computer-assisted personal interviewing (CAPI) at respondents' homes. The sample used in the EWCS is representative of those aged 15 and over (16 and over in Bulgaria, Norway, Spain and the UK) living in private households and in employment (invited participants should have been working for at least 1 hour for payment in the last week).

For the purposes of the present study, we excluded: those who declared as self-employed (due to the lack of questions related to employment quality in self-employed that could be used to construct the different dimensions of precariousness); those unable to work due to long-term illness or disability; those at work on child-care leave or other leave; the retired; full time homemakers/those responsible for shopping and looking after the home;

those in full time education (at school, university, etc.); and those <16 or >65 years old. Therefore, the final sample for this study was n=33938. Of these 13663 were workers not precariously employed, 20022 were precariously employed and 253 were recently unemployed.

**Study variables**

*Exposure variables*

The *precarious employment* variable was conceptualized as a multidimensional construct (Vives et al., 2010). We constructed the variable based on five dimensions (temporariness, not being able to exercise rights, vulnerability, disempowerment and wages) defined from several questions (items). From these items, a score was given (i.e. when zero items were present the score given was zero, when three items were present, the score given was three). As each dimension was constructed from a different number of items, the scale range varied and we transformed the scales into 0-4 for all the dimensions. Next, we summed the five factors, calculated the arithmetic mean of precariousness and defined quartiles of precariousness (quartile 1 the lowest precariousness scores and the quartile 4 the highest) (Supplemental Material Table S1). The punctuation range for each quartile of precariousness was; quartile 1: (0.11-1.01), quartile 2: (1.02-1.32), quartile 3: (1.33-1.68) and quartile 4: (1.69-3.72). *Not precariously employed* workers were those that declared to be working but did not have any item of precariousness. *Unemployed* individuals were those who self-identified as such (n=253), which have been working for at least 1 hour for payment in the last week, so they were recently unemployed.

*Outcome variables*

The *bad health status* variable was constructed from the question: "How is your health in general? Would you say it is…", with the possible answers "very good, good, fair, bad, very bad". We dichotomized the variable as bad health status: no (very good or good) and yes (fair, bad or very bad).

The *health problems* variables were constructed from the question: "Over the last 12 months, did you have any of the following health problems?", with the possible multiple answers: (i) hearing problems, (ii) skin problems, (iii) backache, (iv) muscular pains in shoulders, neck and/or upper limbs (arms, elbows, wrists, hands, etc), (v) muscular pains in lower limbs (hips, legs, knees, feet, etc), (vi) headaches, eyestrain, (vii) injury(ies), (viii) anxiety, (ix) overall fatigue.

*Covariates*

The *covariates* used for the study were sex, age (16-29 years, 30-49 years, 50-65 years), country of origin (native, foreign-born), education level (primary education, secondary and tertiary education, university studies or more) and country typology classification based on the welfare regime type (Thevénon, 2011) as follows: Continental area (Austria, Belgium, Germany, France, the Netherlands, Luxembourg, Switzerland), Anglo-Saxon area (Ireland and the United Kingdom), Eastern European area (Croatia, Czech Republic, Estonia, Hungary, Lithuania, Latvia, Poland, Rumania, Bulgaria, Slovenia, Slovakia, Montenegro, FYROM, Serbia, Albania), Southern European area (Cyprus, Greece, Spain, Italy, Malta, Portugal, Turkey) and Nordic area (Denmark, Finland, Sweden, Norway).

**Statistical Analysis**

We calculated proportions and their 95%CI of being precariously employed in quartiles according to sex, age, country of origin, education level and welfare regime. We calculated the prevalence with their 95%CI of health related outcomes in workers not precariously employed, precariously employed (overall and in quartiles) and unemployed individuals. We constructed a Directed Acyclic Graph (DAG) for representing the associations between employment status (precarious or not and unemployed) and health related outcomes and the relations with the covariates (see Figure S1. Supplemental Material) using 'DAGitty' (Textor, Hardt, & Knüppel, 2011). According to the DAG, the sufficient adjustment variables for estimating the total effect of the employment conditions on the health outcomes were; sex, age, educational level and welfare regime.

Given the high prevalence of the health outcomes, we calculated adjusted prevalence ratios (aPR). We fit a multi-level generalized linear model (GLMM), because the data used has a grouping structure (each country), using the Poisson family with robust variance estimator and country as the random effect, to calculate the adjusted prevalence ratios (aPR) with their 95%CI of health related outcomes according to quartiles of precariousness and unemployment, having as reference the not precariously employed workers (Espelt, Olmo, Penelo, & Bosque-Prous, 2017). We obtained a statistical power of 89% for recognizing as statistically significant a difference of 10% in the prevalence of any health outcome between the unemployed and the not precariously employed workers (accepting an alpha risk of 0.05 in a two-sided test).

As higher degrees of precariousness have been associated with worse health outcomes (Benach et al., 2010), we calculated the aPR with their 95%CI of health related outcomes for workers from quartile 4 of precariousness, having as reference the unemployed individuals (Espelt et al., 2017). We obtained a statistical power of 88% for recognizing as statistically significant a difference of 10% in the prevalence of any health outcome between the quartile 4 of precariousness and the unemployed (accepting an alpha risk of 0.05 in a two-sided test).

We assessed the goodness of fit of the models in the data through quantile-quantile plots (Q-Q plots). We plotted the quantile deviances residuals against the fitted linear predictors for each model (figure S2 and figure S3). The plots showed a binomial distribution of the residuals against the linear predictors; therefore, the models fitted well the data.

All analyses included country-level post-stratification weights subsequently corrected for the size of the in-work population per country for all countries in the survey. We conducted all analyses using Stata 14.0 statistical software.

**RESULTS**

Table 1 shows the proportion of precariously employed workers (in quartiles) and unemployed individuals. We observed that the proportion of women from the quartiles 3 and 4 of precariousness was slightly higher than in men. We noted a decreasing proportion of precariousness (from the quartile 4 to 1) in workers aged 50 to 65 years; a higher proportion of workers aged 16 to 29 years in quartile 4 of precariousness; and an increasing proportion of precariousness (from quartile 1 to 4) in those with only a primary education level and those working in Eastern and Southern European welfare regimes.

Table 2 shows the prevalence of health outcomes among not and precariously employed workers (overall and quartiles), and unemployed individuals. Higher quartiles of precariousness were associated with higher prevalence of self-perceived poor health status, skin problems, headaches or eyestrain, anxiety, fatigue, backache, muscular pain in upper and lower limbs and injuries. Nine out of ten health related outcomes were more common in individuals high precariously employed (quartile 4) than in unemployed. We did not find any clear differences according to the covariates (data not shown).

Figure 1 shows the adjusted prevalence ratios (aPR) of health-related outcomes for precariously employed workers and the unemployed, with workers not precariously employed as the reference category. We found clear associations of higher prevalence of bad health status, headache, skin and hearing problems, anxiety, fatigue, backache, upper and lower muscular pain and injuries among high precariously employed (quartiles 3 and 4) compared with those not precariously employed individuals. Also, the CI95% of the aPR for all health-related outcomes overlapped between the high precariously employed (quartile 4) and unemployed, indicating no differences among these groups.

Figure 2 shows the aPR of health-related outcomes in high precariously employed workers (quartile 4) compared to unemployed individuals. We found that high precariously employed had higher prevalence of muscular pain in upper limbs (aPR:1.26, CI95%:1.10;1.44) and fatigue (aPR:1.18, CI95%:1.01;1.38) than unemployed individuals. We describe borderline associations for headaches (aPR:1.14, CI95%:0.96;1.36), backache (aPR:1.13, CI95%:0.97;1.33), muscular pain in lower limbs (aPR:1.09, CI95%:0.93;1.27) and injuries (aPR:1.56, CI95%: 0.99;2.47).

## DISCUSSION

To the best of our knowledge, this is the first study done in 35 European countries that compares self-declared health outcomes among precariously employed workers with unemployed individuals. We found evidence that unemployment and higher degrees of precariousness are similarly health damaging.

### Precarious employment proportion

We report a proportion of precarious employment of 58.9% among 35 European countries for the year 2015. Previous studies describe a prevalence of precariousness as 42.6% (2010) in Catalonia, Spain (Benach et al., 2016). These differences may be explained by the way precariousness was measured. The previous studies (Benach et al., 2016) used a validated Employment Precariousness Scale (EPRES) while our study used a construct of several items. Differences could also be due the different populations included (Catalonia (Spain) *vs*. 35 European Countries) and years when the research was conducted (2010 *vs*. 2015). Our results are in the same line as other studies done in the European Union (Eurofound, 2013; Puig-Barrachina et al., 2014), in which they describe worst scores of employment quality (proxy indicators of employment precariousness) in women, primary educational level workers and Eastern and Southern European welfare regimes.

### Health outcomes among workers with precarious employment and unemployed individuals

One previous cross-sectional study analysed how different labour market positions were associated with self-perceived health in Belgium between 2008-2010 (n=4377) (Van

Aerden, Gadeyne, & Vanroelen, 2017). They described that, compared with standard jobs, the unemployed and precariously employed individuals (measured through a multidimensional construct) declared the worst self-perceived health, with the prevalence of worst self-perceived health slightly higher among unemployed (Van Aerden et al., 2017). In our study, recent unemployed individuals also more frequently reported worse self-perceived health status, but not other outcomes.

It is important to point that for the adjusted comparisons of health-related outcomes prevalence between unemployed and precariously employed individuals, the confidence intervals overlapped. Therefore, even though the magnitude of the observed difference was in general higher among high precariously employed workers, there were not differences with the recently unemployed individuals. That is, the health status of those unemployed, which has been described as the most harmful labour market condition (Tøge & Blekesaune, 2015; Van Aerden et al., 2017), could be as detrimental to health as precariousness. Our results would support that precarious employment is an important social determinant of health, which may have an important health impact among all European individuals.

Moreover, we described that low precariously employed workers (quartile 1) reported bad health status, fatigue, backache and lower muscular pain less frequently than not precariously employed workers. That may be explained by several reasons. First, the reference group "no-precarious employment" may include employment relationships of varying quality. For example, it may include individuals working under standard employment relationships (SER) (of really good quality), and also, other kind of relationships such as "instrumental job type" or "portfolio job type" (Van Aerden, Moors,

Levecque, & Vanroelen, 2014). Both of these job types have contract stability and provide fair income, but they cannot be classified as standard employment relationships. In the case of instrumental job type, they have limited probability for receiving non-wage benefits, training or being allowed flexible working times. Portfolio jobs are defined by exhausting working times (irregular and very long working hours) together with contract stability, high income and multiple non-wage benefits. Therefore, it could be possible that individuals working under instrumental or portfolio jobs conditions have reported worse health outcomes than low precariously employed workers. Second, we could not take into account other variables (not covered by the questionnaire) that could partially explain how the precarious employment affects the health. These include socioeconomic status, years working under the same employment conditions, and social support. Third, we could not take into account the sixth dimension proposed for measuring precarious employment, that is, the dimension 'rights', as the survey did not include enough questions referring to that. We may therefore have underestimated the relation between health outcomes and lower levels of precariousness.

**Mechanisms of unemployment and precarious employment**

Precarious employment has been hypothesized to affect the health of workers through three main pathways, one direct and two indirect. The direct pathway would be through psychological effects produced by uncertainty, unfairness, and powerlessness; the indirect ones through exposure to detrimental physical and psychological working conditions, and material deprivation (social and material living conditions) (Julià et al., 2017). Unemployment has also been described to affect health through psychological effects of uncertainty and material deprivation (Bartley, 1994). Hence, the results of our

study support the argument that the mechanisms through which unemployment and precariousness affect health may be similar.

**Strengths and limitations of this study**

This study has some limitations. First, we did not have information for individual variables that may be necessary for explaining the effect of employment conditions on health status, such as time in employment condition and unemployment compensation. Possibly, long period of exposure to unemployment either precariousness may have a more detrimental effect on health status. Similarly, to receive unemployment benefits has been described to ameliorate the impact of the unemployment in the health (Cylus et al., 2014; Cylus, Glymour, & Avendano, 2015; F. Norström et al., 2014). However, we included the variable "unemployment compensation" as an unobserved variable in our DAG, that is, a variable not measured, and it turned to do not be necessary for estimating the total effect of employment on the health outcomes.

Further, the measurement of unemployment has some limitations. First, the data used is representative of the working population in Europe, but it is not for the unemployed. Moreover, unemployed individuals included in this study are recently unemployed, and are those that declared that "unemployment" was the situation that described themselves best. But, that may include several options; (i) part-time unemployment, in the case of Belgium, part-time workers are eligible for unemployment benefits, (ii) recent full time unemployed, (iii) individuals working in different NSE arrangements (on-call work). Therefore, future studies could replicate our results by comparing PE workers with unemployed individuals, taking into account that they include short and long-term

unemployed, who receive unemployment benefits or not, and exclude individuals who have recently been working on NSE arrangements.

Next, though self-report bias is likely from data obtained from a questionnaire, trained personnel conducted all the interviews face-to-face. We could not include the dimension "rights" in the precariousness definition, and that could have underestimated the precarious employment prevalence and partially the magnitude of the associations found. Most importantly, given the design of the study, we cannot rule out reverse causation, as previous studies have suggested that suffering from health problems may reduce the chance of achieving a good position in the labour market, thus leading into higher probabilities of being a precarious employee (Virtanen et al., 2005). Therefore, further longitudinal studies are needed to assess the direction of causation. Nevertheless, it should be noted that this is the first study done in 35 European countries, with a large sample size and detailed data on the reported health status of precariously employed workers and unemployed individuals.

## CONCLUSION

We found that both unemployment and higher degrees of precariousness are similarly health damaging. Therefore, we purpose that employment conditions should be better monitored. This is an essential first step in order to document, and identify interventions to prevent the health damaging consequences of growing levels of precarious employment. This will be essential for achieving the 8th sustainable development goal of decent work and economic growth by 2030.

## Conflicts of Interest

The authors declare no conflicts of interest.

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**Table 1. Proportion of precariously (quartiles), not precariously employed and unemployed individuals by socio-economic variables in Europe, 2015 (n=33938).**

| | | No-precarious employment n= 13663 | Precarious employment n=20022 | | | | Unemployed n=253 |
|---|---|---|---|---|---|---|---|
| | | | Quartile 1 N=5368 | Quartile 2 N=5269 | Quartile 3 N=4616 | Quartile 4 N=4769 | |
| | n | % (CI95%) | % (CI95%) | % (CI95%) | % (CI95%) | % (CI95%) | % (CI95%) |
| **Overall** | 33938 | 40.26 (34.10;46.74) | 15.82 (10.76;22.65) | 15.52 (13.25;18.10) | 13.60 (11.74;15.71) | 14.05 (11.19;17.50) | 0.75 (0.49;1.12) |
| **SEX** | | | | | | | |
| ***Men*** | 17649 | 39.12 (32.56;46.09) | 17.27 (12.59;23.22) | 15.45 (13.12;18.12) | 13.51 (11.94;15.25) | 13.90 (11.04;17.36) | 0.75 (0.43;1.29) |
| ***Women*** | 16283 | 41.49 (35.33;47.94) | 14.25 (8.66;22.56) | 15.60 (13.14;18.42) | 13.71 (11.49;16.27) | 14.20 (11.24;17.79) | 0.74 (0.52;1.07) |
| **AGE** | | | | | | | |
| ***16-29*** | 6700 | 41.86 (34.67;49.42) | 12.57 (7.82;19.61) | 13.09 (10.89;15.66) | 12.61 (10.89;14.55) | 18.97 (12.70;27.37) | 0.89 (0.50;1.59) |
| ***30-49*** | 17836 | 39.93 (33.87;46.30) | 15.63 (10.98;21.77) | 15.78 (13.23;18.72) | 13.96 (12.25;15.87) | 14.10 (11.68;16.92) | 0.60 (0.39;0.93) |
| ***50-65*** | 9402 | 39.75 (33.54;46.30) | 18.48 (12.09;27.21) | 16.77 (14.91;18.83) | 13.63 (10.20;17.98) | 10.46 (8.39;12.96) | 0.91 (0.58;1.42) |
| **COUNTRY OF ORIGIN** | | | | | | | |
| ***Native*** | 1439 | 33.17 (24.78;42.80) | 18.45 (11.94;27.40) | 14.90 (12.66;17.46) | 14.59 (10.81;19.39) | 18.21 (10.09;30.64) | 0.68 (0.25;1.84) |
| ***Foreign-born*** | 2814 | 39.06 (35.24;43.02) | 15.35 (8.64;25.79) | 14.89 (12;18.34) | 12.53 (10.41;15.02) | 17.17 (13.16;22.09) | 1 (0.61;1.64) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **EDUCATION LEVEL** | | | | | | | |
| ***Primary education*** | 1269 | 58.05 (45.05;70.02) | 4.27 (3.17;5.72) | 9.46 (7.31;12.15) | 9.74 (7.57;12.44) | 16.41 (9.86;26.06) | 2.08 (0.99;4.31) |
| ***Secondary and tertiary education*** | 24255 | 39.36 (32.88;46.24) | 13.98 (9.23;20.61) | 15.97 (13.36;18.98) | 14.74 (12.58;17.19) | 15.12 (12.32;18.42) | 0.83 (0.56;1.23) |
| ***Unversity studies or more*** | 8282 | 39.60 (34.14;45.33) | 23.10 (17.20;30.28) | 15.27 (13.43;17.31) | 11 (10.03;12.05) | 10.75 (1.77;14.69) | 0.27 (0.13;0.59) |
| **WELFARE REGIME** | | | | | | | |
| ***Nordic*** | 1770 | 20.75 (16.98;25.12) | 37.98 (36.33;39.66) | 16.55 (13.43;20.24) | 12.73 (11.02;14.66) | 11 (9.42;12.82) | 0.97 (0.58;1.62) |
| ***Anglo-Saxon*** | 4491 | 33 (31.39;34.65) | 34.27 (30.88;37.84) | 16.58 (16.30;16.86) | 9.68 (9.01;10.40) | 6.25 (4.96;7.84) | 0.22 (0.21;0.22) |
| ***Continental*** | 12306 | 31.65 (28.19;35.32) | 15.57 (13.17;18.33) | 19.38 (17.71;21.17) | 16.34 (15.21;17.53) | 16.51 (13.49;20.05) | 0.55 (0.37;0.82) |
| ***Southern European*** | 8991 | 53.69 (50.15;57.20) | 8.51 (5.89;12.13) | 11.03 (9.79;12.41) | 12.33 (11.42;13.29) | 13.51 (9.36;19.11) | 0.93 (0.47;1.85) |
| ***Eastern European*** | 6382 | 48.45 (43.57;53.36) | 7.45 (5.73;9.64) | 13.39 (10.68;16.66) | 13.13 (10.17;16.79) | 16.41 (13;20.51) | 1.17 (0.58;2.34) |

*Note: the variable sex, country of origin and educational level have missing values.

Quartiles of precarious employment; quartile 1 (0.11-1.01), quartile 2 (1.02-1.32), quartile 3 (1.33-1.68), quartile 4 (1.69-3.72).

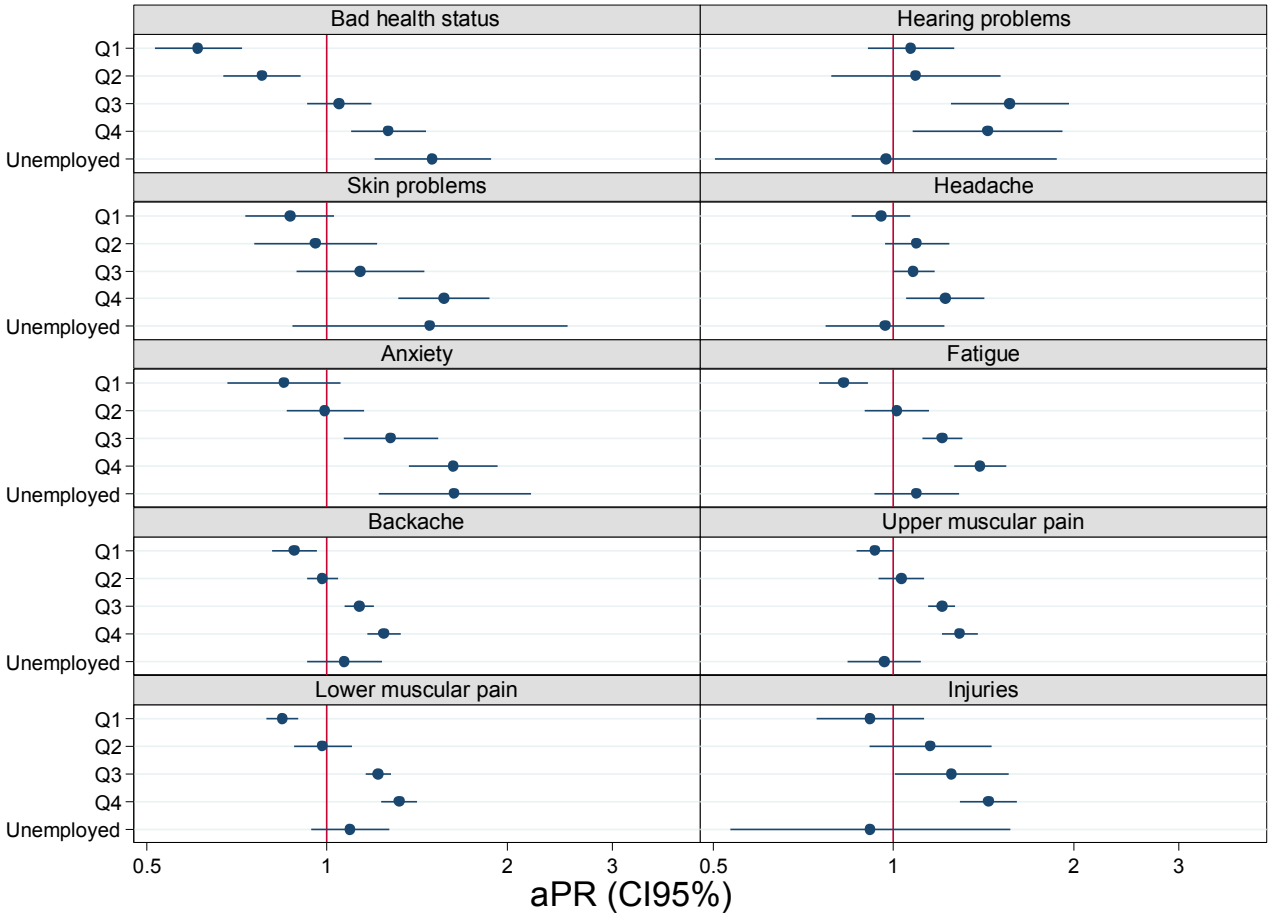
**Table 2. Prevalence of health related outcomes among precariously (overall, quartiles), not precariously employed and unemployed individuals in Europe, 2015 (n=33938).**

| | | No-precarious employment n= 13663 | Precarious employment n=20022 | | | | | Unemployed n=253 |
|---|---|---|---|---|---|---|---|---|
| | | | Overall | Quartile 1 n=5368 | Quartile 2 n=5269 | Quartile 3 n=4616 | Quartile 4 n=4769 | |
| **HEALTH OUTCOMES** | **n** | **% (CI95%)** | **% (CI95%)** | **% (CI95%)** | **% (CI95%)** | **% (CI95%)** | **% (CI95%)** | **% (CI95%)** |
| **Bad Health Status** | 6504 | 20.08 (16.79;23.82) | 18.39 (16.17;20.83) | 12.73 (10.74;15.03) | 16.19 (14.16;18.46) | 21.59 (17.64;26.14) | 24.08 (20.06;28.61) | 33.3 (24.4;43.5) |
| **Hearing problems** | 1800 | 4.10 (3.03;5.54) | 6.15 (4.86;7.76) | 6.37 (4.99;8.09) | 5.34 (3.35;8.40) | 7.19 (5.75;8.96) | 5.80 (4.82;6.96) | 4.09 (1.90;8.55) |
| **Skin problems** | 2609 | 6.58 (5.28;8.18) | 8.44 (6.84;10.37) | 7.48 (5.98;9.32) | 7.37 (5.06;10.63) | 8.22 (6.34;10.59) | 10.91 (9.07;13.07) | 9.13 (5.21;15.53) |
| **Headaches, Eyestrain** | 12937 | 37.18 (30.13;44.83) | 38.92 (33.24;44.92) | 33.20 (28.63;38.10) | 39.25 (33.29;45.54) | 39.03 (32.36;46.14) | 44.89 (37.08;52.96) | 36.23 (29.20;43.89) |
| **Anxiety** | 5308 | 14.21 (10.29;19.29) | 16.62 (10.54;25.21) | 13.27 (8.50;20.13) | 14.02 (8.30;22.69) | 17.71 (10.96;27.35) | 22.19 (14.47;32.46) | 21.14 (14.63;29.54) |
| **Fatigue** | 12451 | 35.91 (27.98;44.69) | 37.39 (27.64;48.29) | 27.15 (20.05;35.65) | 34.50 (24.06;46.68) | 41.38 (31.09;52.48) | 48.27 (36.49;60.25) | 38.95 (30.43;48.20) |
| **Backache** | 14672 | 41.63 (37.54;45.84) | 44.37 (38.38;50.54) | 35.68 (29.54;42.32) | 41.99 (36.97;47.18) | 48.75 (42.70;54.83) | 52.56 (47.22;57.85) | 47.20 (39.32;55.22) |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Muscular pain in upper limbs** | 14310 | 39.46 (34.50;44.65) | 44.16 (38.79;49.67) | 37.34 (31.88;43.15) | 41.35 (36.98;45.85) | 48.48 (41.99;55.03) | 50.75 (45.12;56.36) | 40.28 (33.07;47.93) |
| **Muscular pain in lower limbs** | 10096 | 28.92 (23.90;34.51) | 30.34 (25.32;35.88) | 22.75 (19.29;26.63) | 27.75 (21.58;34.90) | 34.79 (29;41.07) | 37.46 (32.86;42.30) | 35.54 (28.94;42.74) |
| **Injuries** | 2642 | 6.58 (5.29;8.17) | 8.66 (7.16;10.43) | 6.63 (5.65;7.76) | 8.40 (6.42;10.92) | 9.08 (6.75;12.09) | 10.83 (8.63;13.51) | 6.18 (3.59;10.4) |

Note: Quartiles of precarious employment; quartile 1 (0.11-1.01), quartile 2 (1.02-1.32), quartile 3 (1.33-1.68), quartile 4 (1.69-3.72).

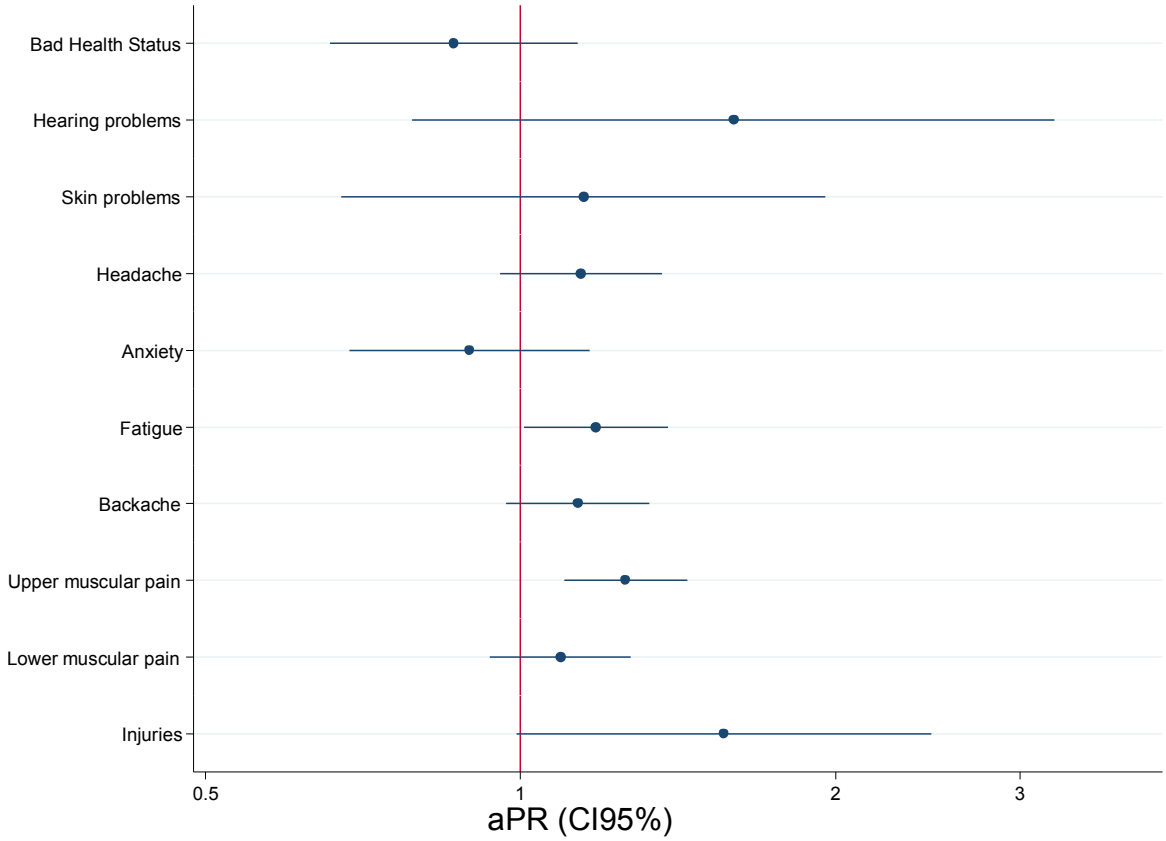
**Figure 1. Adjusted Prevalence Ratios of health-related outcomes in workers precariously employed (quartiles) and unemployed in reference with not precariously employed workers.**




aPR: Adjusted Prevalence Ratios for sex, age in categories, educational level and welfare regime.

**Note:** Quartiles of precarious employment; quartile 1 (0.11-1.01), quartile 2 (1.02-1.32), quartile 3 (1.33-1.68), quartile 4 (1.69-3.72).

**Figure 2. Adjusted Prevalence Ratios of health-related outcomes in high precariously employed workers (quartile 4) in reference with unemployed individuals.**




**aPR:** Adjusted Prevalence Ratios for sex, age in categories, educational level and welfare regime.

**Note:** Quartile 4 of precariousness (1.69-3.72).

# 5.4. Paper IV

**Gig economy delivery workers: use of protective equipment and driving behaviour in Barcelona (Spain), 2018**

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**Abstract**

The aim of this study is to describe the use of personal protection equipment (PPE) and vehicle protection equipment (VPE) and the compliance with traffic regulations of delivery gig workers according to working vehicle. This is a structured covert direct observational study. During a total of 141 hours, from September to December of 2018, we observed 803 delivery gig workers in Barcelona. We calculated the prevalence and prevalence ratios of compliance with traffic regulations (e.g. driving lane), use of PPE (e.g. helmet) and VPE (e.g. bicycle refractors) for the covariates sex, approximate age, company (Deliveroo, Glovo, Stuart, UberEats and JustEat), weather conditions and time of observation stratified by working vehicle. Most of workers were men (98%), aged 18 to 25 years (56.9%), used the bicycle as working vehicle (64.4%), and worked for the companies 'Deliveroo' (45.2%) and 'Glovo' (43.9%). The majority of motorcycle riders complied with traffic regulations, while only 41% of the bicycle riders respected the traffic signals and 46% drove in the correct lane. The use of helmet was much lower among bicycle (13%) than motorcycle riders (99%). 31% had bicycle refractors and 15% had bicycle front light. In general, young and 'Deliveroo' workers less frequently complied the traffic regulations and used PPE and VPE. Delivery gig-workers are at high risk of occupational injuries aggravated by the irregular use of personal protection equipment and frequent violations of traffic regulations. Exploring these issues in qualitative studies is likely provide guidance how to improve Occupational Safety and Health for gig-workers.

**Keywords:** Gig work; Platform digital work; Occupational risks; Non-standard employment

## INTRODUCTION

The shift to economic and political neoliberalism during the mid-1970s, has led to the flexibilization of the labour market and the casualization of the workforce (1). Thus, it transformed the standard employment relationship (full-time, stable employment, with social rights and protection) to other new forms of employment (2). Nowadays, the platform digital work is one of the most popular, mainly attributed to the fast development of the technology and its introduction in the labour market (3). The platform digital work is based on labour platforms that use technology to connect workers with consumers for one-off tasks, or jobs that are completed either virtually or in person by an on-demand workforce (4). They can be classified as crowd work (the task is mostly web-based and is given to crowd) and gig work (the task is location-based and is given to individuals) (5). An index measuring the utilization of digital labour platforms (excluding platforms for local services such as Uber), suggested that their use is growing globally (6). Some authors even, describe gig workers as a new potential social class, similar to the 'Precariat' (7), or a new class of precarious workers named 'Cybertariat' (8).

A report made by the Spanish Association of Digital Economy, which belongs the collective 'Sharing economy' (with company members like Glovo, Deliveroo, Uber, etc…) indicates that the extension planned for the next few years will multiply its impact on the share of the total Spanish economy by 3.5 times (9). It is expected that 50,000 more workers will be working under the gig work conditions, in Spain, on 2020 (9).

The potential implications of the emerging gig economy are not fully understood. On one hand, the gig economy may create new job opportunities in countries and occupations suffering from unemployment and underemployment (6). Also, a common reason for being a gig-worker is

the flexibility it provides (10). On the other hand, gig work challenges the traditional employer-employee relationship (11). Most platforms consider workers as independent contractors instead of employees (12). These workers remain in a grey zone as dependent self-employed between the self-employment and the salaried work, suffering the disadvantages of being self-employed (such as economic insecurity) and dispensing of the benefits (such as control over work) (13). In fact, there have been many mobilizations by the delivery gig workers in Spain, claiming they should be salaried workers instead of self-employed (14). The labour inspection, a body under the Spanish Ministry of Labour, has reported in many cities of Barcelona, Alicante, Zaragoza, Valencia, Madrid, that the gig delivery workers are false self-employed and should be salaried workers (15).

Gig work shares some features with precarious employment (PE), such as low labour organization, temporariness and low social protection (7). PE is an important social determinant of health that has been associated with mental (16) and physical (17,18) health related outcomes, as with occupational accidents and injuries (19) and sick leave of more than 15 days (20). Gig workers might not be properly protected from occupational hazards and so be higher exposed to them (12). In this regard, research should pay attention to the growing sector of gig delivery work (companies such as Deliveroo, Glovo, Uber Eats, etc.).

To the best of our knowledge, there is a lack of evidence regarding the protection from occupational hazards in the gig delivery workers worldwide. Therefore, addressing the occupational safety of the growing gig sector is necessary for preventing health damages both now and in the future. Thus, the aim of this study is to describe the use of personal and vehicle protection equipment (PPE and VPE) and compliance with traffic regulations of the gig delivery workers in Barcelona (Spain).

## METHODS

### Study population and data collection

This is a structured covert direct observational study (21,22) of gig delivery workers. The inclusion criteria for being observed were to be identified as a worker of the companies Deliveroo, Glovo, Stuart, Uber Eats or Just Eat by the visible brand on their backpacks. Two observers did the covert observation and data collection in the city of Barcelona (Spain), from the months of September to December 2018 (141 hours of observation and 803 registers).

The city of Barcelona is organized in 10 districts. We chose one random address in each district and searched for nearby restaurants using a delivery company's website. We selected the 10 first restaurants returned by our search. Subsequently, we entered the addresses of the 10 restaurants in 'Google Maps', which automatically created a route between the 10 restaurants. When the routes did not have a logical sequence, we re-ordered them manually. This procedure was repeated for all 10 districts. For some districts with many restaurants offering delivery by gig companies we choose more than one random address and created several routes for the district. This was done in order to get the maximum possible observations. We obtained a total of 30 routes.

The observers walked each complete route twice, during the midday (13.00-16.00) and at evening (19.00-22.00). They waited approximately for 15 minutes in each corner or traffic light of the routes, and wrote down the observed variables in the data collection sheet. The data collection sheet included items related to 1) socio-demographics characteristics of the gig workers, 2) use of protection equipment, and 3) compliance with traffic regulations (detailed in the study variables section). The observers were trained in data collection to increase reliability. In case they had doubts, a

researcher from the group (NMS) was on call to answer their questions. Further, in case the observers had difficulty recording a variable due to the visibility, it was considered as a missing observation.

The data collection sheet was tested in a pilot study done in a district with many restaurants working with gig companies ("Ciutat Vella" district) at midday and evening. During the three days of the pilot study (4$^{th}$ to 6$^{th}$ of September 2018), we observed 53 individuals from most of the companies, and we decided to add more variables related to the vehicle protection equipment (VPE) to the data collection sheet. The 53 observations were not used for the present study.

The study protocol was approved by the Ethics Committee of the Universitat Internacional de Catalunya.

**Study variables**

For the compliance with traffic regulations, we used the variables respect of traffic signals (no/yes) and driving in the correct lane (dichotomized as 'no' when they were driving in the sidewalk, bus lane and bicycle lane if they were motorcycles, or when they were riding in the bus lane and sidewalk if they were bicycles and 'yes' otherwise). For the use or proper use of PPE, we used the variables use of helmet, buttoned helmet, full-face helmet, use of gloves, use of mask, use of protective clothes and use of reflective clothes all of them with two possible responses (no/yes). For the use of VPE, we used the variables to have reflective in the bicycle (no/yes), to have a front light in the bicycle (no/yes), to have a phone holder (no/yes) and to have vehicle damage (no/yes).

The covariates used for this study were sex, approximate age in three categories: 18-25, 26-30, and 31-50 years, company (Deliveroo, Glovo, Stuart, Uber Eats and Just Eat), working vehicle (classified as 'bicycle'

when they used bicycle, electric bicycle (n=17) or scooter (n=3), and 'motorcycle'), weather (classified as 'good' and 'bad' when it was rainy or windy), and time of observation (midday, evening).

**Statistical Analysis**

We calculated the proportions with their 95% confidence intervals (95%CI) of the covariates (sex, approximate age, company, weather, and time of observation) overall and stratified by working vehicle. We calculated the prevalence of compliance with traffic regulations, use of PPE and use of VPE by the covariates and stratified by working vehicle. Further, we fitted generalized linear models (GLM), using the Poisson family with robust variance estimator (23), to calculate the prevalence ratios (PR) with their 95%CI of compliance with traffic regulations, use of PPE and VPE by the covariates and stratified by working vehicle. Further, we compared the proportions with their 95%CI of the covariates, the compliance with traffic regulations, use of PPE and VPE between the workers with and without missing values in the variable age. We conducted all analysis using R statistical software (version 3.3.3).

**RESULTS**

Most of workers were men (98%), aged 18 to 25 years (56.9%), used the bicycle as working vehicle (64.4%), worked for the companies 'Deliveroo' (45.2%) or 'Glovo' (43.9%), and worked in the evening (54.8%). Further, we collected most of the observations with good weather conditions (92.8%) (Table 1). We found differences according to working vehicle; bicycle riders were more commonly men, young, worked for 'Deliveroo', in good weather days and at midday, while motorcycle drivers were most frequently women, aged 30-50 years old, worked for 'Uber Eats', in bad weather days and at evening. We found that those riders with missing values in the

variable “age” were more frequently working during bad weather days, there were not differences for the rest of covariates (Table S1).

Most of motorcycle riders respected the traffic signals (98%) and were driving in the correct lane (96%). Contrary, 41% and 46% of the bicycle riders respected the traffic signals and were driving in the correct lane, respectively. The prevalence of compliance with traffic regulations was lower among men, young workers (18-25 years), working for ‘Deliveroo’, in good weather days and at midday (Table 2). Also, we describe similar associations for these covariates and compliance with traffic regulations in the figures 1A and 1B.

Table 3 shows the use of PPE of the gig delivery workers by working vehicle. Most of motorcycle riders were wearing helmet (99%), and from those, 48% were wearing full-face helmet. Oppositely, 13% of the bicycle riders were wearing a helmet. Men, young workers (18-25 years), ‘Deliveroo’ and ‘Glovo’ workers, those working in good weather days and at midday, used the helmet less frequently. This can also be observed in the figure 1C. The use of full-face helmet was lower among women, and those working for ‘Glovo’, ‘JustEat’ and ‘UberEats’ (Figure1D). The use of gloves and mask was of 4% and 1% in bicycle riders, and of less than 1% and 4% in motorcycle riders, respectively. Also, less than 1% were using refractor clothes (0.4% bicycle riders and 0.8% motorcycle riders), 0% used protective clothes and, from those using helmet, 100% had it fastened (data not shown).

Table 4 shows the use of VPE of the gig delivery workers by working vehicle. 31% and 15% of the bicycle riders had reflectors and front light in their bicycle, respectively. Motorcycle riders more frequently had a phone holder (78%) than bicycle riders (36%). The prevalence of use of VPE was lower among men, young workers (18-25 years), working for ‘Deliveroo’

and ‘Stuart’, in good weather days and at midday. Similarly, this can be observed in the figures 1F, 1G and 1H. Moreover, less than 1% had some visible damage in the vehicle (data not shown).

## DISCUSSION

To the best of our knowledge, this is the first study using objective data for describing the gig delivery workers’ respect of traffic regulations and use of PPE and VPE worldwide. Around 4 out of 10 bicycle riders respected the traffic regulations, while most of motorcycle riders respected them. Regarding the use of PPE, only 1 out of 10 bicycle riders were wearing a helmet, and the majority of motorcycle riders were wearing it. Almost none of the riders were using reflector and/or protective clothes, and less than 1 out of 10 were wearing masks or gloves. With regards to the use of VPE, a third of the bicycle riders had bike reflectors and less than 2 out of 10 had bike front light.

In our study, almost all the workers were men and a majority were young (18-25 years old). An informal conversation with a union representative from General Union of Workers (Spanish acronym; UGT), described the gig delivery workers working for ‘Glovo’ and ‘Deliveroo’ in Madrid (Spain) were men, young, and mostly immigrants. According to the digital platform work literature as well (mostly based in grey literature), certain groups appear to be overrepresented, such as young, highly educated, male, and white (10,24). We describe that the proportion of using PPE and VPE and compliance with traffic regulation was lower among men and young workers (18-25 years). Male gender has been previously defined as a factor for road accidents while working (25,26). Given our small sample size of women (n=16), further studies should explore this gender difference found in our study. Younger ages are a well-known risk factor for suffering road traffic injuries (27). These differences should be taken into account for

reinforcing the use of protective equipment and attitudes toward driving while working in these groups.

We found that the compliance with traffic regulation, use of PPE and VPE was lower in bicycle riders compared to motorcycle riders. From our results it seems that the level of protection and compliance with traffic regulation may be mostly explained by the traffic laws. For example, the use of helmet is mandatory for motorcycle drivers but not for bicycle riders. Also, we describe that the use of PPE and VPE is less frequent in good weather days. The use of reflective and front lamp for the bicycle is compulsory at night and days where visibility is bad (28). Further, the risk perception of cycling vs. driving may be different. A study done in German general population, found that alcohol consumption was higher among cyclists than drivers, this explained because cycling is perceived as less dangerous than driving (29).

We describe low prevalence of use of VPE and PPE among gig workers. That could be explained partially because gig delivery workers have to provide their own tools and equipment for working (10). However, there were big difference in use of VPE between bicycle riders working for the two major companies (Glovo and Deliveroo). Glovo riders had more often VPE and respected traffic regulations compared to Deliveroo riders. This finding strongly suggests that the companies have different approaches to VPE and traffic rule compliance. Exploring these issues in qualitative studies is likely provide guidance how to improve OSH for delivery gig-workers.

Because of the possible misclassification of their employment relationship as self-employed, that may be exposing them to greater hazards. This also relate to the low prevalence of compliance with traffic regulations by bicycle riders. Gig workers are pressured to perform their work as fast as possible through the monitoring and rating system of the apps. They are

monitored by the companies through apps, knowing if they are logged in, and their location. Moreover, clients of these apps use the platform for rating their services. A qualitative study done with driving gig workers, described that the rating systems were a key source of worry for workers, who may feel punished or to do not have the control of their work (30). Low ratings may imply to be deactivated (fired) with no recourse (31).

The implications of not using protection from occupational hazards are wide. Previous retrospective cohort studies have concluded that non-helmeted riders are more likely to have head fractures and head soft-tissue injuries than those wearing helmets (32,33). In our study, we could not differentiate the use of standard and non-standard covered helmet in motorcycle drivers. But, we did observe if they had their helmet fastened (all of them) and if it was a full-face helmet (more than the half were not wearing it). Evidence shows that motorcycle helmets reduce the risk of death by 42% and head injury by 69% in riders who crash (34), but half-coverage helmets provide the least protection from head injuries (35). We describe that most of workers were not using protective clothes, gloves and mask. Previous studies done in outdoors workers (traffic policemen, postal delivery workers), demonstrate that workers are exposed to air pollution (36) and ultraviolet radiation (37). Further, we describe that 3 out of 10 workers used bicycle reflectors and less than 2 out of 10 had a bike front light. The use of this visibility aid use has been described as protective for motor vehicle related injuries (38). Therefore, even though masks, gloves, bicycle reflectors and protective clothes are not mandatory, their use should be promoted in order to protect the workers from air pollution, ultraviolet radiation and vehicle related injuries.

This study has some limitations. Direct observation has been previously used in public health studies (21,22), but it has some methodological limitations. First of all, the features that are not clear during the observation,

such as the age or the sex, may be misclassified. Also, we describe that those with missing values in the variable age were more frequently working during bad weather days than those without missing values. That may be because those using a full-face helmet are better protected from the rain, and therefore, it is easier for them to work at bad weather conditions. Moreover, we could not report the educational level neither the country of origin of the delivery gig workers. The located-based work (gig work) is not related to professional services, so high skills are not demanded for the work (24), therefore workers may or may not be underemployed. Future studies done in gig workers may want to describe the educational level of workers for analysing the possible underemployment of this type of work, as well as the country of origin for examining inequalities related to the work. Further, we may have observed the same worker more than once. When the observers recognized a rider they already had observed, they did not record any information again. Nevertheless, given that gig delivery workers are hard to reach population due to the characteristics of their work; direct observation has permitted us to acknowledge a first approximation of the use of occupational hazards protection and compliance with traffic regulation.

## CONCLUSION

Delivery gig-workers are at high risk of occupational injuries aggravated by the irregular use of personal protection equipment and frequent violations of traffic regulations. Even though the traffic legislation defines some protection for riders, the occupational safety should be better controlled. Exploring these issues in qualitative studies is likely provide guidance how to improve Occupational Safety and Health for delivery gig-workers.

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**Table 1. Characteristics of the observed delivery gig workers in Barcelona (Spain), 2018 (n=803).**

| | Overall | | Bicycle (n= 517) | | Motorcycle (n=286) | |
|---|---|---|---|---|---|---|
| | **n** | **% (CI95%)** | **n** | **% (CI95%)** | **n** | **% (CI95%)** |
| **Sex** | | | | | | |
| ***Men*** | 786 | 98.0 (96;100) | 507 | 64.5 (55.5;74.4) | 279 | 35.5 (26.5;45.4) |
| ***Women*** | 16 | 2.0 (0.0;4.9) | 9 | 56.3 (47.3;67) | 7 | 43.8 (34.8;54.5) |
| **Age*** | | | | | | |
| ***18-25*** | 369 | 56.9 (46.9;66.9) | 346 | 93.8 (89.8;98.7) | 23 | 6.2 (2.2;11.1) |
| ***26-30*** | 166 | 25.6(15.6;35.6) | 118 | 71.1 (63.1;80.7) | 48 | 28.9 (20.9;38.5) |
| ***30-50*** | 113 | 17.4 (7.4;27.5) | 37 | 32.7 (23.7;42.1) | 76 | 67.3 (58.3;76.6) |
| **Company** | | | | | | |
| ***Deliveroo*** | 363 | 45.2 (35.2;55.8) | 297 | 81.8 (74.8;89.5) | 66 | 18.2 (11.2;25.9) |
| ***Glovo*** | 353 | 43.9 (33.9;54.5) | 189 | 53.5 (44.5;64.4) | 164 | 46.5 (37.5;57.3) |
| ***Stuart*** | 14 | 1.7 (0.0;12.3) | 8 | 57.1 (48.1;67.9) | 6 | 42.9 (33.9;53.6) |
| ***UberEats*** | 54 | 6.7 (0;17.3) | 16 | 29.6 (21.6;39.4) | 38 | 70.4 (62.4;80.1) |
| ***JustEat*** | 19 | 2.4 (0;12.9) | 7 | 36.8 (27.8;46.9) | 12 | 63.2 (54.2;73.3) |
| **Weather** | | | | | | |
| ***Good*** | 745 | 92.8 (88.8;98.3) | 485 | 65.1 (56.1;74.9) | 260 | 34.9 (25.9;44.7) |
| ***Bad*** | 58 | 7.2 (3.2;12.7) | 32 | 55.2 (46.2;66) | 26 | 44.8 (35.8;55.7) |
| **Time of observation** | | | | | | |
| ***Midday*** | 363 | 45.2 (36.2;56.1) | 239 | 65.8 (56.8;75.6) | 124 | 34.2 (25.2;43.9) |
| ***Evening*** | 440 | 54.8 (45.8;65.7) | 278 | 63.2 (54.2;73.3) | 162 | 36.8 (27.8;46.9) |

Note: *The variable sex has n=1 missing observation and age has n=155 missing observations.

**Table 2. Compliance with traffic regulations according to sex, age, company, weather and time of observation, stratified by working vehicle, of the delivery gig workers in Barcelona (Spain), 2018.**

| | Respect the traffic signals (n=720) | | Driving in the correct lane (n=782) | |
|---|---|---|---|---|
| | **Bicycle (n=449)** | **Motorcycle (n=271)** | **Bicycle (n= 503)** | **Motorcycle (n= 279)** |
| **Overall** | 41.6 (32.7;52.2) | 98.1(96.1;100) | 46.3 (37.3;57.2) | 96.1(93.1;99.9) |
| **Sex** | | | | |
| ***Men*** | 40.6(31.6;51.1) | 98.1(96.1;100) | 45.5(36.5;56.4) | 96(93;100) |
| ***Women*** | 100(100;100) | 100(100;100) | 100(100;100) | 100(100;100) |
| **Age** | | | | |
| ***18-25*** | 27.8(19.8;37.2) | 95.7(92.7;100) | 31.1(22.1;40.3) | 91.3(86.3;96.4) |
| ***26-30*** | 77.2(70.2;86.1) | 97.7(95.7;100) | 81.4(74.4;89.1) | 95.6(92.6;99.9) |
| ***30-50*** | 66.7(57.7;76.2) | 97.1(95.1;100) | 64.7(55.7;74.6) | 94.4(90.4;98.5) |
| **Company** | | | | |
| ***Deliveroo*** | 20.9(13.9;29.4) | 100(100;100) | 22.2(15.2;31.1) | 93.9(89.9;98.9) |
| ***Glovo*** | 76.7(68.7;84.9) | 96.8(93.8;100) | 80(73;87.9) | 95.6(92.6;100) |
| ***Stuart*** | 83.3(77.3;91.2) | 100(100;100) | 87.5(81.5;93.6) | 100(100;100) |
| ***UberEats*** | 53.8(44.8;64.8) | 100(100;100) | 68.8(59.8;77.9) | 100(100;100) |
| ***JustEat*** | 71.4(63.4;81) | 100(100;100) | 100(100;100) | 100(100;100) |
| **Weather** | | | | |
| ***Good*** | 39.2(30.2;49.6) | 98(96;100) | 44.2(35.2;55) | 95.7(92.7;100) |
| ***Bad*** | 84(78;91.4) | 100(100;100) | 80(73;87.9) | 100(100;100) |
| **Time of observation** | | | | |
| ***Midday*** | 34.6(25.6;44.3) | 97.5(95.5;100) | 34.7(25.7;44.5) | 95.2(92.2;99.7) |
| ***Evening*** | 47.7(38.7;58.6) | 98.7(96.7;100) | 56.6(47.6;67.3) | 96.8(93.8;100) |

**Table 3. Use of personal protection equipment (helmet, full-face helmet, gloves, mask) according to sex, age, company, weather and time of observation, stratified by working vehicle, of the delivery gig workers in Barcelona (Spain), 2018.**

| | Use of helmet (n=802) | | Full-face helmet (motorcycle) (n=285) | Use of gloves (n=801) | | Use of mask (n= 393) | |
|---|---|---|---|---|---|---|---|
| | Bicycle (n=517) | Motorcycle (n=285) | | Bicycle (n=516) | Motorcycle (n=285) | Bicycle (n=256) | Motorcycle (n=137) |
| **Overall** | 13.3 (7.35;20.1) | 98.9 (96.9;100) | 47.8 (38.8;58.7) | 3.7 (0.7;7.3) | 7.4 (3.4;12.9) | 0.8 (0.0;3.0) | 4.4 (1.4;8.8) |
| **Sex** | | | | | | | |
| ***Men*** | 13 (7;19.8) | 98.9 (96.9;100) | 48.1 (39.1;59.1) | 3.6 (0.6;7.1) | 7.6 (3.6;13.1) | 0.8 (0;2.9) | 4.5 (1.5;8.9) |
| ***Women*** | 33.3 (24.3;42.9) | 100 (100;100) | 33.3 (24.3;42.9) | 11.1 (6.1;17.9) | 0 (0;1.6) | 0 (0;1.6) | 0 (0;1.6) |
| **Age** | | | | | | | |
| ***18-25*** | 6.6 (2.6;11.6) | 100 (100;100) | 0 (0;1.6) | 2.9 (0.9;6.7) | 0 (0;1.6) | 0 (0;1.6) | 0 (0;1.6) |
| ***26-30*** | 25.4 (17.4;34.2) | 97.9 (95.9;100) | 0 (0;1.6) | 5.1 (1.1;9.2) | 2.1 (0.1;5.7) | 0 (0;1.6) | 0 (0;1.6) |
| ***30-50*** | 10.8 (5.8;17.1) | 97.3 (95.3;100) | 1.4 (0;3.7) | 0 (0;1.6) | 7.9 (3.9;13.5) | 0 (0;1.6) | 3.1 (0.1;6.7) |
| **Company** | | | | | | | |
| ***Deliveroo*** | 12.1 (6.1;18.3) | 100 (100;100) | 52.3 (43.3;63.2) | 3 (0;6.7) | 12.1 (6.1;18.3) | 0 (0;1.6) | 0 (0;1.6) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ***Glovo*** | 13.8 (7.8;20.5) | 98.2 (96.2;100) | 43.9 (34.9;54.8) | 3.7 (0.7;7.3) | 6.1 (2.1;11) | 4.5 (1.5;8.9) | 7.1 (3.1;12.7) |
| ***Stuart*** | 0 (0;1.6) | 100 (100;100) | 100 (100;100) | 12.5 (6.5;18.6) | 16.7 (10.7;24.5) | 0 (0;1.6) | 3.1 (0.1;6.7) |
| ***UberEats*** | 31.3 (22.3;40.4) | 100 (100;100) | 50 (41;60.7) | 12.5 (6.5;18.6) | 5.4 (1.4;9.4) | 33.3 (24.3;42.9) | 0 (0;1.6) |
| ***JustEat*** | 28.6 (20.6;38.1) | 100 (100;100) | 41.7 (32.7;52.3) | 0 (0;1.6) | 0 (0;1.6) | 0 (0;1.6) | 0 (0;1.6) |
| **Weather** | | | | | | | |
| ***Good*** | 12.4 (6.4;18.5) | 98.8 (96.8;100) | 43.4 (34.4;54.1) | 2.9 (0.9;6.7) | 6.2 (2.2;11.1) | 0.8 (0;3.0) | 4.4 (1.4;8.8) |
| ***Bad*** | 28.1 (20.1;37.7) | 100 (100;100) | 92 (88;97.4) | 15.6 (9.6;23.1) | 20 (13;27.9) | 0 (0;1.6) | 0 (0;1.6) |
| **Time of observation** | | | | | | | |
| ***Midday*** | 10.9 (5.9;17.2) | 98.4 (96.4;100) | 44.6 (35.6;55.4) | 3.3 (0.3;6.8) | 4.8 (1.8;9.4) | 0.7 (0;2.7) | 6 (2;10.3) |
| ***Evening*** | 15.5 (9.5;23) | 99.4 (98.4;100) | 50.3 (41.3;61.3) | 4 (1;7.8) | 9.3 (4.3;15) | 0.9 (0;3.2) | 2.9 (0.9;6.6) |

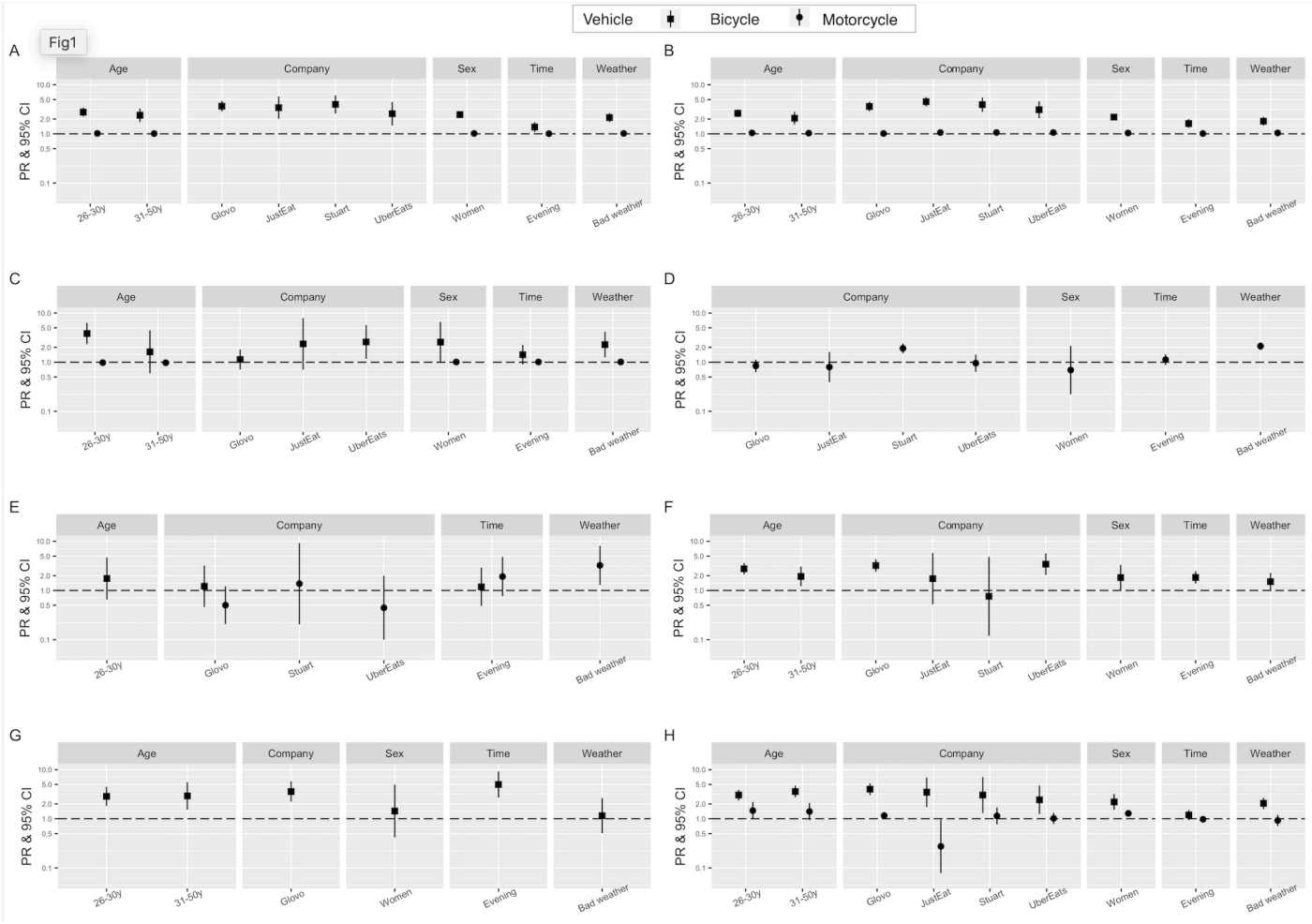
**Table 4. Use of vehicle protection (reflective in bicycle, front lamp in bicycle and phone holder) according to sex, age, company, weather and time of observation, stratified by working vehicle, of the delivery gig workers in Barcelona (Spain), 2018.**

| | Reflectives in bicycle (n=504) | Front lamp in bicycle (n= 483) | Phone holder (n=753) | |
|---|---|---|---|---|
| | | | Bicycle (n=502) | Motorcycle (n=251) |
| **Overall** | 30.8(22.7;40.7) | 15.5(9.6;23.1) | 36.1(27.1;46.2) | 78.1(71.1;86.8) |
| **Sex** | | | | |
| ***Men*** | 30.4(22.4;40.3) | 15.4(9.4;22.9) | 35.3(26.3;45.2) | 77.6(70.6;86.5) |
| ***Women*** | 55.6(46.6;66.3) | 22.2(15.2;31.1) | 77.8(70.8;86.7) | 100(100;100) |
| **Age** | | | | |
| ***18-25*** | 20.1(13.1;28.5) | 9.6(4.6;15.3) | 21.2(14.2;29.9) | 54.5(45.5;65.4) |
| ***26-30*** | 55.8(46.8;66.6) | 27.5(19.5;36.8) | 64.7(55.7;74.6) | 80(73;87.9) |
| ***30-50*** | 38.9(29.9;49.3) | 28.1(20.1;37.7) | 76.5(68.5;84.7) | 76.8(68.8;85.1) |
| **Company** | | | | |
| ***Deliveroo*** | 16.4(10.4;24.2) | 7.6(3.6;13.1) | 16.4(10.4;24.3) | 72.7(64.7;82.1) |
| ***Glovo*** | 52.8(43.8;63.7) | 27.4(19.4;36.7) | 65.9(56.9;75.7) | 84.6(78.6;92.1) |
| ***Stuart*** | 12.5(6.5;18.6) | 0(0;1.6) | 50(41;60.7) | 83.3(77.3;91.2) |
| ***UberEats*** | 56.3(47.3;67) | 35.7(26.7;45.6) | 40(31;50.3) | 74.2(66.2;83.1) |
| ***JustEat*** | 28.6(20.6;38.1) | 28.6(20.6;38.1) | 57.1(48.1;67.9) | 20(13;27.9) |
| **Weather** | | | | |
| ***Good*** | 29.8(21.8;39.6) | 15.4(9.4;22.9) | 33.9(24.9;43.5) | 78.6(71.6;87.2) |
| ***Bad*** | 45.2(36.2;56) | 17.9(10.9;25.2) | 70(62;79.6) | 72.7(64.7;82.1) |
| **Time of observation** | | | | |
| ***Midday*** | 21.1(14.1;29.8) | 4.9(1.9;9.5) | 32.6(23.6;42) | 79(72;87.5) |
| ***Evening*** | 39(30;49.4) | 24.6(16.6;33.2) | 39(30;49.5) | 77.4(70.4;86.3) |

**Figure caption**

**Figure 1. Prevalence Ratios with their Confidence Intervals 95% of compliance with traffic regulations (A,B), use of personal protection equipment (C,D,E) and presence of vehicle protection equipment (F,G,H) for sex, age, company, weather and time of observation by working vehicle of the delivery gig workers in Barcelona (Spain), 2018.**

**Note:** A: Respect the traffic signals, B: Driving in the correct lane, C: Use of helmet, D: Use of full-face helmet in motorcycle drivers, E: Use of gloves, F: Reflectors in the bicycle, G: Front lamp in the bicycle, H: Phone holder. The references for the each of the covariates are: age (18-25 years old), company (Deliveroo), sex (men), time (midday) and weather (good). Some models did not converge and the associations are not shown.


Vehicle
Bicycle
Motorcycle
Fig1
A
B
C
D
E
F
G
H
Age
Company
Sex
Time
Weather
PR & 95% CI
10.0
5.0
2.0
1.0
0.5
0.1
26-30y
31-50y
Glovo
JustEat
Stuart
UberEats
Women
Evening
Bad weather

# 6

# JOINT DISCUSSION

*"Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing and medical care and necessary social services, and the right to security in the event of unemployment, sickness, disability, widowhood, old age or other lack of livelihood in circumstances beyond his control." Article 25.1. Universal Declaration of Human Rights*

## 6.1. Main findings

The results of this thesis provide evidence for closing some gaps in the literature of PE, gig work and health. Three main gaps in the literature are: the presence of PE in Europe years after the Great Recession, unanalysed health problems related to PE and occupational safety of gig work.

The results from the thesis show that PE is present in Europe years after the Great Recession. According to the papers I and II of the thesis, two out of three salaried workers were precariously employed in the EU-28 by 2014. The proportion of women precariously employed was slightly higher than men. Also, the proportion of PE was higher among young workers (16-24 years), workers aged less than 15 years old at the end of the studies and

from Eastern, Continental and Southern European welfare regimes. The paper III shows that in 35 European Countries (including the EU-28), almost one-sixth of workers had a PE in 2015. The proportion of women highly precariously employed was slightly higher than men. Further, it is described a negative gradient of precariousness in workers aged 50 to 65 years old. Also, it is pointed a positive gradient of precariousness in workers with primary educational level, and from Eastern and Southern European welfare regimes.

It is not possible to directly compare the prevalence of PE in 2014 (paper I and II) and in 2015 (paper III). First of all, different constructs for measuring and defining the prevalence of PE are used. Second, the countries and individuals included are not the same; paper I and II includes countries belonging to the EU-28 and paper III includes countries belonging to the EU-28, the five candidate countries for EU membership, Norway and Switzerland. The results found are in the same line as other studies done in the European Union (42,45) in times of crisis (2010). Worst scores of employment quality (proxy indicators of PE) were found among women, workers with primary educational level and from Eastern and Southern European welfare regimes. Again, the problem among all these studies is the different approximations used for measuring PE. Even though the results found according co-variates are consistent, the use of different approximations hampers the monitoring of PE. Therefore, it is evident and urgent to seek a common definition of PE globally.

Second, the results of the thesis corroborate that PE is an important social determinant of health, going one step further, by exploring for the first time if PE is associated to other problems than mental health and self-perceived health, such as musculoskeletal problems, respiratory problems, infectious diseases, allergies, skin problems, etc. The paper II shows positive associations between PE and health problems caused or worsened by the work. After controlling for sex, age, age at the end of studies and welfare regime, the prevalence of declaring stress, depression or anxiety, musculoskeletal problems, infectious diseases, respiratory problems, accidents and injuries and allergies was higher among precariously employed individuals than not precariously employed workers. Further, in paper III a gradient of health-related outcomes among quartiles of precariousness is described. After adjusting for sex, age, educational level and welfare regime, the prevalence of reporting bad health status, headache, skin and hearing problems, anxiety, fatigue, backache, upper and lower muscular pain and injuries was higher among workers from quartiles 3 and 4 of precariousness (higher levels of precariousness) than among not precariously employed individuals.

One previous qualitative study interviewing workers from Toronto (Canada) showed that precariously employed workers declare stress-related health issues, such as headaches, stomach problems, sleeping disorders, high blood pressure, and various muscle pains (back, neck) (63). We hypothesize that

most of the associations described in the the thesis could have been mediated through the exposure to chronic stress. It is recommended that further longitudinal studies explore a range of health problems broader than mental problems and self-perceived health, for disentangle the mechanisms in which PE affects the health.

Previous studies have analysed the health effects of PE in Europe. Results from a study using the European Working Conditions Survey of 2010, described low job satisfaction, self-perceived general health and mental health among precarious intensive jobs (75). Further, a gradient of poor mental health has been described by PE score for permanent and temporary Spanish workers (2010) (72).

These results are contextualized at the initial phases of the crises (2007-2010), where many European countries started adopting measures to maintain employment (17). Therefore, by using data from 2014 and 2015 in the papers II and III, the first austerity measures had already been applied, and their effects in the precarization of the labour market and the health would be observed in the papers II and III.

Unemployment has been described as one of the most health detrimental employment conditions (94). Paper III shows the differences in reporting health problems among unemployed and highly precarious employed individuals. Having as reference the not PE group, and after controlling for sex, age, educational level and welfare regime, recent unemployed

individuals and highly precarious employed workers (quartiles 3 and 4) reported similar prevalence of health-related outcomes. Further, nine out of ten health-related outcomes were more commonly declared in individuals highly precarious employed (quartile 4) than in recent unemployed individuals. After controlling for sex, age, educational level and welfare regime classification, the prevalence of reporting muscular pain in upper limbs and lower limbs, headaches, backache, fatigue and injuries was higher in highly precariously employed compared to recent unemployed individuals.

The results in paper III point that the health status of those recently unemployed is similar to the one of precariously employed individuals. One previous study has also analysed self-perceived health among unemployed, precariously employed (through a multidimensional construct) and workers with standard jobs (71). This article found that unemployment and precarious job labour market positions are related to poor general and mental Health in Belgium at times of the Great Recession (2008-10).

These results support the hypothesis that rather than between the employed and the unemployed, health inequalities prevail across different labour market groups within the employed and the unemployed (70).

Further, paper II shows the association of PE and sick leave due to health problems caused or worsened by the work. After controlling for sex, age, age at the end of studies and welfare regime, the prevalence of reporting

sick leave of more than 15 days was higher among precariously employed individuals. Sick leave shorter than 15 days was not associated to PE. Temporary workers have higher risk of occupational injuries but their sickness absence is lower (65). One previous study using data from Nordic countries (2010) (73), described a positive association between PE and sickness absence. Given the evidence that precariously employed workers have higher prevalence of health problems (paper II and III), these results suggest that; (i) precariously employed workers may just consider sickness absence when the illness is severe and (ii) presenteeism (an employee attending to work even when they feel too ill to work effectively) (95) may be common among precariously employed workers. This would be driven by a fear of job loss. Previous studies have suggested that temporary workers have better physical health, and therefore, lower levels of sickness absence (65). But, in both of the papers (II and III), it is systematically described higher prevalence of health problems among precariously employed workers. Therefore, it is unlikely that precariously employed workers have better physical health.

Third, it is described, using objective data for the first time, that gig workers are poorly protected from occupational hazards. The results found in the papers II and IV show that precariously employed workers and gig workers are exposed to an unhealthy work environment. Paper II shows that the prevalence of health and safety risks faced in the workplace was higher

among PE group compared to the not PE group. After controlling by sex, age, age at the end of education and welfare regime classification, the prevalence of being exposed to violence and harassment, stress and repetitive movements or painful positions in the workplace was still higher among the PE group. Paper IV exposes an irregular use of personal protective equipment and frequent violations of traffic regulations among delivery gig workers. In the case of gig workers using the bicycle; four out of ten respected the traffic signals, five out of ten drove in the correct lane and, just one out of ten used the helmet.

Precarious employment and gig work (dependent self-employment) share some features; low labour organization, temporariness and low social protection (83). Therefore, the way through PE and gig work affect the health, could also be similar. It has been theoretically described, that PE may influence the health through the exposure to a poor work environment (36). The results from paper II support the hypothesis that precariously employed workers are more exposed to occupational risks, and thus probably affecting the worker's health.

Given that delivery gig workers are dependent self-employed, they have to provide their own tools and equipment for working (81). Paper IV shows the use of protective equipment is inadequate and therefore they could be at higher risk of injuries. Further, gig workers are monitored by the companies through the apps. This monitoring is perceived as a key source of worry for

workers (low control over work and job insecurity), which could lead to stress and rush for delivering (not complying the traffic regulations) (96,97). Just as employment precariousness was studied for informal employment (98), and for temporary workers (72), it should also be studied for self-employed workers. Since new forms of work linked to self-employment are appearing, to expand the operationalization of PE by including the self-employed, and not just the salaried workers, would be great for better understanding the precarization of the labour market.

## 6.2. Limitations and strengths

### 6.2.1. Study design

- Cross-sectional study based on secondary analysis of data

  The flash Eurobarometer 398 (used in the papers I and II) and the 6th EWCS (used in paper III) questionnaires were not designed for the research purposes of this thesis. Therefore, some variables for the aims of this research were not available, or the quality of them was not the best. For instance, in the flash Eurobarometer 398 dataset, the variable level of education was not available. Instead, age at the end of education was used as a proxy of educational level. This approximation may have misclassified the individuals that interrupted their education as 'higher level of education'.

Also, one of the exposure variables used in the paper III; unemployment had some limitations. First, the data used in the paper III (the 6th EWCS) is representative of the working population in Europe, but it is not for the unemployed. Thus hampering the representativeness of the sample of unemployed individuals included in the study. Moreover, people are invited to participate in the survey if they have been working for at least 1 hour for payment in the last week. So, in paper III the unemployed sample would be limited to recent unemployed individuals. Further, the individuals classified as unemployed were those that declared that "unemployment" was the situation that described themselves best. But, that may include several options; (a) part-time unemployment, in the case of Belgium, part-time workers are eligible for unemployment benefits, (b) recent full time unemployed, (c) individuals working in different NSE arrangements (on-call work).

Therefore, future studies can replicate our results by comparing PE workers with unemployed individuals, taking into account that they include short and long-term unemployed, who receive unemployment benefits or not, and exclude individuals who have recently been working on NSE arrangements.

Moreover, it is not possible to rule out reverse causation for the associations found between being precariously employed and self-declared health problems. Suffering from poor health may reduce the chance of achieving a good position in the labour market, thus leading into higher probabilities of being precariously employed (99). Therefore, longitudinal studies from a

work life perspective are necessary, to be able to rule out reverse causality and better understand the mechanisms of PE and its effects on health.

Otherwise, using data from European surveys allows to work with huge sample size. This also allows to stratify the results obtained according to important socio-economic variables. In the case of paper II, the associations were stratified according to sex, which has been consistently described as an important effect modifier in the way social determinants of health affect the health (7). Further, the resulting samples are representative of the European population, being able to extrapolate the results to the working population.

- Cross-sectional study based on direct observation

The use of direct observation for data collection (used in paper IV) has some limitations. Features that are not clear during the observation (sex, age) may be misclassified. Further, there is the probability of observing more than once the same worker included in the study. Next, direct observation cannot classify individuals according their employment conditions. Therefore, in paper IV it is not possible to classify individuals according to their employment arrangements. Instead, only delivery gig workers that had a visible brand on their backpacks were included.

Paper IV does not compare individuals in different employment arrangements. It is not possible to compare the occupational safety of

delivery workers employed or in dependent self-employed, because of the study design.

Still, direct observation has been used previously in hard to reach populations (100,101) allowing to shed light on occupational or traffic safety. Further, to the best of our knowledge, this is the first approach done for obtaining objective measures of occupational safety in gig workers.

### 6.2.2. Measurement of precarious employment

The measurement of PE was done by using proxy indicators. This methodology has been used in previous studies using secondary data from European surveys as well (42,45). The choice of indicators was based on the validated scale for measuring precarious employment in Spanish salaried population (EPRES-2010) (20), and in Chilean private sector workers (102). EPRES is constructed from 6 dimensions; exercise rights, vulnerability, disempowerment, temporariness, wages and rights (20). For the papers I and II, the PE was measured through four dimensions: not having the ability to exercise rights, vulnerability, disempowerment and temporariness. In the case of the paper III, the PE was measured through five dimensions: not having the ability to exercise rights, vulnerability, disempowerment, temporariness, and wages.

The measurement of precarious employment using proxy indicators has some limitations. First of all, lack of information for measuring the six dimensions proposed in the EPRES. This may have limited the joint effect

of all dimensions that make up PE on health. Second, the validation of the resulting index was not done for the present thesis. Therefore, the prevalence obtained in the thesis papers may be analysed with caution. Nevertheless, the distribution of PE according to socio-economic variables and health outcomes described in the thesis papers is consistent with previous evidence, using different data sets and populations.

Third, it is not possible to describe the evolution of PE in our papers (paper I and II contextualized in 2014 and paper III contextualized in 2015), because of the different indicators used for measuring PE.

Even though the resulting multidimensional construction has some methodological limitations, it also has strengths. The use of proxy indicators enables the creation of large-scale evidence (European level) using existing data sources (50). The results obtained in the papers that form the thesis could easily be used as the basis for creating longitudinal studies.

# 7

# CONCLUSIONS

*"It is not inequalities that kill people, as the WHO report on social determinants of health states; it is those who are responsible for these inequalities that kill people." Vicenç Navarro*

- Precarious employment is present in the European workforce years after the Great Recession. Women, young workers and individuals with lower educational level are more frequently precariously employed.

- Years after the Great Recession, precariously employed workers in Europe declare in a higher proportion to suffer health problems caused or worsened by the work than those not precariously employed. Further, the prevalence of declaring health problems follows a positive gradient among quartiles of precarious employment.

- High precariously employed workers declare in similar degree health problems (muscular pain, headaches, backache, and injuries) than recent unemployed individuals.

- To be precariously employed is not associated to exercise the right of sick leave shorter than 15 days. Instead, it is related to long sick leave (more than 15 days). This suggesting that precarious employed workers may be at work while sick.

- Precariously employed workers are more exposed to violence and harassment, stress and repetitive movements or painful positions in the workplace than workers not precariously employed.

- Delivery gig workers do have an irregular use of personal protective equipment and frequently violate traffic regulations.

# 8

# RECOMMENDATIONS FROM PUBLIC HEALTH

*"The change has to come at all levels, change in global health policies spearheaded by the WHO, changes within WHO and in countries as well. For me the ultimate yardstick for success would be if Bhasrabai, an agricultural labourer and embroidery worker, and our member, experiences the change concretely in her remote desert hamlet in India. And, of course, other "Bhasrabais" too, in other countries." Mirai Chatterjee*

The results found in this thesis have important public health and policy implications. In the wake of the conclusions raised from the present thesis, some recommendations from public health are pointed out:

- Based on the high prevalence of precarious employment among the European workforce, current labour market regulations should be reconsidered in order to achieve the 8th sustainable development goal of decent work and economic growth by 2030.

- Considering the rising number of studies (including the results from the present thesis) suggesting that precarious employment affect the

workers' health, public Health agencies should monitor precarious employment as another determinant of health.

- In light of the deficient occupational safety of gig workers and the need for improving it, it is necessary to solve the probable misclassification of gig workers as dependent self-employed in order to protect them from occupational risks.

- Found on the characteristics of digital platform work, new approaches for addressing occupational safety in digital platform labour should be carefully reviewed.

# 9

# FUTURE RESEARCH

*"I envision a world in which everyone can live healthy, productive lives, regardless of who they are or where they live." Dr Tredos Adhanom Ghebreyesus, WHO*

Considering the conclusions and recommendations from public health, some future research recommendations for better understanding the health impact of precarious employment and digital platform work are indicated:

- To include a common set of questions for measuring precarious employment in working conditions surveys globally. This would allow the monitoring of precarious employment over the years and among countries.

- To incorporate the self-employed workers when measuring the precarious employment and its health effects.

- To test the associations found in the cross-sectional studies done in this thesis in longitudinal studies. This would permit to infer causality and to test mediation effects in order to disentangle the mechanisms for which precarious employment affect the health.

- To quantitatively measure the employment and working conditions of the gig workers and their health effects.

- To conduct qualitative studies for providing guidance how to improve the employment and working conditions from the own workers' experiences.

# 10

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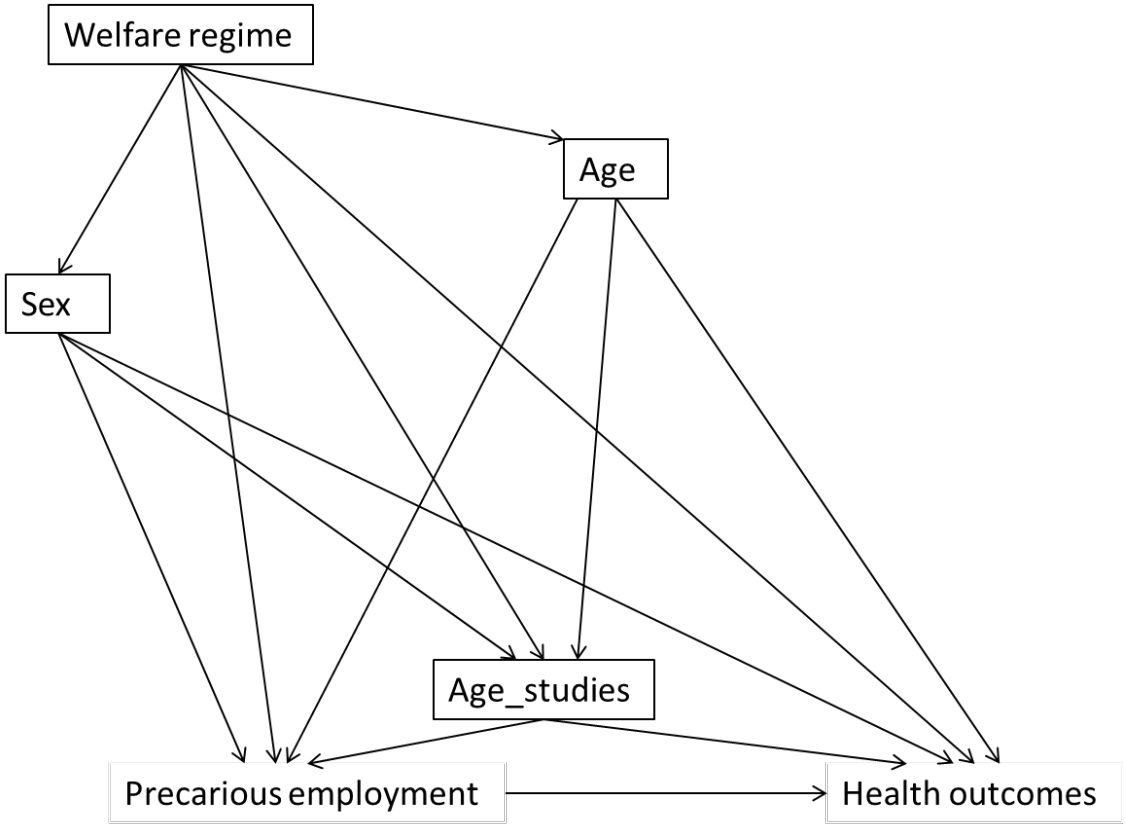
# ANNEX I. Supplementary Material of paper II

**Supplemental Material**

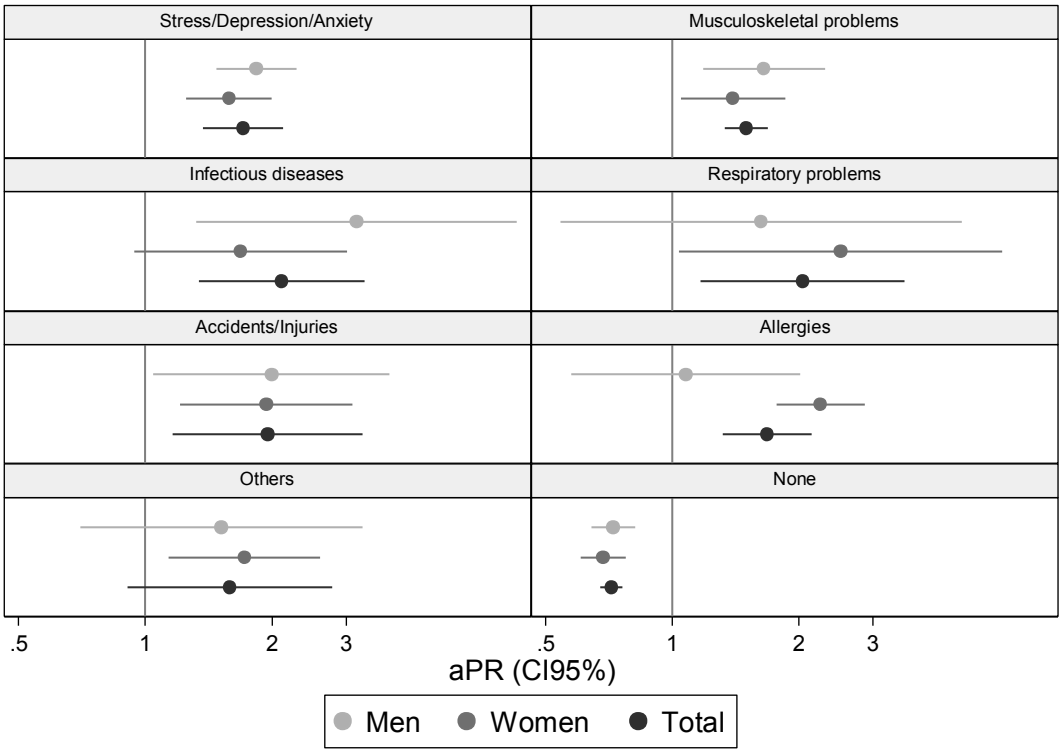
**Association between precarious employment and health related outcomes in the European Union: a cross-sectional study.**

**Figure S1. Directed Acyclic Graph (DAG) of the association between precarious employment and health related outcomes.**



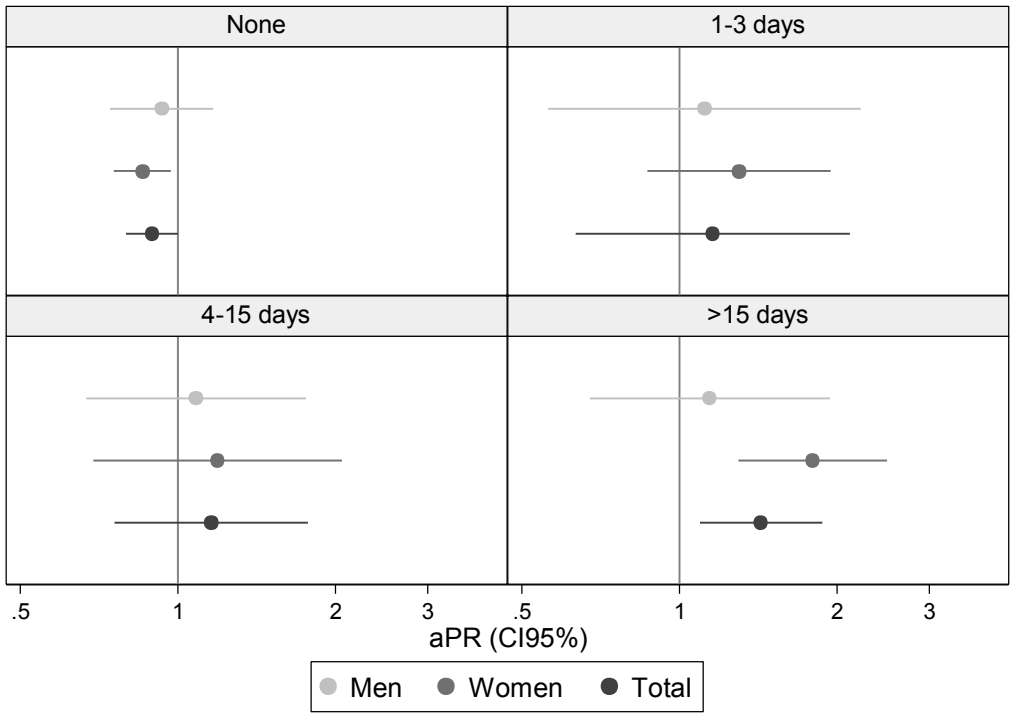

Note: Welfare regime, age, sex and age at the end of the studies may be confounding variables of the association between precarious employment and health related outcomes such as health problems caused or worsened by work, sick leave due to health problems caused or worsened by the work and main health and safety risks faced in the workplace.

**Figure S2. Association between precarious employment and health problems caused or worsened by the work in the EU-28 (2014) by sex.**



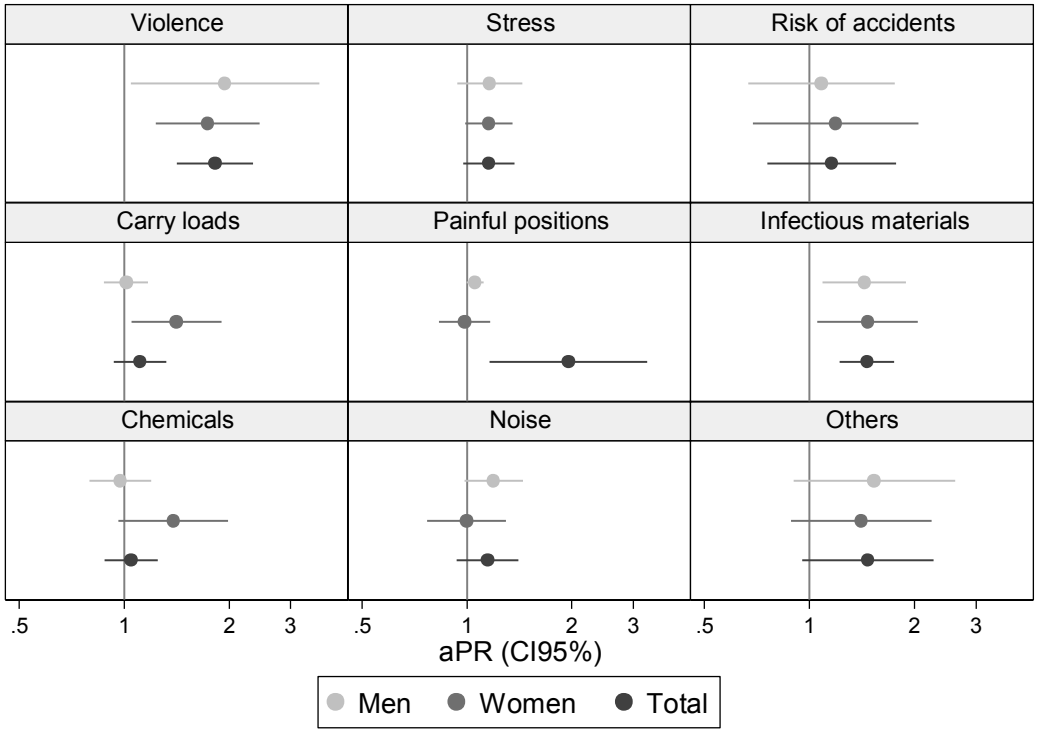

Note: aPR: adjusted Prevalence Ratio. Adjustment variables: sex, age, age at the end of the studies, country typologies. Precarious employment: defined as the presence of one or more of the following factors: temporariness, do not exercise their rights, vulnerability and disempowerment.

**Figure S3. Association between precarious employment and sick leave due to health problems caused or worsened by the work in the EU-28 (2014) by sex.**




Note: aPR: adjusted Prevalence Ratio. Adjustment variables: sex, age, age at the end of the studies, country typologies. Precarious employment: defined as the presence of one or more of the following factors: temporariness, do not exercise their rights, vulnerability and disempowerment.

**Figure S4. Association between precarious employment and main health and safety risks faced in the workplace in the EU-28 (2014) by sex.**




Note: aPR: adjusted Prevalence Ratio. Adjustment variables: sex, age, age at the end of the studies, country typologies. Precarious employment: defined as the presence of one or more of the following factors: temporariness, do not exercise their rights, vulnerability and disempowerment.

**Table S1. Comparison of the covariates and health related outcomes between included and excluded (due to missing values in any of the precariousness factors) individuals.**

| | Excluded[a] | | Included | | |
|---|---|---|---|---|---|
| | **n** | **% (CI95%)** | **n** | **% (CI95%)** | **p-value[b]** |
| **Overall** | 3825 | | 7702 | | |
| **Sex** | | | | | <0.001 |
| ***Men*** | 1331 | 34.79 (28.65;41.48) | 4602 | 59.75 (55.95;63.44) | |
| ***Women*** | 2494 | 65.21 (58.52;71.35) | 3100 | 40.25 (36.56;44.05) | |
| **Age** | | | | | <0.001 |
| ***16-24 years*** | 460 | 12.02 (9.49;15.11) | 537 | 6.97 (5.37;8.99) | |
| ***25-39 years*** | 1408 | 36.81 (33.65;40.08) | 2928 | 38.02 (33.83;42.40) | |
| ***40-54 years*** | 1415 | 36.99 (33.20;40.94) | 3161 | 41.04 (38.84;43.27) | |
| ***55-70 years*** | 542 | 14.18 (12.73;15.77) | 1076 | 13.97 (12.08;16.10) | |
| **Age at the end of the studies** | | | | | <0.001 |
| ***<15 years*** | 231 | 6.10 (3.61;10.14) | 380 | 4.98 (3.27;7.52) | |
| ***16-19 years*** | 1644 | 43.43 (36.63;50.49) | 3044 | 39.81 (32.52;47.59) | |
| ***>20 years*** | 1747 | 46.17 (39.40;53.08) | 4149 | 54.26 (45.69;62.59) | |
| ***Still studying*** | 162 | 4.30 (2.84;6.46) | 72 | 0.95 (0.68;1.33) | |
| **Country typologies [c]** | | | | | 0.108 |
| ***Continental*** | 1669 | 43.63 (14.56;77.86) | 2801 | 36.37 (12.31;69.95) | |
| ***Anglo-Saxon*** | 709 | 18.52 (2.74;64.77) | 1208 | 15.68 (2.25;60.00) | |
| ***Eastern European*** | 590 | 15.43 (4.63;40.68) | 1896 | 24.62 (8.70;52.82) | |
| ***Southern European*** | 700 | 18.30 (4.47;51.75) | 1398 | 18.15 (5.22;47.14) | |
| ***Nordic*** | 157 | 4.11 (0.96;15.94) | 398 | 5.17 (1.27;18.75) | |
| **HEALTH PROBLEMS** | | | | | |
| **None** | 1831 | 48.05 (45.78;50.33) | 3798 | 49.32 (45.97;52.67) | 0.248 |
| **Stress/depression/ anxiety** | 995 | 26.12 (22.13;30.54) | 2141 | 27.81 (25.57;30.16) | 0.204 |
| **Musculoskeletal** | 1060 | 27.82 | 2096 | 27.21 | 0.584 |

| | | | | | |
|---|---|---|---|---|---|
| **problems** | | (24.08;31.89) | | (23.91;30.78) | |
| **Infectious diseases** | 202 | 5.29 (2.61;10.45) | 237 | 3.07 (1.98;4.74) | 0.009 |
| **Respiratory problems** | 146 | 3.82 (2.85; 5.12) | 254 | 3.29 (2.81;3.85) | 0.347 |
| **Accidents/injuries** | 208 | 5.45 (4.20;7.06) | 452 | 5.87 (4.64;7.41) | 0.611 |
| **Allergies** | 230 | 6.04 (4.95;7.36) | 343 | 4.45 (3.68;5.38) | <0.001 |
| **Others** | 230 | 6.03 (4.54;7.96) | 447 | 5.80 (4.97;6.75) | 0.705 |
| **More than one** | 1970 | 51.69 (49.41;53.97) | 3873 | 50.29 (46.99;53.58) | 0.204 |
| **SICK LEAVE** | | | | | |
| **None** | 1211 | 61.93 (51.75;71.17) | 2402 | 62.31 (55.21;68.92) | 0.905 |
| **1-3 days** | 228 | 11.66 (9.66;14.02) | 409 | 10.61 (7.89;14.13) | 0.555 |
| **4-15 days** | 289 | 14.78 (9.74;21.79) | 568 | 14.73 (10.85;19.70) | 0.985 |
| **>15 days** | 227 | 11.62 (7.76;17.05) | 476 | 12.34 (8.97;16.76) | 0.793 |
| **EXPOSURE TO RISKS** | | | | | |
| **Exposure to violence** | 488 | 12.80 (9.06;17.78) | 940 | 12.20 (8.45;17.30) | 0.655 |
| **Exposure to stress** | 1861 | 48.85 (45.37;52.33) | 4286 | 55.65 (53.42;57.86) | <0.001 |
| **Risk of accidents or serious injuries** | 588 | 15.43 (12.67;18.66) | 1556 | 20.21 (16.97;23.88) | 0.061 |
| **Carrying or moving loads daily** | 1019 | 26.75 (23.23; 30.59) | 1806 | 23.44 (19.39;28.05) | 0.043 |
| **Repetitive movement or painful positions** | 1114 | 29.24 (23.77;35.38) | 2115 | 27.46 (23.23;32.13) | 0.211 |
| **Exposure to infectious materials** | 367 | 9.62 (7.15;7.79) | 705 | 9.15 (7.79;10.7) | 0.653 |
| **Exposure to chemicals** | 409 | 10.74 (9.09;12.65) | 864 | 11.22 (9.40;13.33) | 0.7170 |
| **Exposure to noise** | 565 | 14.83 (12.45;17.58) | 1539 | 19.98 (17.14;23.17) | <0.001 |
| **Others** | 295 | 7.75 (5.87;10.16) | 559 | 7.25 (6.01;8.73) | 0.4585 |
| **More than one** | 3407 | 89.41 (85.37;92.43) | 7055 | 91.60 (88.18;94.10) | <0.001 |

Note: [a]Excluded: due to missing values in any of the precariousness factors (a part of the exclusion criteria of the study) [b] p-value obtained with Chi-squared test. [c] Country typologies based on Welfare regime: Continental area (Austria, Belgium, Germany, France, the Netherlands and Luxembourg), Anglo-Saxon area (Ireland and the United Kingdom), Eastern European area (Croatia, Czech Republic, Estonia, Hungary, Lithuania, Latvia, Poland, Rumania, Bulgaria, Slovenia and Slovakia), Southern European area (Cyprus, Greece, Spain, Italy, Malta and Portugal) and Nordic countries (Denmark, Finland and Sweden).

**Table S2. Adjusted Prevalence Ratios between precarious employment and health problems, sick leave and risks exposure in the workplace in the EU-28 (2014) by welfare regime classification.**

| | Continental N=2801 | Anglo-Saxon N=1208 | Eastern European N=1896 | Southern European N=1398 | Nordic N=398 |
|---|---|---|---|---|---|
| **HEALTH PROBLEMS** | | | | | |
| **None** | 0.67 (0.58;0.77) | 0.77 (0.71;0.84) | 0.74 (0.69;0.79) | 0.69 (0.60;0.79) | 0.75 (0.67;0.84) |
| **Stress/depression/anxiety** | 2.45 (1.58;3.78) | 1.42 (1.38;1.46) | 1.49 (1.09;2.02) | 1.71 (1.45;2.01) | 1.28 (1.24;1.32) |
| **Musculoskeletal problems** | 1.49 (1.10;2.01) | 1.39 (1.33;1.46) | 1.74 (1.47;2.06) | 1.44 (0.91;2.28) | 1.29 (1.17;1.42) |
| **Infectious diseases** | 2.37 (1.51;3.71) | 4.21 (4.01;4.42) | 0.91 (0.31;2.69) | 3.89 (1.81;8.35) | 1.30 (0.73;2.31) |
| **Respiratory problems** | 11.86 (1.80;78.04) | 2.23 (0.90;5.56) | 1.44 (1.15;1.82) | 0.76 (0.26;2.27) | 2.57 (0.19;33.37) |
| **Accidents/injuries** | 2.70 (1.37;5.31) | 0.93 (0.87;0.99) | 1.77 (0.85;3.70) | 4.80 (1.33;17.31) | 1.36 (1.19;1.55) |
| **Allergies** | 1.50 (1.11;2.04) | 0.99 (0.13;7.65) | 2.42 (1.80;3.27) | 1.63 (0.77;3.47) | 1.97 (0.64;6.03) |
| **Others** | 3.68 (1.08;12.49) | 0.90 (0.49;1.65) | 0.98 (0.59;1.62) | 1.32 (0.50;3.50) | 1.85 (0.49;2.31) |
| **More than one** | 1.57 (1.39;1.77) | 1.40 (1.39;1.41) | 1.46 (1.20;1.78) | 1.38 (1.16;1.65) | 1.19 (1.14;1.24) |
| **SICK LEAVE** | | | | | |
| **None** | 0.75 (0.71;0.80) | 1.08 (1.03;1.13) | 0.95 (0.88;1.03) | 0.86 (0.58;1.28) | 0.90 (0.72;1.14) |
| **1-3 days** | 2.94 (1.03;8.40) | 0.48 (0.44;0.52) | 2.09 (0.71;6.20) | 0.92 (0.41;2.05) | 0.65 (0.36;1.18) |
| **4-15 days** | 0.87 (0.65;1.16) | 4.25 (2.08;8.70) | 0.83 (0.60;1.15) | 1.93 (0.79;4.70) | 1.63 (0.92;2.88) |
| **>15 days** | 1.71 (1.18;2.48) | 1.01 (0.82;1.22) | 1.23 (0.78;1.94) | 1.38 (0.64;2.99) | 2.04 (1.40;2.98) |

| | | | | | |
|---|---|---|---|---|---|
| **EXPOSURE TO RISKS** | | | | | |
| **Exposure to violence** | 2.12 (1.41;3.19) | 1.46 (1.40;1.51) | 1.46 (1.27;1.67) | 3.98 (1.97;8.03) | 1.47 (0.94;2.30) |
| **Exposure to stress** | 1.41 (0.87;2.28) | 0.96 (0.68;1.36) | 1.11 (0.97;1.26) | 1.09 (0.97;1.21) | 0.93 (0.86;1.01) |
| **Risk of accidents or serious injuries** | 0.93 (0.50;1.75) | 1.02 (0.98;1.07) | 1.10 (1.03;1.19) | 1.53 (1.34;1.75) | 1.13 (0.97;1.31) |
| **Carrying or moving loads daily** | 0.91 (0.75;1.12) | 1.19 (1.18;1.20) | 1.33 (0.93;1.91) | 1.38 (1.19;1.61) | 1.18 (0.98;1.41) |
| **Repetitive movement or painful positions** | 0.93 (0.85;1.02) | 1.09 (1.08;1.10) | 1.17 (1.01;1.37) | 0.94 (0.83;1.06) | 1.10 (0.97;1.25) |
| **Exposure to infectious materials** | 1.33 (1.09;1.64) | 1.38 (1.28;1.49) | 1.12 (0.84;1.49) | 2.75 (2.15;3.51) | 1.43 (0.89;2.29) |
| **Exposure to chemicals** | 1.29 (1.11;1.49) | 0.76 (0.70;0.83) | 0.93 (0.57;1.51) | 1.01 (0.87;1.19) | 0.81 (0.53;1.24) |
| **Exposure to noise** | 1.10 (0.85;1.44) | 1.92 (1.50;2.44) | 0.81 (0.73;0.90) | 1.35 (0.92;1.97) | 1.32 (0.96;1.80) |
| **Others** | 2.13 (0.48;9.42) | 2.01 (0.20;19.68) | 0.79 (0.54;1.14) | 2.69 (1.17;6.17) | 0.89 (0.55;1.42) |
| **More than one** | 1.16 (0.99;1.36) | 1.01 (0.98;1.03) | 1.01 (0.96;1.04) | 1.06 (1.02;1.10) | 1.02 (0.99;1.05) |

Note: aPR: adjusted Prevalence Ratio. Adjustment variables: sex, age, age at the end of the studies. Precarious employment: defined as the presence of one or more of the following factors: temporariness, do not exercise their rights, vulnerability and disempowerment.

# ANNEX II. Supplementary Material of paper III

**Supplementary material**

## Precarious Employment, Unemployment and their association with health-related outcomes in 35 European countries: a cross-sectional study.

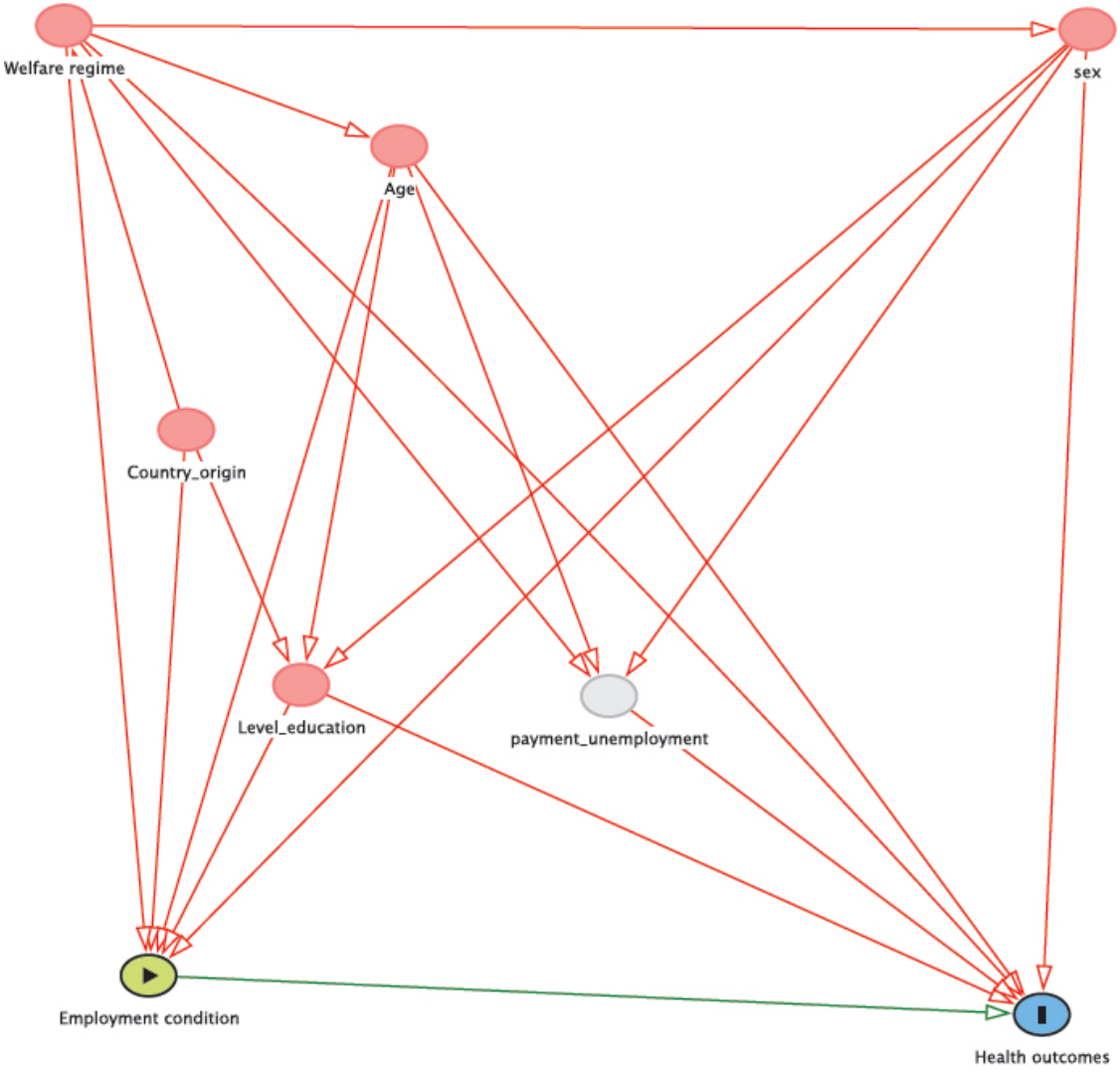
**Table S1. Construction of the variable precariousness based on the factors temporariness, exercise rights, vulnerability, disempowerment and wages.**

| PRECARIOUSNESS FACTOR | QUESTION NUMBER | QUESTION | Categories/ Ranges (taken into account) | VARIABLE TREATMENT | ITEM | SCALE |
|---|---|---|---|---|---|---|
| **TEMPORARINESS** | q11 | What kind of **employment contract** do you have in your main paid job? | 1. Unlimited duration, 2. limited duration, 3. temporary employment agency contract | 0: unlimited duration<br>1: temporary employment (fixed-term or temporary employment agency contract) | 1 | 0-4 |
| **TO DON'T BE ABLE TO EXERCISE RIGHTS** | q33 | Regarding the **health and safety risks** related to the performance of your job, how well **informed** would you say you are? | 1. Very well informed, 2. well informed, 3. not very well informed, 4. not at all well informed | 0: informed (1-2)<br>1: informed (3-4) | 1 | 0-5 |
| | q38 | In the last month, has it happened at least once that you had **less than 11 hours between the end of one working day and the start of the next working day**? | 1.Yes, 2.No | 0: No<br>1.Yes | 2 | |
| | q46 | Since you started your main paid job, how often have you **worked in your free time** to meet work demands? | 1. daily, 2. several times a week, 3. several times a month, 4. less often, 5. never | 0: No (5)<br>1.Yes (1-4) | 3 | |
| | q47 | Would you say that for you **arranging to take an hour** or two off during working hours to **take care of personal or family matters** is… | 1. very easy, 2. fairly easy, 3. fairly difficult, 4. very difficult | 0: easy (1,2)<br>1: difficult (3,4) | 4 | |
| **VULNERABILITY** | q61b | For each of the following statements, please select the response which best describes your work situation. "**Your manager helps and supports you**" | 1. always, 2. most of the time, 3. sometimes, 4. rarely, 5. never | 0: support (1-2)<br>1: no support (3-5) | 1 | 0-6 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | q61L | For each of the following statements, please select the response which best described your work situation. "**You are treated fairly at your workplace**" | 1. always, 2. most of the time, 3. sometimes 4. rarely, 5. never | 0: treated fairly (1-2)<br>1. no (3-5) | 2 | |
| | q63a | To what extent do you agree or disagree with the following statements? Your immediate **boss**… "**Respects you as a person**" | 1. strongly agree, 2. tend to agree, 3. neither agree nor disagree, 4. tend to disagree, 5. strongly disagree | 0: respect (1-2)<br>1. no (3-5) | 3 | |
| | q65b | Over the past 12 months, have you undergone any of the following types of training to improve your skills? | 1. yes, 2. no | 0: No<br>1.Yes | 4 | |
| | Q89G | To what extend do you agree or disagree with the following statments about your job? "I might lose my job in the next 6 months" | 1. strongly agree, 2. tend to agree, 3. neither agree nor disagree, 4. tend to disagree, 5. strongly disagree | 0: no (4-5)<br>1.Yes (1-3) | 5 | |
| **DISEMPOWERMENT** | q40 | Since you started your main paid job, how often have you been requested to **come into work at short notice**? | 1. daily, 2. several times a week, 3. several times a month, 4. less often, 5. never | 0: No (5)<br>1.Yes (1-4) | 1 | 0-8 |
| | q42 | How are your **working time arrangements** set? | 1. set by the company, with no possibility for changes, 2. choose between several fixed working schedules, 3. adapt your working hours within certain limits, 4. working hours determined by yourself | 0. Flexibility (3,4)<br>1: No flexibility ( 1,2) | 2 | |
| | q43 | Do **changes to your working time** arrangements occur regularly? (IF YES) How long before are you informed about these changes? | 1. no, 2. yes, the same day, 3. yes, the day before, 4. yes, several days in advance, 5. yes, several weeks in advance | 0: no (1)<br>1.Yes (2-5) | 3 | |
| | q61c | For each of the following statements, please select the response which best describes your work situation. "You are **consulted before objectives are set for your work**" | 1. always, 2. most of the time, 3. sometimes, 4. rarely, 5. never | 0: yes (1-3)<br>1.no (4-5) | 4 | |
| | q61n | For each of the following statements, please select the response which best describes your work situation. "You can **influence decisions** that are important for your work" | 1. always, 2. most of the time, 3. sometimes, 4. rarely, 5. never | 0: yes (1-3)<br>1.no (4-5) | 5 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | q71a | Does the following **exist** at your company or organisation? "**Trade union, works council or a similar committee representing employees**?" | 1. yes, 2. no | 0: yes (1)<br>1: no (2) | 6 | |
| | q71c | Does the following **exist** at your company or organisation? "A **regular meeting** in which **employees can expess their views** about what is happening in the organisation?" | 1. yes, 2. no | 0: yes (1)<br>1: no (2) | 7 | |
| **WAGES** | q89a | To what extend do you agree or disagree with the following statments about your job? "Considering all my efforts and achievements in my job, **I feel I get paid appropiately**" | 1. strongly agree, 2. tend to agree, 3. neither agree nor disagree, 4. tend to disagree, 5. strongly disagree | 0: yes (1-2)<br>1: no (4-5) | 1 | 0-4 |
| | q101 | Thinking about your **earnings** from your main job, what do they include? " **advantages of other nature** (for instance medical services, access to shops) | 1. yes, 2.no | 0: yes (1)<br>1: no (2) | 2 | |
| | q104 (Q104_EURO) | Please can you tell us how much are you **net monthly earnings** from your main paid job? Please refer to the average earnings in the recent months. If you don't know the exact figure, please give an estimate | Using this variable (amount of euros per month) and with the average net monthly earnings of each of the 35 countries at the year 2015, we constructed the variable "wages" with the categories:<br>0. Under the average net monthly earnings (relative within country)<br>1. Above the average net monthly earnings (relative within country) | 0. Low (0)<br>1. Medium-High (1) | 3 | |

**Figure S1. Sufficient adjustment variables (welfare regime, age, sex and level of education) for estimating the total effect of the employment conditions on the health outcomes.**




Note: Directed Acyclic Graph (DAG) of the exposure employment conditions (to be unemployed, to be a worker with or without precarious employment), the health-related outcomes and the observed (welfare regime, age, level of education, sex, country of origin) and unobserved (unemployment compensation) covariates. The unmeasured variable "unemployment compensation" would be determined by the welfare regime policies, which are

profoundly connected to the protection of people from labor market risks and that may affect the employment conditions (quality of job accepted) and the health status. According to the drawn DAG with the measured and unmeasured variables, the sufficient adjustment variables for estimating the total effect of the employment conditions on the health outcomes would be: sex, age, educational level, and welfare regime.

**Figure S2. Quantile-quantile plots for the deviance residuals and linear predictions of the multi-level generalized linear model, using the Poisson family, robust variances and country as the random effect, with exposure employment situation (no precarious employment, quartiles of precarious employment and unemployed) and health-related outcomes, adjusted by sex, age in categories, educational level and welfare regime.**

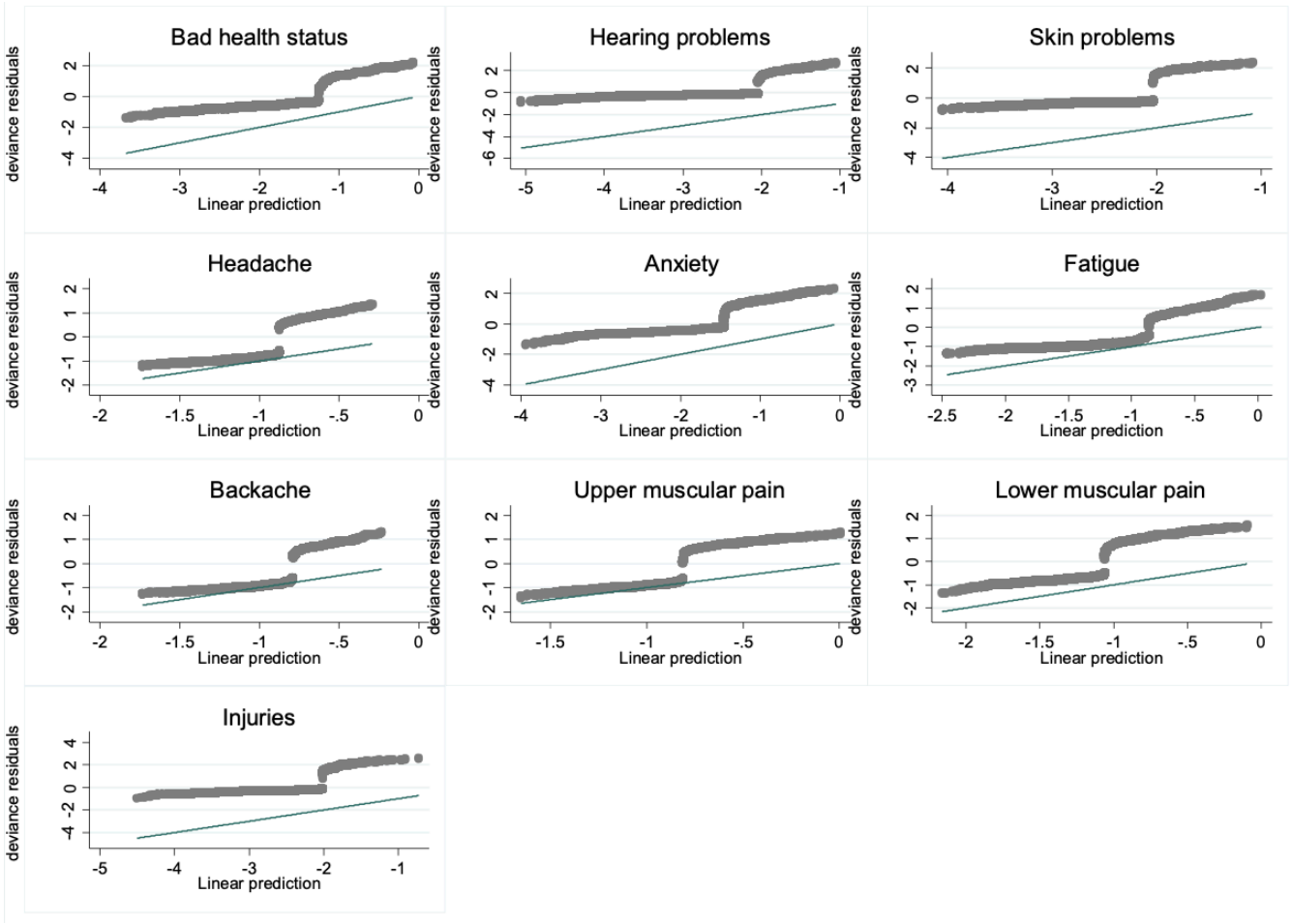
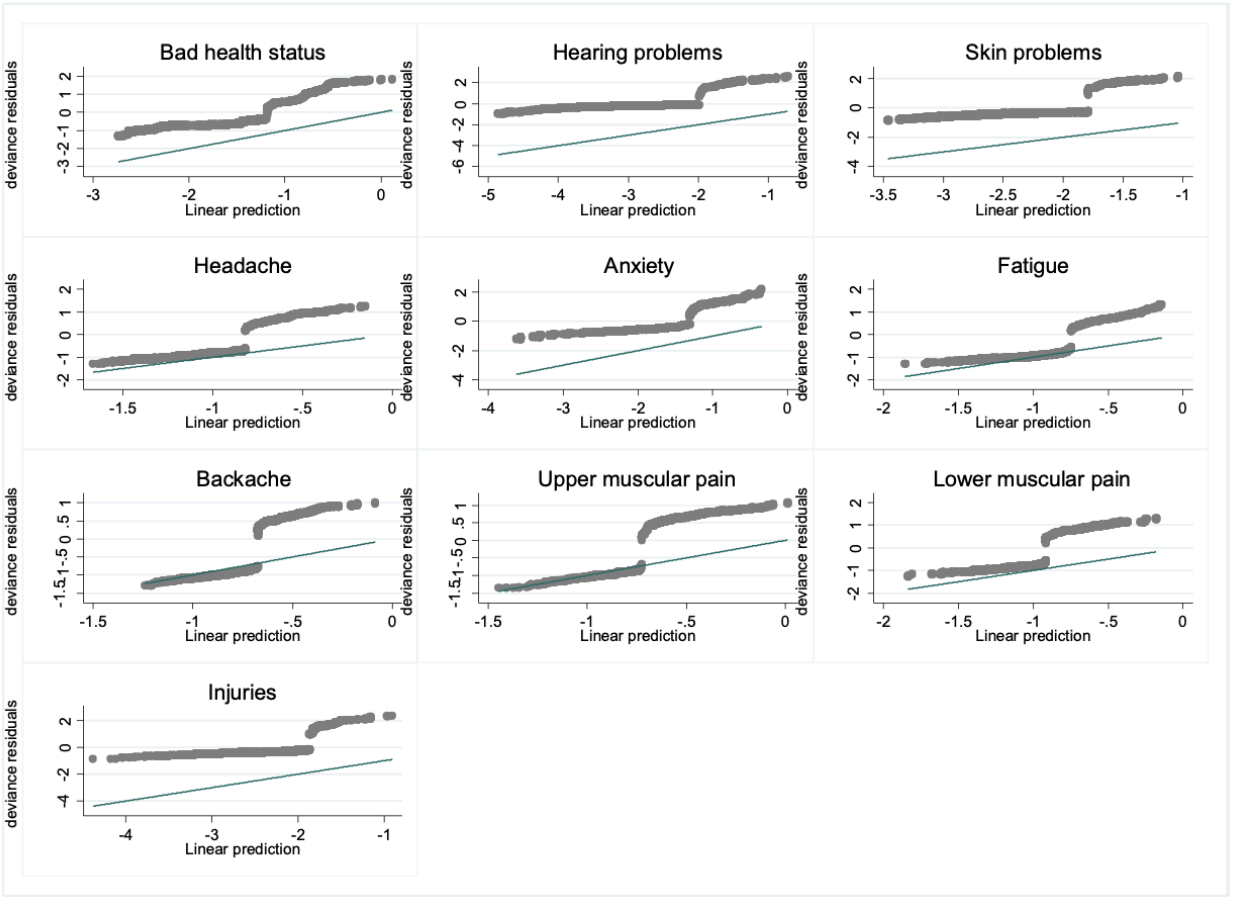


**Figure S3. Quantile-quantile plots for the deviance residuals and linear predictions of the multi-level generalized linear model, using the Poisson family, robust variances and country as the random effect, with exposure employment situation (unemployment and quartile 4 of precariousness) and health-related outcomes, adjusted by sex, age in categories, educational level and welfare regime.**



# ANNEX III. Supplementary Material of paper IV

**Supplementary Material**

**Gig economy delivery workers: use of protective equipment and driving behavior in Barcelona (Spain), 2018**

**Table S1. Comparison of the covariables, compliance with traffic regulations, use of personal protection equipment and vehicle protection between the included individuals with and without missings values in the variable age using motorcycle.**

| | Without missing values (n=147) | | With missing values (n=139) | |
|---|---|---|---|---|
| | **n** | **%(CI95%)** | **n** | **%(CI95%)** |
| **COVARIABLES** | | | | |
| **Sex** | | | | |
| ***Men*** | 142 | 96.6(93.6;100) | 137 | 98.6(96.6;100) |
| ***Women*** | 5 | 3.4(0.4;6.9) | 2 | 1.4(0;3.7) |
| **Company** | | | | |
| ***Deliveroo*** | 29 | 19.7(10.7;29.6) | 37 | 26.6(17.6;37.4) |
| ***Glovo*** | 90 | 61.2(52.2;71.1) | 74 | 53.2(44.2;64) |
| ***Stuart*** | 0 | 0(0;9.9) | 6 | 4.3(0;15.1) |
| ***UberEats*** | 21 | 14.3(5.3;24.2) | 17 | 12.2(3.2;23) |
| ***JustEat*** | 7 | 4.8(0;14.7) | 5 | 3.6(0;14.4) |
| **Observation time** | | | | |
| ***Midday*** | 65 | 44.2(35.2;55) | 59 | 42.4(33.4;53.1) |
| ***Evening*** | 82 | 55.8(46.8;66.6) | 80 | 57.6(48.6;68.2) |
| **Weather** | | | | |
| ***Good*** | 144 | 98(96;100) | 116 | 83.5(77.5;91.3) |
| ***Bad*** | 3 | 2(0;5.7) | 14 | 16.5(10.5;24.4) |
| **COMPLIANCE WITH TRAFFIC REGULATIONS** | | | | |
| **Respect traffic lights** | 131 | 97(95;100) | 135 | 99.3(98.3;100) |
| **Driving in the correct lane** | 132 | 94.3(90.3;98.4) | 136 | 97.8(95.8;100) |
| **USE OF PERSONAL PROTECTION EQUIPMENT** | | | | |
| **Use of helmet** | 143 | 97.9(95.9;100) | 139 | 100 (100;100) |
| **Use of gloves** | 7 | 4.8(1.8;9.3) | 14 | 10.1(5.1;16.4) |
| **USE OF VEHICLE PROTECTION** | | | | |
| **Phone holder** | 101 | 74.3(66.3;83.1) | 95 | 82.6(75.6;89.9) |

# ANNEX IV. Reviewers' responses of paper I

**Cover letter to the Editors in Chief of the Journal of Public Health**

Sant Cugat del Vallès (Spain), January 23th, 2018.

Professors Eugene Milne and Ted Schrecker

Editors in Chief

Journal of Public Health

Dear Eugene Milne and Ted Schrecker,

Please find enclosed our manuscript "Measuring precarious employment in Europe eight years into the global crisis" for your consideration in the Journal of Public Health as an *Original Paper*.

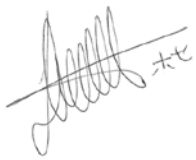
This manuscript describes, for the first time, the precarious employment prevalence eight years into the global crisis in the EU using a multidimensional approach. We show that two out of three EU workers have a precarious employment. Precarious employment is a well-known social determinant of health. Therefore, we conclude that the European Comission should take into account new employment forms and their health impact.

All the authors carefully read the manuscript and fully approve of it. In their name I also declare that the manuscript is original and it is not submitted anywhere other than your journal. The authors declare there are no conflicts of interest.

We would of course be ready to provide further information about our data and methods you desire. Correspondence about the manuscript should be addressed to me as indicated in the first page of the manuscript.

Thank you very much for your kind attention.

Yours sincerely,



Jose M Martínez-Sánchez, PhD, MPH, BSc

E-mail: jmmartinez@uic.es

**Point-by-point reply to reviewers' Comments of Paper I**

**Ref: JPH-18-0051**

**Measuring precarious employment in Europe eight years into the global crisis**

**Point-by-point reply to reviewers' Comments**

We would like to thank the reviewers for their useful comments.

## Reviewer 1

**Generally, good and interesting article on a relevant topic for public health. The following are comments to help the Authors to improve the manuscript.**
Thank you very much for the kind comments to our work.

**The Authors use a conceptualization of precariousness that differs from other previous studies they cite. For instance, low wages and limited social protection are not included, and it lacks the reason for doing that. It's because data source limitations? It should be stated. So, the explanation of how the precariousness variable was constructed in page 6 is a little confusing. Perhaps the reference # 7 is wrong, and the Authors should use the Vives et al 2011 published in the IJHS.**

We could not account for the dimensions of 'low wages' (current salary allows to cover the basic needs, to cover unexpected expenses and the net monthly wage or salary) and 'rights' (having a right to pension for old age or disability, severance pay or maternity/paternity leave), because the Eurobarometer 398 survey, survey that we used for this study, has not these questions in the questionnaire referring to that. As the reviewer suggested, we have now better addressed this in the methods section as follows:

> "[…] Given the available data in the Eurobarometer 398, we could not account for the dimensions low wages and limited social protection or rights for the construction of the variable precariousness. […]"

And in the discussion:

> "[…] Next, we could not account for the 6 dimensions described of precarious employment (42); not being able to take into account the factors "rights or limited social

> protection" and "wages", as there are no questions in the questionnaire referring to that, and that may have underestimated the prevalence shown in the study […]"

As the reviewer suggested, we have we have included the reference of Vives et al 2011, published in IJHS, in the methods section as follows:

> "The precarious employment variable was conceptualized as a multidimensional construct (39,76,86)"

---

References added:

Vives A, Vanroelen C, Amable M, et al. Employment Precariousness in Spain: Prevalence, Social Distribution, and Population-Attributable Risk Percent of Poor Mental Health. *Int J Heal Serv*. 2011.

**Along with this, in page 8 the Authors comment on an increase of precariousness prevalence from 2005 to 2014 in the EU even though this statement is based on different studies with different measurement methods – similar statement is made at first paragraph of page 10. Despite this limitation regarding different measures is mentioned in the discussion, in my opinion it should be given more importance.**

Thank you very much for the comment, we agree with the reviewer and now we discuss further the limitation of using different approaches in the discussion section. We have also added one more reference in regards to different ways in which precariousness has been measured as follows:

> "Although, it is important to take into account that the measurement of precariousness differed among the different studies, thus, making slightly different estimations among the prevalence of precariousness."

And:

> "It is important also, to take into account, that the use of an approach based on indicators with the available information has some data limitations for collecting all the desired information, such as not being able to include self-employed workers or not having information about the salaries or wages. Although, it enables to create large-scale evidence using existing data sources. Further, we believe the results obtained through this approach are

complementary to previous studies (45). Nevertheless, a validated scale like the one used in Spanish salaried workers (42), may be useful and necessary for the rest of Europe, in order to monitor the prevalence of precariousness and to disentangle the causes of increases in precariousness."

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References added:

Julià M, Vanroelen C, Bosmans K, Van Aerden K, Benach J. Precarious Employment and Quality of Employment in Relation to Health and Well-being in Europe. *Int J Heal Serv*. 2017;47(3):389-409. doi:10.1177/0020731417707491.

**At the end of page 8, I do not understand the term "tendency", which I think incorrect since no trend is described in this article. Should "relationship" be used?**

Thank you very much for the observation. We have changed the term as 'relationship' instead of 'tendency', just as the reviewer mentioned.

**Also, in the last line of this page, it looks strange to find the first mention to health status in this article out of the introduction; but health is not an objective and no result on health status is presented. I would suggest commenting on what the Authors think their results are important for the health of the working population beyond the association between temporariness and young age.**

We agree with the comment of the reviewer and now we discuss further how our results may impact the health of the working population in the discussion section as follows:

"Epidemiological evidence supports that non-standard employment forms (9) and flexible labor markets (87) have a negative health effect in the employees. Precarious employment has been previously associated with lower job satisfaction, general health and mental health in European Union salaried workers (74). Further, we have described differences in the precariousness prevalence according to age, age at the end of studies and welfare regime. Therefore, the high prevalence of precariousness described in our study may have important

consequences in the health of the working population and further, it may create health inequalities."

---

References added:

"Ferrie JE, Westerlund H, Virtanen M, Vahtera J, Kivimki M. Flexible labor markets and employee health. *Scand J Work Environ Heal Suppl*. 2008;(6):98-110."

"Van Aerden K, Puig-Barrachina V, Bosmans K, Vanroelen C. How does employment quality relate to health and job satisfaction in Europe? A typological approach. *Soc Sci Med*. 2016;158:132-140. doi:10.1016/j.socscimed.2016.04.017."

**Finally, at the end of 2nd paragraph in page 9, austerity policies "after the crisis" are mentioned regarding the high prevalence of precariousness in some countries. I think this is a too simple explanation. First, because some economical and structural characteristics are probably deeply related to precarious labour management practices and employment policies –i.e. high unemployment history in the south of Europe; and that may differ across countries. Second, because these policies may come from long time before "the crisis" that, in the other hand, is not defined in the article. I suggest re-writing this final part of this paragraph.**

As the reviewer suggested we have rewritten the paragraph and added more possible explanations for the differences found, also, we have included new references as follows:

"[…] Moreover, studies done in European workforce, have shown that precarious job types (low quality employment) are more prevalent in Southern and Eastern European countries, while SER-like and portfolio job types (high level quality employment) are more strongly present in Nordic and Central European countries (74). Our results therefore, are coherent with the welfare regime of these countries, while Nordic welfare regimes are characterized by active labor policies and reliable social protection measures, Southern, Eastern and Continental welfare regimes the social protection regulations are weak or highly fragmented, and labor policies follow principles of neo-liberalism (88). Further, austerity policies of these countries after the crisis and the

low quality of new employment forms (88) may have exacerbated the precariousness in those regimes."

---

References added:

"Dragano N, Siegrist J, Wahrendorf M. Welfare regimes , labour policies and unhealthy psychosocial working conditions : a comparative study with 9917 older employees from 12 European countries. *J Epidemiol Community Heal*. 2010:793-800. doi:10.1136/jech.2009.098541."

## Reviewer 2

**This is an interesting and simple study about the prevalence of precarious employment in the European Union using a multidimensional approach, eight years into the economic crisis. However, I have some comments in order to improve your manuscript:** Thank you very much for the kind comments to our work.

**ABSTRACT**

**In methods authors said employment "Two out of three workers had a precarious employment" but this is a result, which not should be in method section (PAGE 2, LINE 22).**

Thank you for noticing this. It was a mistake from reordering the abstract, so we state "Two out of three workers had a precarious employment" as a first sentence in the results section of the abstract as follows:

"Results: Two out of three workers had a precarious employment. […]The most prevalent factor was not having the ability to exercise rights (42.39%)."

**INTRODUCTION**

**Need to define precarious employment, because authors only define what dimensions compose it, but they not gave a theoretical definition (PAGE 3, LINE 18).**

Precarious employment has been defined in several ways. As the reviewer suggested, we have provided the definition broaden from Rodgers in 1989 as follows:

"[…] Precarious jobs are those, in which the risk of job loss is high, with a short time horizon, the control over

> working conditions, wages and pace of work is low, the extent in which workers are protected is poor (by law or through collective organizations) and workers suffer from poverty and insecure social insertion(28). […].

---

References:

Rodgers G, Rodgers J. *Precarious Jobs in Labour Maket Regulation. The Growth of Atypical Employment in Western Europe.*; 1989. Available from: http://staging.ilo.org/public/libdoc/ilo/1989/89B09_333_engl.pdf.

**METHODS**

**Describe the psychometric properties of the questionnaire used (PAGE 5).**

We use data from the Flash Eurobarometer questionnaire 398. The questionnaire covers questions related to working conditions, health and risks in the workplace, and socio-demographic characteristics. The questionnaire does not measure any construct, and therefore there is no available information regarding psychometric properties. However, we constructed a new variable (precarious employment) from several questions regarding working conditions. We used the dimensions previously described and validated in salaried Spanish working population (Vives et al., 2010). Now we mention this in the methods section as follows:

> "The prevalence of precarious employment was defined as the presence of one or more dimensions of precarious employment (as described previously by Vives et al. (42)). Vives et al (42), measured precarious employment through an instrument that has been previously validated in salaried Spanish working population (42) . A more detailed description of the construction of the variable precarious employment is in Figure 1."

However, currently this instrument is not validated for non-salaried workers. We have mentioned this limitation in the discussion section (please see second comment of the discussion of the reviewer #2).

**Some factors of the precarious employment only have integrated by one or two items, so I recommend substitute the word "factor" by "indicator or dimension". In fact, there is a discussion about if a single item can reflect a construct, while some authors have recommended against retaining factors with fewer than three items (Tabachnick & Fidell, 2001), others said that only is possible with two items when them are highly correlated (Worthington & Whittaker, 2006). So, I consider that if substitute factor by dimension, would be more conservative, also the authors said that the evaluation or precarious employment is multidimensional, so unified with "dimension" would not affect the manuscript in general.**

Thank you very much for the comment. We completely agree with the reviewer comment, and as he/she suggested, we have changed the word "factor" by "dimension" throughout the manuscript.

**In description of the factors of precarious employment, authors confuse items with the answer options; "temporariness" was evaluated by the answer to one question. So, describe that the indicator was constructed when some of those response options was responded (PAGE 5, LINE 49).**

We agree with the comment of the reviewer and we have rephrased this in methods section as follows:

> "[…] "temporariness" (constructed when some of those response options were responded: temporary employment agency contract, fixed term contract, apprenticeship or other training scheme)."

**Describe the reason why consider age at the end of education, instead of level of education (PAGE 6, LINE 5).**

Unfortunately, the Flash Eurobarometer 398 questionnaire did not include a specific question for the level of education of the participant; instead, it included the variable age at the end of education. Age at the end of education would be a proxy of level of education, understanding that being older at the end of the studies would mean higher levels of education. We have included a description of the variable "age at the end of the studies" in the methods section as follows:

> "Also, we include age at the end of education (<15 years, 16-19 years, >20 years, still studying), which would be a proxy of level of education (understood as the higher the

age is at the end of the studies, the higher the level of education is)."

**DISCUSSION**

**Discuss the implications of the definition of precarious employment with at least having one of the four dimensions, as there could be an overestimation.**

We have defined the prevalence of precariousness based on previous studies for being consistent. Nevertheless, we agree with the reviewer that the use of one dimension for defining precarious employment could be overestimated the prevalence. We have added this limitation in the discussion section as follows:

"[…] On the contrary, using the definition of precariousness of having at least one dimension may have overestimated the prevalence. […]"

**Describe if there have been evaluations of the precarious employment construct with the questionnaire used.**

We have not evaluated the precarious employment construct because it was not the main objective our study. However, we constructed the variable precariousness using proxy indicators of each of the dimensions described previously in the questionnaire designed to measure precariousness. That questionnaire was validated in salaried Spanish working population (Vives et al., 2010). We have mentioned, in the methods section that the instrument used to measure the precarious employment was previously validated for salaried workers (see first comment of the methods section of the reviewer #2). However, this instrument currently is not validated for non-salaried workers. For this reason, we have recommended in the discussion section that the creation of a validated questionnaire for salaried and non-salaried working population is necessary and so, the use of the questionnaire for the rest of Europe. We now discuss further the limitations of using this approach for measuring the variable precarious employment in the discussion as follows:

"It is important also, to consider, that the use of an approach based on indicators with the available information has some data limitations for collecting all the desired information, such as not being able to include self-employed workers or not having information about the salaries or wages. However, it enables to create large-scale evidence using existing data sources. Moreover, we

> believe the results obtained through this approach are complementary to previous studies (45). Nevertheless, a validated scale like the one used in Spanish salaried workers (42), but that took into account non-salaried workers as well, may be useful and necessary for the rest of Europe, in order to monitor the prevalence of precariousness and to disentangle the causes of increases in precariousness."

**Due to the difference in the measurement of the variables in previous evaluations, it cannot be assured that this increase is not due to the measurement, especially when in this work it is considered as precarious work with at least one dimension, so the authors have to describe the definition of precarious employment in those evaluations (PAGE 8, LINE 38).**

We agree with the comment of the reviewer, which it was in the same line as a previous comment of the reviewer 1 (please see responses to second comment of the reviewer #1). So, we now state, that the increase in precariousness prevalence cannot be assured as the measurement of precariousness differed in between studies, in the discussion section as follows:

> "Although, it is important to take into account that the measurement of precariousness differed among the different studies, thus, making slightly different estimations among the prevalence of precariousness."

**Describe the implications of the prevalence of each factor of the precarious employment (TABLE 2)**

We believe that the main implications of the differences found according to each of the precariousness dimensions would be related to the policies focused on reducing precarious employment. As the reviewer suggested, we have described it in the discussion section as follows:

> "Key policies and interventions for reducing precarious employment and its health inequalities have already been described elsewhere [35]. Given that the dimensions "to not be able to exercise rights" and "vulnerability" were the most prevalent, an objective of the policies may be to decrease the prevalence of each of these dimensions. Some examples of

> those would be to limit temporary contracts, to create incentives and sanctions for reduction of employment violations, to provide incentives for unionization and collective bargaining, and to define integrated minimum labor standards."

**Discuss the limitations of not having taken into account self-employment, because by definition it is a situation of precarious employment.**

As the reviewer suggested, we have specified that the measure of precarious employment has been limited to individuals in (formal) waged employment, thus excluding self-employment, because the available data from the dataset was not enough to measure precariousness in other forms of employment relationships (most of questions referring on employment quality were designed for individuals in formal waged employment). We have included it in the methods section as follows:

> "[…] For the purpose of the present study, we excluded people who declared not to be working, self-employed (due to lack of variables regarding employment quality), […]"

Furthermore, we have also suggested that future studies analyzing the precarious employment could beneficiate from including self-employed arrangements in their analysis. We have included it in the discussion section as follows:

> "Further, precarious employment has been measured in individuals with a formal employment contract, thus excluding self-employment, because the available data from the dataset was not enough to measure precariousness in other forms of employment. It is important also, to consider, that the use of an approach based on indicators with the available information has some data limitations for collecting all the desired information, such as not being able to include self-employed workers or not having information about the salaries or wages."

And

> "[…] Nevertheless, a validated scale like the one used in Spanish salaried workers (42), but that took into account

non-salaried workers as well, may be useful and necessary for the rest of Europe, in order to monitor the prevalence of precariousness and to disentangle the causes of increases in precariousness."

**Authors should to describe possible reason to increase in the precarious prevalence from 2005**

Following the comment of the reviewer, we hypothesize different reasons for the increase observed in the precarious employment from 2005 to 2014 in the discussion section as follows:

"Since 2005, there have been important changes in the labor markets of the EU countries that could explain the increase seen in the precariousness prevalence. First, increases in unemployment have been correlated to a deterioration in working conditions (17), in the EU, the unemployment rates increased from 21 million persons (2005) to 25 million persons (2014) (89). Further, there have been an increase in new forms of employment poorly regulated, such as casual work or crowd employment (4), which could represent new risks for deteriorating the employment conditions. Moreover, the economic crisis has been associated with an increase in job insecurity among workers (90), which would be related to precarious conditions of employment."

---

New references added:

Eurostat. Unemployment rates in the European Union. Available at: http://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Unemployed_persons,_in_millions,_seasonally_adjusted,_EU-28_and_EA-19,_January_2000_-_March_2018_.png.

Eurofound. *New Forms of Employment*. Luxembourg; 2015. doi:10.2806/989252.

Torá I, Martínez JM, Benavides FG, Leveque K, Ronda E. Effect of economic recession on psychosocial working conditions by workers' nationality. *Int J Occup Environ Health*. 2015;21(4):328-332. doi:10.1080/10773525.2015.1122369.

**FIGURES AND TABLES**

**I consider that Figure 1 is a table.**

As the reviewer suggested, we changed Figure 1 by table 1.

**References:**

**Roger L. Worthington and Tiffany A. Whittaker. Scale Development Research A Content Analysis and Recommendations for Best Practices. The Counseling Psychologist. 2006, 34(6);806-838.**

**Tabachnick, B. G., & Fidell, L. S. (2001). Using multivariate statistics (4th ed.). New York: Harper & Row.**

Thank you for the interesting references. We did not include them in our manuscript because we did not create a scale neither validated it (see response to 2nd comment to reviewer #2).

**Letter of acceptance of paper I**

20-May-2018

Dear Dr Martínez-Sánchez:

Manuscript ID JPH-18-0051.R1 entitled
"Measuring precarious employment in Europe eight years into the global crisis" which you submitted to the Journal of Public Health, has been reviewed. The comments of the reviewer(s) are included at the bottom of this letter.

The reviewer(s) have recommended publication, but also suggest some minor revisions to your manuscript. Therefore, I invite you to respond to the reviewer(s)' comments and revise your manuscript.

To revise your manuscript, log into https://mc.manuscriptcentral.com/jph and enter your Author Center, where you will find your manuscript title listed under "Manuscripts with Decisions." Under "Actions," click on "Create a Revision." Your manuscript number has been appended to denote a revision.

You will be unable to make your revisions on the originally submitted version of the manuscript. Instead, revise your manuscript using a word processing program and save it on your computer.

Please ensure the word count is below 3000 words.

Once the revised manuscript is prepared, you can upload it and submit it through your Author Center.

When submitting your revised manuscript, you will be able to respond to the comments made by the reviewer(s) in the space provided. You can use this space to document any changes you make to the original manuscript. In order to expedite the processing of the revised manuscript, please be as specific as possible in your response to the reviewer(s). Please also attach a file with changes tracked, showing how you have responded to comments, as well as a clean copy of the manuscript.

IMPORTANT: Your original files are available to you when you upload your revised manuscript. Please delete any redundant files before completing the submission.

Because we are trying to facilitate timely publication of manuscripts submitted to the Journal of Public Health, your revised manuscript should be uploaded as soon as possible. If it is not possible for you to submit your revision in a reasonable amount of time, we may have to consider your paper as a new submission.

Once again, thank you for submitting your manuscript to the Journal of Public Health and I look forward to receiving your revision.

Kind Regards

Professor Eugene Milne

Co-editor, Journal of Public Health

JPH.editorialoffice@oup.com

Editor's Comments to Author:

I will be happy to accept this paper once it has had thorough proof-reading and correction for English grammar. Please see that this is done to a first-language standard before final submission. Thank you.

# ANNEX V. Reviewers' responses of paper II

**Cover letter to the Editors in Chief of the Critical Public Health Journal.**

Barcelona, September 4th, 2018.

Judith Green and Lindsay McLaren

Editors

Critical Public Health

Dear Judith Green and Lindsay McLaren,

Please find enclosed our manuscript "Association between precarious employment and health related outcomes in the European Union" for your consideration in Critical Public Health as a *Research paper*.

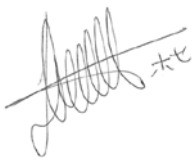
Previous studies have evaluated the relationship between precarious employment and health using a unidimensional approach. Our study is one of the largest studies describing the association between precarious employment, understood as a multidimensional construct, and health related outcomes in the European Union. The present study suggests that precariousness is associated with health problems, sick leave and exposure to violence, stress and repetitive movements or painful positions. According to our results, European Union politicians should regulate precarious employment forms in order to prevent their negative impact in the society.

All the authors carefully read the manuscript and fully approve of it. In their name I also declare that the manuscript is original and it is not submitted anywhere other than your journal. The authors declare there are no conflicts of interest.

We would of course be ready to provide further information about our data and methods you desire. Correspondence about the manuscript should be addressed to me as indicated in the first page of the manuscript.

Thank you very much for your kind attention.

Yours sincerely,



Jose M Martínez-Sánchez, PhD, MPH, BSc

E-mail: jmmartinez@uic.es

## Point-by-point reply to reviewers' Comments of Paper II

**Ref: CCPH-2018-0220**

**Association between precarious employment and health related outcomes in the European Union**

**Point-by-point reply to reviewers' Comments**

We would like to thank the reviewers for their useful comments. We have increased the critical content to better contextualize our results.

**Reviewer: 1**

**Thank you for submitting this manuscript. It deals with an important topic of clear relevance to public health, and it will be of particular interest to the readership of Critical Public Health. You start by describing how in the last few years neoliberal policies have led to the casualisation of the work force, exemplified through many forms of precarious employment. Your hypothesis is that there is a positive connection between such forms of employment and negative health outcomes. You test this hypothesis by performing secondary analysis of cross-sectional data from 28 countries, collected in 2014 (i.e. a few years since the most recent financial crisis began).**

**My comments below aim to help you further refine and strengthen your argument.**

Thank you very much for the kind comments to our work and for the recommendations and suggestions you raised to our work. They certainly improved the quality of the manuscript.

**Abstract**

**In the abstract, and also elsewhere in the manuscript, you talk about the negative impact of precarious employment on health. However, your methodology was not designed to examine causal relationships but associations. Please reword/rephrase where necessary.**

We agree with the reviewer, we have rephrased the final conclusion of the abstract as follows:

> "Therefore, we recommend prioritizing legislative measures for reducing non-standard arrangements and for improving the conditions of workers at non-standard arrangements."

We have also reworded through the manuscript all the sentences that could mislead the methodology that we used.

**Introduction and background**

**You offer some helpful information in this section, but as it stands it is quite short and some important background information is missing. More specifically, please elaborate on:**

**a) The transformation from standard employment to precarious employment (i.e. the casualisation of the work force) in the European Union.**

Thank you for the recommendation. We believe it is important also to explain the casualization of the workforce because it has its origins from an important economic crisis (mid-1970s). Recently, we suffered a global financial crisis (mid-2000s) which has had also important market regulations, and that may have influenced the creation of more employment relations based on casual work (we discuss also this further in the next comment of the reviewer). We have included more information of casualization of the workforce in the introduction section as follows:

> "In the mid-1970s there was an economic downturn driven by the economic oil, which resulted in important political and economic changes (Scott 2004). To surpass this economic crisis, a shift from Keynesianism (generous welfare states, strong labor unions and strong regulation of employment relations) toward neoliberal economic policies happened in most industrialized countries, including the ones belonging at the moment to the European Union (Palley 2005). That implied a change in the structure of the labor markets to make them more flexible, to prioritize the casual workforce, because employers 'needed' to ease the movement of the workers into and out of jobs (Standing 2014)."

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References added:

Palley, Thomas I. 2005. "From Keynesianism to Neoliberalism: Shifting Paradigms in Economics." *Neoliberalism: A Critical Reader*, no. April: 20–29. doi:10.1108/08876041011060440.

Scott, Heather K. 2004. "Reconceptualizing the Nature and Health Consequences of Work-Related Insecurity for the New Economy: The Decline of Workers' Power in the Flexibility Regime." *International Journal of Health Services* 34 (1): 143–153.

doi:10.2190/WAM3-MNN2-6UNF-FDEX.

Standing, Guy. 2014. “The Austerity Area.” In *A Precaritat Charter: From Denizens to Citizens*, 1st ed. Bloomsbury Academic.

**b) The characteristics and the effects of precarious forms of employment, including who gets affected (gender, disability, age, and education might be dimensions that need to be raised, especially if you want to discuss these later on).**

We agree with the reviewer, we have added more information about how employment conditions are affected by gender, age, education and political and economic determinants in the introduction as follows:

> “Furthermore, employment relations are affected by power relations at society, thus by axes of social inequality such as social class, gender, race, age, level of education, etc. (Muntaner et al. 2010). Also, by political and economic determinants such as labor market policies and welfare regimes (Dragano, Siegrist, and Wahrendorf 2011). Therefore, precarious employment may be defined as well by all those characteristics. It has been previously described that non-standard arrangements and precariousness is more common among the most vulnerable labor market individuals; women, younger, immigrants, with lower educational level and from manual social classes (Committee on Employment and Social Affairs. 2016; Benach et al. 2014).”

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References added:

Dragano, Nico, Johannes Siegrist, and Morten Wahrendorf. 2011. “Welfare Regimes, Labour Policies and Unhealthy Psychosocial Working Conditions : A Comparative Study with 9917 Older Employees from 12 European Countries.” *Journal of Epidemiology & Community Health* 65: 793–799. doi:10.1136/jech.2009.098541.

Muntaner, Carles, Carme Borrell, Christophe Vanroelen, Haejoo Chung, Joan Benach, Il Ho Kim, and Edwin Ng. 2010. “Employment Relations, Social Class and Health: A Review and Analysis of Conceptual and Measurement Alternatives.” *Social Science and Medicine* 71 (12). Elsevier Ltd: 2130–2140. doi:10.1016/j.socscimed.2010.09.038.

**c) The financial crisis which forms the background, since data were collected in 2014, when several of the EU28 countries (and especially the Southern European countries and Ireland) were experiencing severe effects and undergoing ambitious restructuring programmes.**

We appreciate your recommendation. Linked with the previous comment (#a) we have discussed further the implications of the recent global economic crisis in the quality of employment arrangements in the introduction as follows:

> "The economic crisis released by the bank failures of 2008 has been one of the most severe. With the experience and evidence of past recessions, (Peters 2008), it would be expected a deterioration of the employment quality. Results from the European Social Surveys (19 European countries), pointed that the quality of work was affected by the crisis through a decline in the opportunities for training, and a rise in work intensity, job insecurity and work-family conflict among workers from 2004 to 2010 (Gallie 2013). Further, there is evidence that the proportion of jobseekers accepting non-atypical employment arrangements (temporary agency work, fixed-term work, zero hours contracts) increased in Europe the years following the crisis (Committee on Employment and Social Affairs. 2016). […]"

Moreover, we have mentioned it in the Discussion section as follows:

> "Further, according to the different measures/reforms undertaken during the economic crisis (employment protection legislation, unemployment benefits, wage setting) in some of the countries of the European Union, that may have exacerbated the proportion of precariousness and its health effects ( (Escribà-Agüir and Fons-Martinez 2014). More particularly, the largest changes occurred in the southern European countries, that suffered the most severe shocks in terms of GDP and unemployment, and therefore they adopted more structural measures (employment protection, criteria for

unemployment benefits and structure of the collective bargaining system). Also, Ireland suffered from structural measures, but, as can be observed through the OECD's employment protection index, the index from southern European countries declined considerably between 2008 and 2013, and instead, for Ireland there was almost no change, because the labour markets were already flexible before the crisis for this country (Izquierdo et al. 2017). Changes in the time of adoption of measures for the economic crisis according to each country may explain also the differences found. During the initial phases of the crises (2007-10) many countries adopted measures to maintain employment, but as crisis progressed, some countries had to apply more in-depth reforms (Izquierdo et al. 2017). As in this study we are using data from 2014, we could be observing the possible effects of the applied reforms by some countries during the initial phases of the crises, but not those that were undergoing at the moment, or were applied recently."

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References added:

Escribà-Agüir V, Fons-Martinez J (2014) Economic crisis and employment conditions: gender differences and the response of social employment policies. SESPAS report 2014. Gac Sanit 28:37–43 . doi: 10.1016/j.gaceta.2014.01.013

Gallie, Duncan. 2013. *Economic Crisis , Quality of Work and Social Integration : Topline Results from Rounds 2 and 5 of the European Social Survey*. *Centre for Comparative Social Surveys*. London. http://www.nesstar.com/index.html%0Ahttp://www.europeansocialsurvey.org.

Izquierdo M, Jimeno JF, Kosma T, et al (2017) Labour Market Adjustment in Europe During the Crisis: Microeconomic Evidence from the Wage Dynamics Network Survey. Ssrn. doi: 10.2139/ssrn.2999598

Peters, John. 2008. "Labour Market Deregulation and the Decline of Labour Power in North America and Western Europe." *Policy and Society* 27 (1): 83–98. doi:10.1016/j.polsoc.2008.07.007.

**Methodology**

**You need to offer more information regarding the survey. I understand that you**

**performed secondary analysis of cross-sectional data (this needs to be explicitly stated) but still you need to offer some information, and at the very least: when (and whom by) was the study carried out, representativeness of sample, confidentiality. You also need to state how you gained access to the microdata and whether it is publicly available.**

As the reviewer suggests, we have given more details regarding the survey. Regarding the representativeness of the sample, a multi-stage random sampling design was used. The sample is representative of residents of each country that have a sufficient command of the national language to answer the questionnaire. Further, in our statistical analysis we took into account that most of the countries have almost identical samples sizes (n=1,000), no matter how large or small their populations are, therefore we used population size weighting to ensure that each country is represented in proportion to its population size. We have stated it in Methods section as follows:

> "This is a cross-sectional study based on secondary data […]. The survey was carried out between the 3rd and 5th April 2014 by the TNS Political & Social, a consortium created between TNS political & social, TNS UK and TNS opinion. It was requested by the European Comission, Directorate-General for Employment, Social Affairs and Inclusion (European Comission 2014). […]Therefore, the survey covers the population of citizens of all the European Union Member States that are residents in these countries and have a sufficient command of the national languages to answer the questionnaire by 2014. […]The data is anonymous and publicly available at GESIS Data Archive (European Commission-Brussels 2014)."

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References added:

European Commission-Brussels. 2014. "Flash Eurobarometer 398 (Working Conditions)." Cologne: GESIS Data Archive. doi:10.4232/1.11949.

**You need to clearly state your aim (and hypothesis if you used one); at the moment these are implied but not explicitly stated.**

We have clarified our aim in the Introduction section and we have also included our research hypothesis as follows:

> "We hypothesize that individuals with a precarious employment will have higher prevalence of health-related problems, and will be more frequently exposed to risks at the workplace. Regarding the sick leave, we believe the associations could be in two different directions: those individuals with a precarious employment will have more health problems and therefore higher proportion of sick leave, or, it could be possible that due to the job insecurity of the precariousness, they would not take sick leave or take it when the illness is really severe. Further, we expect that the prevalence of health-related outcomes among individuals with precarious employment will be higher among most vulnerable groups (women, younger and those with lower educational level) and also, among those individuals living in countries with regimes with poorer social policies."

**If I understand correctly, you used several dimensions to describe the concept 'precarious employment'. Some issues that need clarification here are the following:**

**a) Did you develop the definition of "precarious employment" (if so, how?), or is it taken from Vives, or other sources?**

Based on the validated scale in Spanish salaried workers for measuring precarious employment (EPRES), we constructed the variable precariousness based on four out of the six dimensions proposed in the EPRES: "do not exercise rights", "vulnerability", "disempowerment", "temporariness". This construct is an approach based on indicators obtained through the questionnaire. As reviewed suggested, we have included this amplified definition in the methods section as follows:

> "We defined the variable based on the validated scale in Spanish salaried workers for measuring precarious employment (EPRES) (Vives et al. 2010), based on several indicators obtained through the questions as follows and classified in 4 dimensions"

**b) You need to clarify whether the stated dimensions all describe the same concept; did you, for example, check for internal consistency?**

We constructed the variable precariousness using proxy indicators of each of the dimensions described previously in the questionnaire designed to measure precariousness, which was validated in the salaried Spanish working population (Vives et al., 2010). The definition of precarious employment was to have one or more than one item in at least one dimension (temporariness, vulnerability, do not exercise rights and disempowerment). So, not necessarily a lot of items must be present to classify an individual in precarious employment. Thus, we may not expect a high correlation among the items. Nevertheless, as the reviewer suggested, we checked for internal consistency of our instrument using the Kuder-Richardson Formula 20 (KR-20), which is a measure of internal consistency reliability for measures with dichotomous choices. We obtained a coefficient of 0.3, which would be similarly interpreted as the coefficient given by the Cronbach's alpha.

If the editor considers it necessary to add this information in the manuscript, the authors do not have any problem in adding it.

**Minor comments:**

**You report that 507 people were excluded due to missing data. Did this introduce any bias and did it affect the representativeness of the sample?**

Thank you for your suggestion. We realized that those with missing values in the four factors of precariousness are not 507, if not 3825, this was a typo error. We changed the numbers in the methods section. In order to understand if the exclusion of those with missing values was introducing bias or affecting the representativeness of the sample, we compared the covariates and the health related outcomes of those excluded (by the missing values in the precarious employment variable) and those included and we are showing them at the Table S1.

We have included the explanation of this analysis in the statistical analysis as follows:

> "In order to understand if the exclusion of those with missing values (n=3825) may have introduced any bias we compared the characteristics of the included and excluded individuals."

We have also included, the results obtained in the results section as follows:

> "Among those included in the sample, 59.7% were men, 41% were 40-54 years old, 54.3% were aged more than 20 years old when finishing their studies and 36.4% were from Continental welfare regime. The proportion of women, younger workers, those with lower ages by the end of the studies, and the prevalence of infectious

> diseases, allergies and exposure to carrying or moving loads daily was higher in the excluded participants due to missing values than in the included. Also, the prevalence of exposure to stress, and noise was higher in the included than excluded individuals. (Table S1)"

We have also discussed the implications of the differences found in the Discussion section as follows:

> "Moreover, the proportion of those excluded due to missing values was higher in women, younger workers and those with lower educational level. On one hand, that may have underestimated the proportion of precarious employment, as those groups have been described the most vulnerable for suffering from precarious employment (Committee on Employment and Social Affairs. 2016). On the other hand, we did not find a clear pattern of differences in the proportions of health related outcomes between the excluded and included individuals, so the magnitude of the associations would not be biased."

**Table 1 (descriptive statistics) should show the differences between people in precarious and non-precarious employment.**

Thank you for your recommendation. We have added the non-precarious employment people in the table, and we have also added the confidence intervals for each proportion.

**Covariates: Why did you choose "age at the end of education"? What about people that interrupted their education and continued it later? Could you have used "years of education" instead?**

Given the data availability, the questionnaire did not include a specific question for level of education; instead it included the variable "age at the end of education". We considered 'age at the end of education' as a proxy of 'level of education', understanding that being older at the end of the studies would mean higher levels of education. Of course, this has some limitations as the one stated by the reviewer; people that may have interrupted their education. So, we have included a description of the variable "age at the end of the studies" in the methods section as follows:

> "age at the end of education (<15 years, 16-19 years, >20 years, still studying), which would be a proxy of level of education (understood as the higher the age is at the end of the studies, the higher the level of education is) […]"

Further, we have included the possible limitation of using this variable in the Discussion section:

> "Further, we used the variable age at the end of the education as a proxy of level education which could have misclassified those individuals that interrupted their education as 'higher level of education' being not necessarily the case."

**Findings and Discussion**

**The results were appropriately presented and you offered a well-argued discussion. You mention that precarious employment might affect women more severely than men, but you need to expand on this; how/ why does this happen? Can you offer any possible reasons?**

We have given three possible explanations of why precarious employment may affect in higher levels women than men. Mainly we refer to the underrepresentation of women in labor trade unions, the breadwinner model and the burden of household responsibility of women, and the gender division in the labor market. We have discussed it in discussion as follows:

> "That may be explained by the low level of trade union involvement in the 'feminized fields' and the lack of representation of women's interests in the labor movement (Ledwith 2012). Also, driven by the patriarchy and the breadwinner model, and according to the 'human capital theory' women bear greater burden of household responsibility and housework than men, and that may push them to accept non-standard arrangements of work to facilitate their work-life balance (Hašková and Dudová 2016; Artazcoz et al. 2018). Further, the gender division in the labor market (occupational gender segregation), which tends to exclude women from jobs characterized by better working conditions and greater prestige (Bettio and Verashchagina 2009)."

References added:

Artazcoz L, Cortès-Franch I, Escribà-Agüir V, et al (2018) Long Working Hours and Job Quality in Europe: Gender and Welfare State Differences. Int J Environ Res Public Health 15: . doi: 10.3390/ijerph15112592

Bettio F, Verashchagina A (2009) Gender segregation in the labour market: Root causes, implications and policy responses in the EU

Hašková H, Dudová R (2016) Precarious work and care responsibilities in the economic crisis. Eur J Ind Relations 23:47–63 . doi: 10.1177/0959680116672279

Ledwith S (2012) Gender politics in trade unions. The representation of women between exclusion and inclusion. Transf Eur Rev Labour Res 18:185–199 . doi: 10.1177/1024258912439145

**Also, I think it would be useful to discuss the findings in relation to the financial crisis and the casualisation of labour; you could, perhaps, use literature from countries that have gone through extensive neoliberal restructuring of their economies, such as Chile, or that have a high percentage of casual labour force, to discuss the negative effects of precarious employment.**

Thank you for your suggestion. In relation to this suggestion and the following one of the reviewer, we discuss the differences among the welfare regimes and the main reasons of the reason found (one of them, the economic crisis). We have added this in the discussion as follows:

> "Finally, we described differences in precariousness according to welfare regime; being higher among Eastern, Southern and Continental welfare regimes. Further, the prevalence of health problems and exposure to some risks was more strongly associated to precarious employment in Continental, Anglo-Saxon and Eastern European welfare regimes, while the prevalence of sick leave of more than 15 days was more strongly associated with precariousness in Nordic welfare regimes. That may be explained because in Nordic welfare regimes, active labor policies and reliable social protection are the norm, while in the other welfare regimes, social protection regulation is weak or highly fragmented, and labor policies follow principles of neo-liberalism (Dragano et al. 2010; Artazcoz et al. 2018). More specifically, welfare

regime may protect the health damage of hazardous work conditions through sickness absence compensation, active labor market policies, generous out-of-work benefits, higher minimum wages, taxation-financed service provision (care for children and the elderly to reduce the work-life balance conflicts) and greater power for labor unions (Bambra et al. 2014). Based on previous research of the impact of liberalization of the markets, in the case of post-socialist EU member states (classified as Eastern European Welfare regimes), the transition resulted in a decline in unionization and in higher levels of perceived job insecurity (Dixon et al. 2013). Further, according to the different measures/reforms undertaken during the economic crisis (employment protection legislation, unemployment benefits, wage setting) in some of the countries of the European Union, that may have exacerbated the proportion of precariousness and its health effects (Escribà-Agüir and Fons-Martinez 2014). More particularly, the largest changes occurred in the southern European countries, that suffered the most severe shocks in terms of GDP and unemployment, and therefore they adopted more structural measures (employment protection, criteria for unemployment benefits and structure of the collective bargaining system). Also, Ireland suffered from structural measures, but, as can be observed through the OECD's employment protection index, the index from southern European countries declined considerably between 2008 and 2013, and instead, for Ireland there was almost no change, because the labour markets were already flexible before the crisis for this country (Izquierdo et al. 2017). Changes in the time of adoption of measures for the economic crisis according to each country may explain also the differences found. During the initial phases of the crises (2007-10) many countries adopted measures to maintain employment, but as crisis progressed, some countries had to apply more in-depth reforms. As in this study we are

using data from 2014, we could be observing the possible effects of the applied reforms by some countries during the initial phases of the crises, but not those that were undergoing at the moment, or were applied recently."

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References added:

Artazcoz L, Cortès-Franch I, Escribà-Agüir V, et al (2018) Long Working Hours and Job Quality in Europe: Gender and Welfare State Differences. Int J Environ Res Public Health 15: . doi: 10.3390/ijerph15112592

Bambra C, Lunau T, Van Der Wel K, et al (2014) Work, health, and welfare: The association between working conditions, welfare states, and self-reported general health in Europe. Int J Heal Serv 44:113–136 . doi: 10.2190/HS.44.1.g

Dixon JC, Fullerton AS, Robertson DL (2013) Cross-national differences in workers' perceived job, labour market, and employment insecurity in Europe: Empirical tests and theoretical extensions. Eur Sociol Rev 29:1053–1067 . doi: 10.1093/esr/jcs084

Dragano N, Siegrist J, Wahrendorf M (2010) Welfare regimes , labour policies and unhealthy psychosocial working conditions : a comparative study with 9917 older employees from 12 European countries. J Epidemiol Community Heal 793–800 . doi: 10.1136/jech.2009.098541

Escribà-Agüir V, Fons-Martinez J (2014) Economic crisis and employment conditions: gender differences and the response of social employment policies. SESPAS report 2014. Gac Sanit 28:37–43 . doi: 10.1016/j.gaceta.2014.01.013

Izquierdo M, Jimeno JF, Kosma T, et al (2017) Labour Market Adjustment in Europe During the Crisis: Microeconomic Evidence from the Wage Dynamics Network Survey. Ssrn. doi: 10.2139/ssrn.2999598

**Given the differences between the countries included in the study, a table showing differences between the countries (or at least the country typologies as stated in table 1) would be helpful, if possible.**

We completely agree with the suggestion of the reviewer. We believe that to show the differences among welfare regime countries classification could be useful for policy makers and also to support the policy recommendations we discuss in the discussion. We are showing the adjusted prevalence ratios of health problems, sick leave and exposure to risks according to precarious or no precarious employment stratified by welfare regime classification as Supplemental Material (Table S2).

We have added this new analysis in the methods section as follows:

"[…] Moreover, we stratified the adjusted analysis by sex and welfare regime […]"

We have added the results found in the results section as follows:

> "[…] When stratifying by welfare regime, the results were in the same line (Table S2). The highest magnitude of the associations for more than one heath problem was in continental welfare regime [aPR: 1.57, (CI95%: 1.39;1.77)], and the lowest was in Nordic welfare regime [aPR: 1.19, (CI95%: 1.14;1.24)]. […]"

And

> "When stratifying by welfare regime, the highest magnitudes of the association for sick leave of more than 15 days was in Nordic welfare regime compared to the continental (Table S2)."

And

> "When stratifying by welfare regime, the highest magnitudes of the association for exposure to violence was in Southern welfare regime compared to the Anglo-Saxon (Table S2)."

We have discussed these results in the Discussion section as follows:

> "Finally, we compared the proportion of precariousness according to welfare regime; being higher among Eastern, Southern and Continental welfare regimes. Further, the prevalence of health problems and exposure to some risks was more strongly associated to precarious employment in Continental, Anglo-Saxon and Eastern European welfare regimes, while the prevalence of sick leave of more than 15 days was more strongly associated with precariousness in Nordic welfare regimes. That may be explained because in Nordic welfare regimes, active labor policies and reliable social protection are the norm, while in the other welfare regimes, social protection regulation is weak or highly fragmented, and labor policies follow principles of neo-liberalism (Dragano et al. 2010; Artazcoz et al. 2018). More specifically, welfare regime may protect the health damage of hazardous work conditions through sickness absence compensation,

active labor market policies, generous out-of-work benefits, higher minimum wages, taxation-financed service provision (care for children and the elderly to reduce the work-life balance conflicts) and greater power for labor unions (Bambra et al. 2014). Based on previous research of the impact of liberalization of the markets, in the case of post-socialist EU member states (classified as Eastern European Welfare regimes), the transition resulted in a decline in unionization and in higher levels of perceived job insecurity (Dixon et al. 2013). Further, according to the different measures/reforms undertaken during the economic crisis (employment protection legislation, unemployment benefits, wage setting) in some of the countries of the European Union, that may have exacerbated the proportion of precariousness and its health effects (Escribà-Agüir and Fons-Martinez 2014). More particularly, the largest changes occurred in the southern European countries, that suffered the most severe shocks in terms of GDP and unemployment, and therefore they adopted more structural measures (employment protection, criteria for unemployment benefits and structure of the collective bargaining system). Also, Ireland suffered from structural measures, but, as can be observed through the OECD's employment protection index, the index from southern European countries declined considerably between 2008 and 2013, and instead, for Ireland there was almost no change, because the labour markets were already flexible before the crisis for this country (Izquierdo et al. 2017). Changes in the time of adoption of measures for the economic crisis according to each country may explain also the differences found. During the initial phases of the crises (2007-10) many countries adopted measures to maintain employment, but as crisis progressed, some countries had to apply more in-depth reforms. As in this study we are using data from 2014, we could be observing the possible effects of the applied reforms by some countries during

the initial phases of the crises, but not those that were undergoing at the moment, or were applied recently."

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References added:


Artazcoz L, Cortès-Franch I, Escribà-Agüir V, et al (2018) Long Working Hours and Job Quality in Europe: Gender and Welfare State Differences. Int J Environ Res Public Health 15: . doi: 10.3390/ijerph15112592

Bambra C, Lunau T, Van Der Wel K, et al (2014) Work, health, and welfare: The association between working conditions, welfare states, and self-reported general health in Europe. Int J Heal Serv 44:113–136 . doi: 10.2190/HS.44.1.g

Dixon JC, Fullerton AS, Robertson DL (2013) Cross-national differences in workers' perceived job, labour market, and employment insecurity in Europe: Empirical tests and theoretical extensions. Eur Sociol Rev 29:1053–1067 . doi: 10.1093/esr/jcs084

Dragano N, Siegrist J, Wahrendorf M (2010) Welfare regimes , labour policies and unhealthy psychosocial working conditions : a comparative study with 9917 older employees from 12 European countries. J Epidemiol Community Heal 793–800 . doi: 10.1136/jech.2009.098541

Escribà-Agüir V, Fons-Martinez J (2014) Economic crisis and employment conditions: gender differences and the response of social employment policies. SESPAS report 2014. Gac Sanit 28:37–43 . doi: 10.1016/j.gaceta.2014.01.013

Izquierdo M, Jimeno JF, Kosma T, et al (2017) Labour Market Adjustment in Europe During the Crisis: Microeconomic Evidence from the Wage Dynamics Network Survey. Ssrn. doi: 10.2139/ssrn.2999598


**Please add a footnote at the end of the results tables stating "significant results are in bold".**

Thank you for your suggestion. We decided to delete the bold in the tables because we did find some relevant associations even they were "not statistically significant".

**Conclusions**

**Please add a separate conclusions section, expanding a bit on the implications from your study. Highlight the important information from your study and how policy makers can use this information. What changes should we see being implemented to improve the issue you describe?**

Thank you for your suggestion. We have expanded a bit more on policies for reducing the non-standard employment arrangements in the discussion section as follows:

"Hence, we recommend to prioritize some of the legislative measures proposed by the ILO (International Labour Office

2016). On one hand, measures to reduce the non-standard arrangements through preventing abuses in its use (seen as cheaper alternatives or for evading responsibilities), that address employment status misclassification (the classification defines the protection of the worker), and limit the renewals or overall duration of the contracts. On the other hand, measures to improve the quality of the jobs for non-standard arrangements through removing the legal barriers for equal treatment between non-standard and standard employment arrangements, according minimum hours and other safeguards, and ensuring the freedom of association and collective bargaining."

And we have added a new section of conclusions as follows:

"In conclusion, our study shows an association of precarious employment, understood as a multidimensional construct, and negative health related outcomes and sick leave of more than 15 days. Therefore, we recommend prioritizing legislative measures for reducing non-standard arrangements and for improving the conditions of workers at non-standard arrangements. "

**Reviewer: 2**

**Comments to the Author**

**Good careful approach to employment conditions and health using the precariousness concept. The addition of a DAG is helpful. In my opinion its among the best empirical articles on the precariousness indicator. The relation between precociousness and health in the EU during the austerity years is still important. Many in epidemiology and public health would rather look elsewhere.**

Thank you so much for the nice comments to our work.

**I believe that the authors should make an effort to increase the critical content of the paper (in many areas of public health a critical approach would involve a departure from empiricism). That could be made without too much effort in the discussion and introduction.**

**Drawing on the work of Amable for example would be a good idea, since the origins of the Catalan group work on precariousness are actually critical (the large amount of self citation gives away the authorship). The authors may consider to reduce the amount of self citation by only citing the most important/cited papers. This is just a recommendation.**

Thank you for your suggestion. But, we have just one self-citation to our work. Actually, we have based the definition and construction of the variable precariousness based on the work of Benach's group, we believe is the group that the reviewer is referring to. They validated the EPRES in salaried Spanish population, and that's the reason why we cite their work.

**My only (minor) recommendation is to add critical content**

Thank you for your suggestion. We believe we increased the critical content throughout the paper by adding some new references and removing others (as suggested by the reviewer), analyzing more deeply the possible implications of a shift from Keynesianism to neoliberal economic model, the origins of precarious employment, the impact of the economic crisis on the employment conditions and the differences found according to welfare regime and gender (please see the answers of the comments of reviewer #1).

**Editor's Comments to Author:**

**Associate Editor**

**Comments to the Author:**
**Both reviewers agree this needs a little more critical content to contextualise the findings, and reviewer #1 has in addition listed some methodological issues which will need some further explication, including some details of the data source. To add in these details without adding too much to the length of the paper will perhaps require some tightening elsewhere - including taking up reviewer 2's suggestion of reducing the self-citations to the essential ones.**

The authors are particularly thankful to the Associate Editor and to the reviewers for their fruitful comments and suggestions. We have increased the critical content to contextualize our findings. We also have clarified some aspects of our methodology as reviewer #1 suggested. We have added these details but we have not surpassed the number of words recommended by the journal. We already had just one self-citation (Matilla-Santander N, et al 2018), but if the editor considers it necessary, we can delete it.

**Point-by-point reply to Editorial Office comments of paper II:**

**Ref: CCPH-2018-0220.R1**

**Precarious employment and health related outcomes in the European Union: a cross-sectional study**

**Point-by-point reply to Editorial Office comments:**

**We thank you for your detailed responses to the reviewers' comments, and would be pleased to consider this paper for publication if you can address a few remaining editorial issues:**

**1. The paper is now a little over length - we recognise this is because you have added material, but would ask if you could perhaps remove a few redundant references to ensure it is under 8000 words**

We have removed redundant references and the paper is under 8000 words (6598).

**2. The references need completing in some cases, and setting in line with the journal style guide.**

Done.

**3. This needs the English language tidying up a bit. Please see the comments and edits we have made on the track changed version of your ms, which I will send by separate email.**

Thank you for your edits and nice revisions. We have gone through the paper, and we have accepted all the changes. Also, we have added subheadings to the discussion section for organizing it better.

**4. We have just published a paper on a similar topic in south America: as suggested by reviewer #1. it would be worth just looking at this (and other material we have published in the region) just to perhaps make the point that similar processes may be at play in other regions of the world: https://www.tandfonline.com/doi/full/10.1080/09581596.2018.1559923**

Thank you for the suggestion. We have included briefly at the end of the discussion that similar efforts for monitoring employment conditions may be at play in other regions of the world, and that the use of a validated scale for measuring precariousness in the European Union and other regions is necessary to monitor employment quality.

**Letter of acceptance of paper II**

From:judith.green@lshtm.ac.uk

To:judith.green@lshtm.ac.uk

CC:judith.green@lshtm.ac.uk

Subject: Critical Public Health - Decision on Manuscript ID CCPH-2018-0220.R2

Body:

Ref: Precarious employment and health related outcomes in the European Union: a cross-sectional study

We thank you for attending to the remaining editorial issues and submitting a final version of the above paper, which has been recommended for publication in Critical Public Health.

We are now pleased to accept your paper in its current form which will now be forwarded to the publisher for copy editing and typesetting.

You will receive proofs for checking, and instructions for transfer of copyright in due course.

The publisher also requests that proofs are checked and returned within 48 hours of receipt.

Thank you for your contribution to Critical Public Health and we look forward to receiving further submissions from you.

Yours sincerely,

Professor Judith Green

Editor, Critical Public Health

Date Sent:22-Feb-2019

# ANNEX VI. Letter to the editor. Digital platforms and employment: the need for public health monitoring and surveillance.

CARTA A LA DIRECCIÓN

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# PLATAFORMAS DIGITALES Y EMPLEO: NECESIDAD DE MONITORIZACIÓN Y VIGILANCIA DE SALUD PÚBLICA

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Los autores declaran no tener ningún conflicto de intereses.

Actualmente, la relación entre las condiciones del trabajo y empleo con la salud es bien conocida, además esta relación es un importante determinante social de la salud de la población trabajadora incluido en la agenda de la Organización Mundial de la Salud. El empleo precario es una de estas condiciones que se caracteriza por los bajos salarios, la inseguridad del/a trabajador/a respecto a la pérdida del trabajo, el control limitado del/a trabajador/a sobre sus condiciones laborales y la baja protección de los/as trabajadores/as a nivel legislativo[1]. Estudios recientes han asociado la precariedad laboral con padecer pensamientos y/o acciones suicidas[2], peor estado de salud mental y salud auto-percibida[3,4]. Según resultados de un estudio de nuestro grupo, dos de cada tres trabajadores/as asalariados/as tenían un empleo precario en la Unión Europea en el 2014[5].

El empleo precario tiene su origen en la aparición de nuevas formas de empleo atípicas o no-estándar, es decir, aquellas que son alternativas al denominado "empleo estándar"[6]. El empleo estándar, es el considerado a tiempo completo, de contrato indefinido y basado en una relación de trabajo subordinada y bilateral[1]. Algunos ejemplos de empleo no estándar son el empleo temporal, el trabajo a tiempo parcial o el empleo bajo demanda[6]. Ya en 1989, Rodgers[1] describía la existencia de un debate acerca de estas nuevas formas de empleo y su posible implicación sobre los derechos de la población trabajadora[1]. Actualmente, existe una gran evidencia en la literatura sobre el empleo no estándar y su impacto en la salud; las personas con empleos no-estándar tienen mayor riesgo de sufrir accidentes laborales, de estar expuestos a acoso laboral y peores condiciones laborales, así como presentar peor salud mental y cansancio[6].

En la actualidad, la digitalización presenta un gran reto para las relaciones laborales, ya que algunas empresas se han originado a partir de plataformas digitales[7]. Algunos ejemplos de nuevos empleos ligados a plataformas digitales son los generados por Uber, Deliveroo o Glovo. Esto ha hecho que se cree un debate sobre los derechos laborales de trabajados ligados a plataformas digitales, ya que las plataformas conectan y emplean a trabajadores independientemente de los límites geográficos[7]. Por otra parte, debido a su rápido crecimiento (acceso a un gran número de personas, con mayor costo-eficiencia,

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ahorro de costes y la fiabilidad en el pago) [7], la legislación vigente en ocasiones ha quedado obsoleta y se ha generado la necesidad de crear nueva regulación para incluir este tipo de empleo ligado a plataformas digitales[8]. Asimismo, algunas de estas plataformas se han descrito de manera errónea como un modelo basado en la economía participativa; sistema opuesto a la economía capitalista, con el que se promueve democracia y justicia económica, sostenibilidad del medio ambiente y solidaridad humana[9]. En cambio, las plataformas que operan bajo demanda generan "empleo bajo demanda", y este es un tipo de empleo no estándar. Este aspecto también ha generado gran controversia en los medios de comunicación.

En los últimos meses, hemos vivido movilizaciones por parte de trabajadores de estas plataformas para reivindicar mejores condiciones laborales. También, éstos/as se han agrupado e incluso han formado sindicatos para defender sus derechos laborales. De hecho, estas movilizaciones tienen el eje común de la inseguridad laboral y el control limitado sobre sus condiciones laborales, características propias del empleo precario. Por todo ello, los empleos generados por plataformas digitales son susceptibles a ser empleos precarios por varios motivos: La cobertura social de estos tipos de trabajo no es clara, no está bien definido si los trabajadores son autónomos o no, en la mayoría de casos el empleo es bajo demanda y esto es sinónimo de temporalidad y la flexibilidad horaria genera dudas sobre el balance trabajo-vida personal[10]. Además, también se han producido recientemente manifestaciones y huelgas por parte de trabajadores/as de sectores tradicionales como el del taxi, para protestar contra las nuevas plataformas "Uber" o "Cabify" por competencia desleal, e incluso ha entrado a trámite una demanda contra "Uber" al Tribunal de Justicia Europeo. Esto demostraría que los empleos ligados a plataformas digitales también tendrían un impacto en otros puestos de trabajo, generando inseguridad laboral, la cual se ha asociado a un peor estado de salud[11].

Como salubristas y epidemiólogos/as, nos preocupa el tipo de empleo que están generando estas plataformas en rápido crecimiento y el posible impacto en la salud de estos trabajadores. Además, actualmente no existe evidencia científica sobre el posible impacto en salud de estos nuevos puestos de trabajo asociados a plataformas digitales. Por todo ello, creemos que es imprescindible que se lleve a cabo una monitorización de los indicadores de empleo precario y condiciones laborales, para poder ejercer una vigilancia de la salud de estos trabajadores, actualmente nula o escasa. Esta monitorización y vigilancia permitirá conocer si estas nuevas formas de empleo afectan a la salud y cómo la afectan. Y finalmente, con la evidencia epidemiológica sobre la mesa, promover la legislación pertinente de estas nuevas formas de empleo para así evitar la creación y el aumento del empleo precario.

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# ANNEX VII. Technical note Occupational Risk Surveillance in informal vendors from Maputo: Experience with the use of direct observation.

# Vigilancia de los riesgos laborales en vendedores/as informales de Maputo: Experiencia del uso de la observación directa para su monitorización

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**RESUMEN**

En Mozambique el porcentaje de empleo informal es del 90%. Debido a la escasez de medios y las dificultades de monitorizar el trabajo informal, hay muy poca literatura sobre exposición a riesgos laborales en empleo informal. La observación directa es un método sencillo, fácil, económico y rápido de monitoreo y obtención de datos. El objetivo de este trabajo es explicar nuestra experiencia del uso de la observación directa para la monitorización de los riesgos laborales en vendedores/as informales de las calles de Maputo. Los resultados de la observación directa ponen de manifiesto que un elevado porcentaje de vendedores/as está expuesto a riesgos laborales sin ningún tipo de protección. La observación directa ha sido útil para la vigilancia de la salud laboral, en fases exploratorias de investigación y como método complementario a la creación de bases de datos.

PALABRAS CLAVE: Empleo informal; riesgos laborales; observación directa.

**OCCUPATIONAL RISK SURVEILLANCE IN INFORMAL VENDORS FROM MAPUTO: EXPERIENCE WITH THE USE OF DIRECT OBSERVATION**

**ABSTRACT**

Over 90% of employment in Mozambique is informal. Given scarce resources and difficulties with monitoring informal employment, little is known about exposure to occupational hazards among informal workers in this country. Direct observation is a simple, easy, economical and rapid method for monitoring and obtaining data. We describe our experience with the use of direct observation of occupational hazards among informal street vendors in Maputo. Results reveal a high percentage of vendors are exposed to occupational hazards without any form of protection. Direct observation is a good method for monitoring occupational risks in exploratory phases of research or as a complementary method to quantitative data collection.

KEYWORDS: Informal employment; occupational hazards; direct observation.

## INTRODUCCIÓN

El empleo informal se define como aquel que incluye todos los trabajos remunerados (trabajo autónomo y asalariado) que no están reconocidos ni protegidos por convenios reguladores, así como, los trabajos no remunerados realizados en una empresa generadora de ingresos. Se caracteriza por bajos salarios, seguridad laboral limitada, muy baja o nula protección social, falta de servicios de salud ocupacional y seguridad, y seguro por daños laborales[1,2]. El empleo informal se ha asociado con problemas de salud mental, enfermedades crónicas y a un peor estado de salud autopercibida[3], así como a un menor uso de sistemas de atención de la salud[4], y a mayor riesgo de sufrir accidentes[5].

El porcentaje de economía informal en los países de ingresos bajos es elevado[6]. En la mayoría de países africanos, el porcentaje de economía informal varía entre el 45% y el 90%[7]. Mozambique está clasificado en la posición 180 de 189 en el Índice de Desarro-

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llo Humano del 2017, la esperanza de vida es de 58,9 años y cuenta con una de las mayores tasas de trabajadores/as informales (siendo un 90% de sus 28,83 millones de habitantes)[7]. La capital, Maputo, tiene 1.178.116 habitantes y un 62% tiene entre 15 y 64 años[8].

La literatura sobre el empleo informal y su relación con la salud en África es escasa, a pesar de ser uno de los continentes con mayor tasa de empleo informal[2]. Esto es debido a las dificultades de capturar información precisa de un gran número de trabajadores/as informales por su baja accesibilidad, junto con sistemas nacionales de información sobre accidentes y enfermedades ocupacionales de escasos recursos[5]. Actualmente, no existe ningún estudio en Mozambique donde se haya monitorizado las características y la exposición a riesgos laborales en trabajadores/as informales. Se han propuesto distintas estrategias para promover condiciones de trabajo dignas en el empleo informal[3], pero sin datos disponibles, el diseño de programas se hace muy difícil. En este sentido, la observación directa, podría ser una herramienta útil. Se trata de un método de obtención de información, donde el/la observador/a observa a los individuos en su entorno sin alterarlo. Según si los sujetos saben que están siendo observados o no, la observación puede ser abierta o encubierta, respectivamente[9]. Ésta, se realiza por parte de observadores/as entrenados/as, utilizando una plantilla estandarizada de observación. Así pues, se podría usar en las fases exploratorias en el diseño de bases de datos de vigilancia de salud laboral en trabajadores informales. Además, cuando los medios no permitiesen realizar una vigilancia muy seguida en el tiempo, se podría complementar mediante estudios de observación directa[10].

El objetivo de este trabajo es explicar nuestra experiencia de monitorización del trabajo informal en Maputo (Mozambique) a través de observación directa encubierta en vendedores/as de las calles.

## DESARROLLO DE LA EXPERIENCIA

Se realizó un estudio piloto mediante observación directa encubierta, realizado en tres días laborables por una observadora (NMS), entre las 15.00 y 17.00 horas, en mayo de 2018 en Maputo. Las rutas se realizaron de manera aleatoria en calles y avenidas alrededor del Hospital Central de Maputo, debido a que era el centro de trabajo de la observadora y una zona segura. Las rutas aleatorias se recogieron a través de una aplicación de seguimiento con GPS del móvil (figura 1).

**Figura 1**
**Ruta aleatoria realizada en la ciudad de Maputo.**


Durante la observación, cuando se veía a un/a vendedor/a, se registraba la información mediante una hoja de recogida de datos diseñada ad hoc. Se incluyeron todos/as aquellos/as vendedores/as de fruta, comestibles, ropa, zapatos, artesanía, animales, así como aquellos que ofrecían servicios como limpieza de calzado. Se excluyeron a las personas que daban servicios de seguridad en los portales de los pisos, tiendas, cafeterías y restaurantes, ya que no se podía saber si eran trabajadores/as informales.

El segundo día, en una zona de mucha concentración de vendedores/as, se realizó un vídeo con una cámara pequeña para poder recoger los datos de todos/as los/as vendedores/as. Posteriormente, se eliminó el vídeo tras haber anotado los datos. Respecto a las características individuales, se anotó sexo y edad. En cuanto a las características del lugar de trabajo, se recogió tipo de producto vendido, y lugar dónde se vendía. Finalmente, se monitorizaron la exposición (sí/no) a los siguientes riesgos laborales: (i) exposición a contaminación atmosférica y acústica (venta cercana al tráfico de los coches); (ii) uso de herramientas manuales peligrosas (uso de herramientas punzantes como punzón o machete), y, en caso afirmativo, se recogió uso de protección (uso de guantes); (iii) exposición a rayos UV (trabajo bajo el sol), y, en caso afirmativo, se recogió uso de protección (uso de gorras, sombrilla, trabajo debajo de un árbol o tejado), (iv) riesgos ergonómicos, uso de silla (entendida como una silla con respaldo y excluyendo a cajas o poyetes), y llevar carga pesada sobre los hombros o cabeza.

Se realizaron 102 observaciones (n=31 el primer día, n=33 el segundo día y n=38 el 3terer día). En la tabla 1 se pueden observar los resultados de la observación. El 98% de los trabajadores estaba expuesto a rayos UV, y de éstos, un 27% estaban protegidos del sol, un 15% tenía una silla, y un 7% cargaban con peso en los hombros o la cabeza. En cuanto a los resultados obtenidos, cabe decir que el uso de herramientas punzantes sólo se contemplaba como 'sí' cuando en la observación el/la trabajador/a lo estaba usando. Por ello, creemos que la proporción podría estar infra-estimada. Una limitación de la observación directa es la representatividad de la muestra, sin embargo, al utilizar rutas aleatorias dentro de la zona escogida por conveniencia, se reduce esta potencial limitación. En este estudio piloto, el lugar y tiempo de observación se escogieron por conveniencia, pero, otros estudios que quisieran utilizar la observación directa deberían escoger las zonas y los tiempos de observación asegurando la representatividad de la muestra. Además, los resultados de nuestro estudio, van en la misma línea que estudios previos realizados mediante cuestionario cara a cara en Sud-África[5], Camerún[7], Ghana[4] y Zimbabwe[8] en los que también se observaron frecuencias muy elevadas de exposición a riesgos laborales y de accidentes laborales entre los/as trabajadores/as informales.

Otra limitación de la observación directa es la posible mala clasificación de las variables de estudio por parte del/a observador/a. En este sentido, la variable edad, sería la que más probabilidad de sesgo de clasificación tiene, por ello, la observadora usó un rango de edad más amplio entre los 30 y 50 años. Además, otra limitación a tener en cuenta es la dificultad de recoger la exposición a riesgos psicosociales en el ambiente del trabajo. Por otra parte, la principal fortaleza de la observación directa

**TABLA 1**
**Características individuales, del puesto de trabajo y exposición a riesgos laborales en vendedores/as de Maputo (Mozambique), 2018 (n=102).**

| Características individuales | n | % (CI 95%) |
|---|---|---|
| **Sexo** | | |
| Hombre | 60 | 58,82 (48,64-68,48) |
| Mujer | 42 | 41,18 (31,52-51,36) |
| **Edad** | | |
| <18 | 7 | 6,86 (2,80-13,63) |
| 18-30 | 46 | 45,10 (35,22-55,26) |
| 30-50 | 40 | 39,22 (29,69-49,38) |
| >50 | 9 | 8,82 (4,11-16,10) |
| **Características del lugar de trabajo** | **n** | **% (CI 95%)** |
| **Producto de venta** | | |
| Fruta | 35 | 34,31 (25,19-44,37) |
| Comida envasada | 29 | 28,43 (19,94-38,22) |
| Comida preparada | 12 | 11,76 (6,23-19,65) |
| Ropa | 11 | 10,78 (5,55-18,48) |
| Piezas de arte y accesorios digitales | 11 | 10,78 (5,55-18,48) |
| Animales | 1 | 0,98 (0,02-5,34) |
| Servicios | 3 | 2,94 (0,61-8,35) |
| **Lugar de venta** | | |
| Suelo | 34 | 34,31 (25,19-44,37) |
| Carro | 15 | 14,71 (8,47-23,09) |
| Puesto | 30 | 29,41 (20,80-39,25) |
| Andando | 23 | 22,55 (14,86-31,89) |
| **Exposición a riesgos laborales** | **n** | **% (CI 95%)** |
| **Trabajo cercano al tráfico** | | |
| No | 0 | 0 (0,00-0,35) |
| Si | 102 | 100 (96,45-100) |
| **Uso de herramienta punzante** | | |
| No | 100 | 98,04 (93,10-99,76) |
| Si | 2 | 1,96 (0,24-6,90) |
| **Uso de protección para herramienta punzante** | | |
| No | 2 | 100 (15,81-100) |
| Si | 0 | 0 (0-84,19) |
| **Exposición a rayos UV** | | |
| No | 2 | 1,96 (0,24-6,90) |
| Si | 100 | 98,04 (93,10-99,76) |
| **Protección para exposición a rayos UV** | | |
| No | 73 | 73 (61,78-80,06) |
| Si | 27 | 27 (18,22-36,13) |
| **Silla** | | |
| No | 87 | 85,29 (76,91-91,53) |
| Si | 15 | 14,71 (8,47-23,09) |
| **Carga pesada en hombros o cabeza** | | |
| No | 95 | 93,14 (86,37-97,20) |
| Si | 7 | 6,86 (2,80-13,63) |

es su simplicidad. Es una técnica que permite recoger una muestra grande en poco tiempo y a muy bajo coste (102 observaciones en tres días y seis horas). Asimismo, no se necesita tener contacto con los sujetos del estudio, por lo que no es necesario hablar el idioma de los/as participantes (como en el caso de este estudio, el cual se realizó durante una estancia pre-doctoral). También, los/as observadores/as sólo necesitarían el entrenamiento para llevar a cabo la observación, ya que no se han de obtener muestras biológicas ni realizar una encuesta.

## CONCLUSIÓN

La observación directa ha sido útil para la vigilancia de la salud laboral, en fases exploratorias de investigación y como método complementario a la creación de bases de datos.

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# ANNEX VIII. Article. Prevalence and determinants of metabolic syndrome in Spanish salaried workers: evidence from 15614 men and women.

Journal of Public Health | pp. 1–8 | doi:10.1093/pubmed/fdz003

# Prevalence and determinants of metabolic syndrome in Spanish salaried workers: evidence from 15 614 men and women

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## ABSTRACT

**Objective** To describe the prevalence of Spanish workers with Metabolic Syndrome (MetS) and those at risk of developing MetS in 2015.

**Methods** Cross-sectional study of workers ($n$ = 15 614). We used a modified definition of the NCEP:ATPIII criteria for MetS (we used body mass index (BMI) above 28.8 kg/m$^2$ instead of the waist circumference criterion). We calculated the prevalence of MetS (having at least three components) and of being at risk of MetS (having one or two components). We calculated adjusted odds ratios (aOR) of MetS according to socio-economic and workplace characteristics.

**Results** The proportions of workers with and at risk of MetS were 7.1 and 31.9%, respectively. The most prevalent criterion was having a BMI > 28.8 kg/m$^2$ (24.1%) in men and cHDL < 40 mg/dl in women (12.9%). There were significant associations between MetS and men (aOR compared to women = 3.73, CI 95%: 3.19; 4.36); age (higher among oldest, aOR = 5.75, CI 95%: 4.37;7.56); and social class (higher among lower social class, aOR = 2.03, CI 95%: 1.65;2.48).

**Conclusion** Reducing any of the five MetS components, while taking into account the differences found by socio-economic and workplace characteristics, should be one priority for reducing MetS prevalence.

**Keywords** health promotion, metabolic syndrome, preventive medicine, working population

## Introduction

Metabolic syndrome (MetS) is characterized by an aggrupation of metabolic disorders (abdominal obesity, dyslipidemia, insulin resistance and hypertension).[1] Based on those characteristics, there are different definitions of MetS according to different expert panels.[1] The prevalence of MetS is estimated to be 20–25% globally (according to the different MetS definitions).[2] One study using the NCEP:ATPIII criteria, described a MetS prevalence of 24.3% with data from 12 cohorts of 10 European countries and 1 from USA ($n$ = 34821).[3] Another study conducted in general Spanish population,

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using the NCEP:ATPIII criteria, found a MetS prevalence of 22.7%.[4]

There has been a relative increase of attributable death and disease burden due to metabolic risks (fasting glycaemia, total cholesterol, systolic blood pressure) by more than 15% from 2005 to 2015 globally.[5] Further, it is estimated that the prevalence of non-communicable diseases such as cardiovascular diseases and diabetes will increase by 15% between 2010 and 2020 in middle income countries, which is partially explained by unhealthy lifestyle changes.[6] For those reasons, data seems to point that the MetS prevalence will increase. The MetS is associated with an increased risk of type 2 diabetes mellitus,[7] cardiovascular diseases[8] and of several common cancers.[9] Moreover, individuals diagnosed with MetS are often working-age individuals, meaning that the development of MetS not only has consequences for the patient, but also for the patient's dependents, their working environment, and for the human resources of the country.[10]

The main risk factors described for developing MetS are behavioral. These include diets rich in saturated and trans-fats, refined carbohydrates and low content in crude fibers, physical inactivity and high intake of alcohol;[11,12] all of which are modifiable. Importantly, these behavioral factors are influenced by socio-economic factors, such as social class,[13] occupation and working conditions,[14] as well as social policies.[15,16] Therefore, the implementation of health programs and the creation of healthy environments as recommended by the WHO may be a good strategy to reduce the incidence of MetS and minimize its health impact.[17] In this sense, the workplace is recognized for its importance influencing the health behaviors of large proportions of population, as well as for providing opportunities to implement multilevel interventions aimed at influencing the workers' health behaviors.[17] Further, some studies suggest that shift workers are less likely to be reached by interventions done in the workplace than day workers.[18] Thus, the scope of programs at workplace may be lower within other workers characteristics (such as social class). Therefore, understand better the distribution of the MetS factors according to individual, socio-economic and working conditions, would give clues for the design of health promotion programs at the workplace.

Given the increasing trends for metabolic risks factors,[5] the importance of the workplace as an environment generator of health and disease,[19] and the need of creating promotion programs that take into account the social determinants of MetS, the objective of the present study was to describe the prevalence of MetS and of being at risk of MetS (defined as having one or two criteria) among men and women workers in Spain, as well as of its social determinants.

## Methods

### Study population and data collection

This is a cross-sectional study using data from 77 899 salaried Spanish workers who participated in annual voluntary medical checkups by the company Medycsa conducted during 2015. The checkups were done by qualified clinical personnel (a doctor and a nurse for each checkup). Medycsa asked to the workers to come to the checkup without having eaten anything in the previous 8 h (8-h fasting conditions). During the checkups, the personnel practiced standardized physical examinations, obtained urine and blood samples, and asked the workers about their socio-demographic characteristics, job position, lifestyle and health condition. The Ethics Committee of the Universitat Internacional de Catalunya approved this study protocol. All the participants provided written informed consent for the checkups. For the purposes of the present study, we eliminated the duplicated registries of the same individual for more than one checkup, and we used data from the first checkup ($n = 2953$). Further, we excluded workers younger than 18 years old and those older than 70 years of age ($n = 31$), and workers who had missing information in any of the MetS criteria; triglycerides ($n = 55\,548$), cHDL ($n = 58\,052$), systolic/diastolic blood pressure ($n = 889$), glucose ($n = 6346$) and BMI ($n = 837$). This yielded a final study population of 15 614 workers.

We calculated the necessary sample size using the simple random sampling formula $\left(N = \left(Z\alpha \cdot \frac{pq}{e}\right)^2\right)$ to estimate the prevalence of MetS among working population in Spain. We presumed an estimated prevalence of 50%, which maximizes the sample size and representativeness of the sample, a confidence level of 95% ($\alpha = 0.05$) and a precision of 1% ($e = 0.01$) and the resulting sample size needed was of 9513 individuals.

### Study variables

The MetS was defined following the National and Cholesterol Education Program—Third Adult Treatment Panel (NCEP:ATPIII) criteria, with some modifications.[20] We defined the MetS as having at least three out of the five following criteria; (i) triglycerides ≥150 mg/dl, (ii) high density lipoprotein cholesterol (cHDL) <40 mg/dl for men and <50 mg/dl for women, (iii) systolic blood pressure ≥130 mmHg and diastolic blood pressure ≥85 mmHg, (iv) glycaemia ≥100 mg/dl and (v) body mass index (BMI) ≥ 28.8 kg/m$^2$. Using BMI instead of waist circumference has been validated in large cohorts[21,22] and has been used in previous studies.[23]

We defined being at risk of MetS as having one or two of these criteria based on the 'high-risk strategy' described by Rose.[24] Which is, the population group that is 'healthy' or

'symptomless' today, but at risk of suffering from an illness (in this case, MetS). The objective of describing this 'high-risk' population group is to stop the transition into the illness and truncate the MetS risk distribution.

The covariates used were socio-economic variables; sex (women, men), age (18–34 years old, 35–44 years old, 45–70 years old), and occupational social class (CSO-12; Spanish acronym). The CSO-12 was obtained through the classification of the job position declared by the worker according to the national occupation classification (CNO-11). For this study we used the CSO-12 grouped in three categories; I (I–II): directors and managers, II (III–IV): intermediate occupations and freelancers and III (V–VII): manual workers (blue-collar workers).[25] We also used workplace characteristics: labor sector (construction, industry and services), seniority in the job position (<1 year, 1–4 years, 5–9 years and ≥10 years) and job position with shift work or night work (no and yes).

### Statistical analysis

We calculated the prevalence of each MetS criterion and their 95% confidence intervals (CI 95%), and compared the differences among socio-economic and workplace covariates using the Chi-2 test. Moreover, we calculated the frequency of having none, one, two or three, or more MetS criteria. Next, we calculated the prevalence of MetS and of being at risk of MetS, the crude odds ratio (cOR) and adjusted odds ratio (aOR) of MetS by sex and age according to socio-economic and workplace characteristics by logistic regression and also by multinomial logistic regression. We applied a complete-case analysis because some covariates were missing in some participants.

Given the influence of socio-economic and working conditions on the behavioral risk factors described for developing MetS and their function as axes of social inequalities in health,[26] we decided to stratify all analyses by socio-economic (sex, age, occupational social class) and workplace characteristics (labor sector, seniority in the workplace, night shift or shift work).

To guarantee the representativeness of the sample of Spanish salaried workers, for all analyses we used sampling weights calculated from the salaried population in Spain the year 2015[27] by sex and age. We designed the weights for the analytical sample of 15 614 workers, which included those workers aged between 18 and 70 years old. The threshold for statistical significance was set to a two-sided *P*-value <0.05. All analyses were conducted using Stata 14.0 statistical software.

## Results

From the 15 614 salaried workers, 54.52% were men, mean age was 43.89 years (SD: 0.09), 79.98% were from the services labor sector, 51.42% had been in their job position for more than 10 years, 6.26% had a shiftwork or nightshift work, and 60.33% were from the occupational social class II (intermediate occupations).

Table 1 shows the five MetS components according to socio-economic and workplace determinants. The most prevalent component for men was BMI >28.8 kg/m$^2$ (24.13%, CI 95%: 23.26;25.03), while for women was cHDL <50 mg/dl (12.91%, CI 95%: 12.11;13.77). The least prevalent for men and women was glycaemia ≥100 mg/dl (7.08%, CI 95%: 6.70; 7.49). The five criteria were more prevalent in men, in construction labor sector workers, and in nightshift/shift work workers, being in an increasing trend among elderly ages, more years in the job position, and lower occupational social classes (Table 1).

Figure 1 shows the percentage distribution of MetS criteria by socio-economic and workplace characteristics. The percentage of workers that had one criterion was higher than those having two criteria (defined in both cases as those at risk of MetS).

Table 2 shows the proportion and associations of workers with MetS and at risk of MetS according to socio-economic and workplace determinants. Overall, the proportion of workers with MetS was 7.08% (CI 95%: 6.69;7.48). There were statistically significant associations of MetS according to socio-economic and workplace characteristics, which decreased in their magnitude after adjustment by sex and age. Men (aOR: 3.73, CI 95%: 3.19;4.36), older workers (aOR: 5.75, CI 95%: 4.37;7.56) and from lower occupational social class (aOR: 2.03, CI 95%: 1.65;2.48) had higher odds of presenting MetS. Contrary, workers from the service sector had lower odds of presenting MetS (aOR: 0.55, CI 95%: 0.40; 0.75). The proportion of workers at risk of MetS was 31.86% (CI 95%: 31.13; 32.61). We found higher odds for being at risk of MetS among men (aOR: 2.03, CI 95%: 1.89; 2.18), older workers (aOR: 2.44, CI 95%: 2.19; 2.72), more years in the same job position (aOR: 1.39, CI 95%: 1.13;1.71), and with lower occupational social class (aOR: 1.28, CI 95%: 1.15;1.43). The aORs obtained with the multinomial logistic regression were similar than the obtained in the binomial logistic regression (data not shown).

## Discussion

### Main finding of this study

This is one of the largest studies conducted in Europe describing the prevalence of MetS and of being at risk of MetS among workers, by socio-economic and workplace characteristics. We found that the proportion of workers with MetS was 7.08%,

**Table 1** Metabolic syndrome components, overall and by socio-economic and workplace determinants, among Spanish workers, 2015

| | n | *Triglycerides (≥150 mg/dl)* | | *cHDL (<40 mg/dl for men and <50 mg/dl for women)* | | *Blood pressure (SBP ≥ 130 mmgHg and DBP ≥85 mmHg)* | | *Glycaemia (≥100 mg/dl)* | | *BMI (>28.8 kg/m$^2$)* | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *% (CI 95%)* | P-*value*[a] | *% (CI 95%)* | P-*value*[a] | *% (CI 95%)* | P-*value*[a] | *% (CI 95%)* | P-*value*[a] | *% (CI 95%)* | P-*value*[a] |
| Overall | 15 614 | 13.77 (13.25;14.31) | – | 16.20 (15.63;16.79) | – | 11.04 (10.56;11.53) | – | 7.08 (6.70;7.49) | – | 18.41 (17.81;19.02) | – |
| Sex | | | <0.001 | | <0.001 | | <0.001 | | <0.001 | | <0.001 |
| Women | 7101 | 6.01 (5.45;6.61) | | 12.91 (12.11;13.77) | | 5.04 (4.54;5.59) | | 3.85 (3.42;4.34) | | 11.54(10.79;12.35) | |
| Men | 8513 | 20.25 (19.44;21.09) | | 18.94 (18.15;19.76) | | 16.04 (15.30;16.81) | | 9.78 (9.19;10.41) | | 24.13 (23.26;25.03) | |
| Age | | | <0.001 | | <0.001 | | <0.001 | | <0.001 | | <0.001 |
| 18–34 | 3202 | 6.78 (5.90;7.79) | | 11.45 (10.28;12.73) | | 3.47 (2.81;4.28) | | 1.18 (0.84;1.65) | | 7.97 (6.98;9.09) | |
| 35–44 | 4932 | 11.94 (11.09;12.84) | | 17.26 (16.24;18.32) | | 6.76 (6.12;7.47) | | 3.19 (2.74;3.70) | | 15.62 (14.65;16.64) | |
| 45–70 | 7480 | 17.97 (17.14;18.83) | | 17.54 (16.71;18.40) | | 17.10 (16.28;17.95) | | 12.19 (11.48;12.93) | | 24.71 (23.77;25.68) | |
| Sector | | | <0.001 | | <0.001 | | <0.001 | | <0.001 | | <0.001 |
| Construction | 317 | 22.27 (18.11;27.06) | | 23.89 (19.46;28.95) | | 15.66 (11.82;20.45) | | 11.05 (8.12;14.88) | | 31.15 (26.23;36.54) | |
| Industry | 2808 | 22.24 (20.77;23.79) | | 21.10 (19.65;22.64) | | 14.30 (13.06;15.65) | | 10.24 (9.19;11.38) | | 24.58 (23.04;26.19) | |
| Services | 12 489 | 11.65 (11.10;12.22) | | 14.90 (14.28;15.54) | | 10.19 (9.68;10.72) | | 6.28 (5.87;6.71) | | 16.69 (16.05;17.36) | |
| Seniority in the workplace | | | <0.001 | | <0.001 | | <0.001 | | <0.001 | | <0.001 |
| <1 year | 1049 | 6.89 (5.42;8.71) | | 10.58 (8.55;13.01) | | 3.87 (2.87;5.21) | | 1.73 (1.10;2.71) | | 8.68 (6.98;10.74) | |
| 1–4 years | 2234 | 10.54 (9.32;11.90) | | 14.54 (13.12;16.09) | | 7.27 (6.26;8.42) | | 4.54 (3.79;5.49) | | 14.43 (13.01;15.98) | |
| 5–9 years | 2793 | 11.66 (10.54;12.88) | | 16.46 (15.14;17.88) | | 8.17 (7.22;9.23) | | 5.36 (4.59;6.23) | | 15.68 (14.40;17.06) | |
| ≥10 years | 6433 | 16.53 (15.67;17.44) | | 17.45 (16.55;18.38) | | 14.02 (13.21;14.87) | | 10.10 (9.41;10.84) | | 22.42 (21.44;23.44) | |
| Night shift or shift work | | | <0.001 | | 0.008 | | <0.001 | | 0.4488 | | <0.001 |
| No | 14 637 | 13.50 (12.97;14.06) | | 16.00 (15.41;16.61) | | 10.82 (10.33;11.33) | | 7.03 (6.64;7.45) | | 17.94 (17.33;18.57) | |
| Yes | 977 | 17.76 (15.53;20.24) | | 19.15 (16.86;21.68) | | 14.27 (12.28;16.51) | | 7.87 (6.33;9.74) | | 25.42 (22.85;28.17) | |
| CSO-12[b] | | | <0.001 | | <0.001 | | <0.001 | | <0.001 | | <0.001 |
| I–II (Professionals and managers) | 2551 | 11.44 (10.29;12.71) | | 13.48 (12.21;14.86) | | 9.17 (8.14;10.33) | | 5.85 (5.03;6.81) | | 15.59 (14.25;17.04) | |
| III–IV (Intermediate occupations) | 9406 | 11.34 (10.72;11.99) | | 15.29 (14.57;16.05) | | 9.69 (9.12;10.30) | | 6.12 (5.66;6.61) | | 16.52 (15.78;17.29) | |
| V–VII (Manual occupations) | 3634 | 21.62 (20.34;22.96) | | 20.40 (19.13;21.72) | | 15.81 (14.67;17.02) | | 10.42 (9.49;11.43) | | 25.25 (23.88;26.67) | |

Note: the variables CSO-12 and seniority in the workplace contain missings. [a]*P*-value calculated through the Chi$^2$ test; [b]CSO-12, Social Class Classification based on the Spanish National Classification of Occupations 2011.

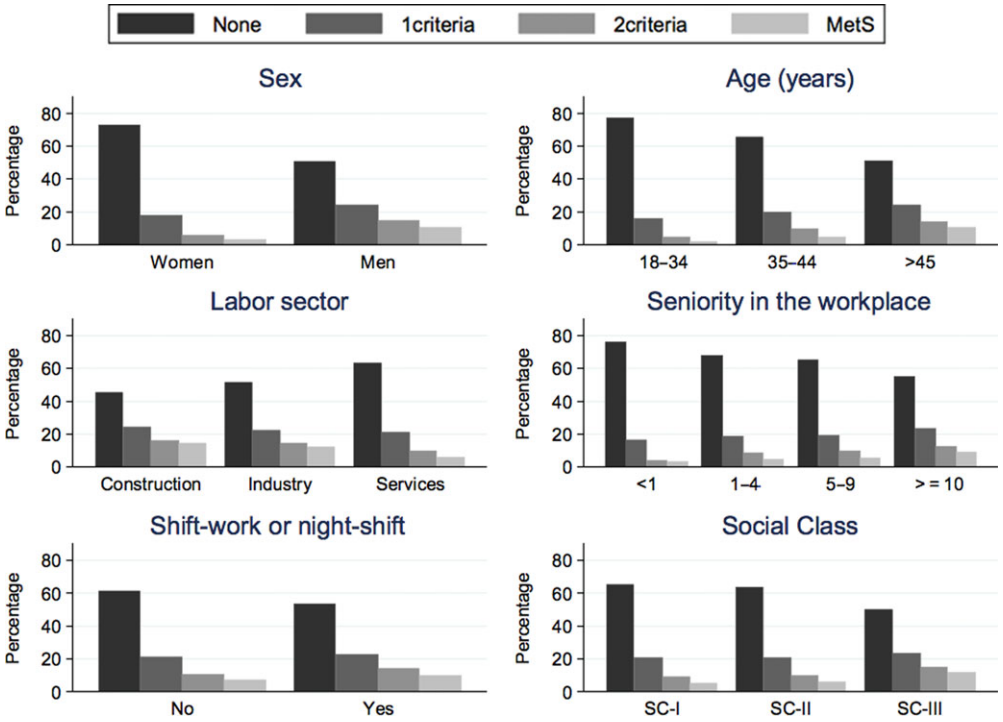


**Fig. 1** Percentage distribution of Metabolic Syndrome (MetS) criteria (0 criteria, 1 criteria, 2 criteria and 3 or more criteria) by socio-economic and workplace determinants, Spain 2015.

and at risk of MetS was 31.86%. These proportions were higher in men, older workers, workers with more years in the same job position, from the construction labor, and from lower occupational social class.

### What is already known on this topic

In Spain, two previous cross-sectional studies, the MESYAS[23] (recruitment year: 2003; $n = 7256$) and the ICARIA[28] (recruitment year: 2004–5; $n = 259\,014$) studies, have described the prevalence of MetS among the working population, being of 10 and 9.5%, respectively. They described a higher prevalence of MetS among men, older workers and blue collar workers. Therefore, our results are in the same line as previous studies done in Spanish workers.

### What this study adds

Compared to the previous studies done in Spain, we further describe a higher prevalence of MetS and risk of MetS for those workers with higher years in the same position (even after adjusting for age and sex) and lower prevalence of MetS among workers from the service sector than the construction sector. So, in our study we describe sector and seniority in the job position, together with sex, age and social class as determinants of MetS and of risk of MetS.

We identified a positive trend of being at risk of MetS or having MetS and lower social classes. This is in the same line as previous epidemiological evidence, which describes a strong association between socio-economic status (SES) and the MetS.[29–31] At least two mechanisms may explain this strong association: (i) higher risk behaviors among lower SES population[32] and (ii) weaker control over life and work (poor work-life balance and working conditions) is linked with higher psychological stress and therefore higher morbidity, including MetS.[33] This is especially important because it has been described that individuals from lower SES are less likely to participate in lifestyle interventions,[34] therefore, this should be taken into account in the design of future interventions at the workplace.

We did find borderline associations among night shift or shift work workers and higher prevalence of MetS and of risk of MetS. The borderline associations could be explained because we did not have information about when workers started working in night shift or shift work, thus, we did not have information of exposure period. Nevertheless, several studies (none of them done with Spanish population) concluded that MetS is associated in a positive dose–response relationship with duration of night shift work, due to a decrease of night sleep duration and desynchronization of circadian rhythm.[35] Further, shift workers are less likely to

**Table 2** Prevalence and determinants of metabolic syndrome and of being at risk of metabolic syndrome, overall and by socio-economic and workplace characteristics, among Spanish workers, 2015

| | | *Metabolic syndrome* | | | *At risk of metabolic syndrome* | | |
|---|---|---|---|---|---|---|---|
| | n | *% (CI 95%)* | *cOR (CI 95%)* | *aOR[a] (CI 95%)* | *% (CI 95%)* | *cOR (CI 95%)* | *aOR[a] (CI 95%)* |
| Overall | 15 614 | 7.08 (6.69;7.48) | – | – | 31.86 (31.13;32.61) | – | – |
| Sex | | | | | | | |
| Women | 7101 | 2.97 (2.59;3.41) | Ref | Ref | 23.56 (22.53;24.62) | Ref | Ref |
| Men | 8513 | 10.50 (9.89;11.15) | 3.83 (3.28;4.48) | 3.73 (3.19;4.36) | 38.79 (37.78;39.81) | 2.06 (1.91;2.21) | 2.03 (1.89;2.18) |
| Age | | | | | | | |
| 18–34 | 3202 | 1.99 (1.53;2.57) | Ref | Ref | 20.12 (18.60;21.74) | Ref | Ref |
| 35–44 | 4932 | 4.82 (4.27;5.42) | 2.49 (1.86;3.34) | 2.47 (1.84;3.31) | 29.51 (28.27;30.78) | 1.66 (1.48;1.86) | 1.66 (1.48;1.86) |
| 45–70 | 7480 | 10.75 (10.09;11.45) | 5.94 (4.52;7.80) | 5.75 (4.37;7.56) | 38.44 (37.37;39.53) | 2.48 (2.22;2.76) | 2.44 (2.19;2.72) |
| Sector | | | | | | | |
| Construction | 317 | 13.97 (10.67;18.08) | Ref | Ref | 40.68 (35.21;46.40) | Ref | Ref |
| Industry | 2808 | 12.01 (10.88;13.25) | 0.84 (0.61;1.16) | 1.03 (0.74;1.43) | 36.58 (34.82;38.36) | 0.84 (0.66;1.07) | 0.96 (0.75;1.24) |
| Services | 12 489 | 5.79 (5.41;6.21) | 0.38 (0.28;0.52) | 0.55 (0.40;0.75) | 30.58 (29.77;31.41) | 0.64 (0.51;0.81) | 0.82 (0.64;1.05) |
| Seniority in the workplace | | | | | | | |
| <1 year | 1049 | 4.62 (3.85;5.54) | Ref | Ref | 27.40 (25.53;29.36) | Ref | Ref |
| 1–4 years | 2234 | 5.57 (4.79;6.48) | 1.68 (1.12;2.52) | 1.09 (0.71;1.67) | 29.06 (27.42;30.76) | 1.59 (1.30;1.95) | 1.31 (1.06;1.62) |
| 5–9 years | 2793 | 2.81 (1.98;3.96) | 2.04 (1.38;3.02) | 1.12 (0.72;1.73) | 19.17 (16.51;22.14) | 1.73 (1.42;2.11) | 1.28 (1.04;1.58) |
| ≥10 years | 6433 | 9.29 (8.63;10.01) | 3.55 (2.46;5.12) | 1.26 (0.83;1.92) | 36.06 (34.91;37.22) | 2.38 (1.97;2.87) | 1.39 (1.13;1.71) |
| Night shift or shift work | | | | | | | |
| No | 14 637 | 6.89 (6.51;7.31) | Ref | Ref | 31.55 (30.79;32.31) | Ref | Ref |
| Yes | 977 | 9.77 (8.12;11.72) | 1.46 (1.18;1.81) | 1.15 (0.92;1.44) | 36.64 (33.70;39.67) | 1.25 (1.10;1.43) | 1.08 (0.94;1.23) |
| CSO-12[b] | | | | | | | |
| I–II (Professionals and managers) | 2551 | 5.08 (4.32;5.97) | Ref | Ref | 29.56 (27.82;31.35) | Ref | Ref |
| III–IV (Intermediate occupations) | 9406 | 5.81 (5.37;6.29) | 1.15 (0.95;1.39) | 1.33 (1.10;1.62) | 29.99 (29.05;30.95) | 1.02 (0.93;1.12) | 1.10 (0.99;1.21) |
| V–VII (Manual occupations) | 3634 | 11.73 (10.75;12.80) | 2.48 (2.04;3.02) | 2.03 (1.65;2.48) | 38.33 (36.77;39.92) | 1.48 (1.33;1.65) | 1.28 (1.15;1.43) |

Note: the variables CSO-12 and seniority in the workplace contain missings. [a]aOR, adjusted by sex and age (categorical); [b]CSO-12, Social Class Classification based on the Spanish National Classification of Occupations 2011. The aOR for sex and age are from the same model.

be reached by interventions done in the workplace than day workers.[18] Therefore, when designing health promotion interventions, we should bear in mind that night shift and shift workers may have higher risk of MetS and that it may be harder to reach them with the interventions.

It is important to point that the most prevalent criteria of MetS was a BMI higher of 28.8 kg/m$^2$ (used as a proxy of waist circumference), followed by levels of cHDL lower than 40 mg/dl for men and 50 for women, and triglycerides levels higher than 150 mg/dl. This is especially important because even though the way the MetS components interact is not well understood, it has been described that depending on the criteria that the individuals present, the risk of cardiovascular disease and mortality differ. Individuals with MetS that have central obesity, high blood pressure and hyperglycemia have a 2.36-fold increase in incident cardiovascular diseases events and 3-fold increase risk of mortality than in the general population.[36] Moreover, some studies point that obesity may precede the development of MetS, and therefore interventions based on preventing it may reduce the incidence of MetS in non-diabetic individuals.[37] Therefore, targeted interventions in the working population based on preventing any of the components, may reduce the risk of developing MetS and its health-related consequences.

Further, it has been proved that strategies targeting the whole population aimed at reducing cholesterol levels are cost-effective even if the reduction achieved is only 2%.[17] Moreover, as previously mentioned, the way the MetS components interact is not well understood, but it has been hypothesized that each MetS criterion has an additive effect.

Therefore, when preventing one of the MetS components, the MetS risk would also diminish and in consequence, the health-related consequences of MetS.[1] So, a small variation in one of the MetS criteria may have a huge impact in the community.[24] Furthermore, working population constitutes more than the half of the worldwide population and they are the one that most contribute to the economic and social development.[38] Then, interventions done in working population may have great consequences.

### Limitations of this study

This study has some limitations. First of all, we could not account for medication intake, and that may have infrastimated the prevalence shown of MetS. On the contrary, we used BMI as a proxy of waist circumference, and although it has been used in large cohorts, that could have overestimated the prevalence of MetS. Moreover, the prevalence of MetS may be lower in our study than in studies done in general population given the healthy worker bias. Next, data used for the study is a secondary data source (done without research purposes). But, we used biomarkers reducing threats to internal validity. Also, workers were asked to come in fasting conditions, but information related to that condition was not available, and thus may have infrastimated the biomarkers levels and then the MetS prevalence. Nevertheless, we account for a large sample size, according to the sample calculation, 9513 individuals were necessary and we are using a sample of 15 614 workers. Finally, we weighted our analytical sample by sex and age. So, our sample size and representativeness is far enough to infer the results to the salaried working population in Spain.

## Conclusion

Our study shows a high prevalence of MetS and risk of MetS within lower occupational social classes, men, older workers, more years in the same job position and workers from the construction sector. Further, we found that high BMI, as a proxy of waist circumference, was the most prevalent criteria of the MetS in men, while low cHDL was the most prevalent in women. In this sense, reducing any of the five components among workers should be one priority for reducing the MetS prevalence, while taking into account differences found by socio-economic and workplace characteristics in workers at risk of MetS and with MetS.

## Conflicts of interest

The authors declare no conflicts of interest.

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# ANNEX IX. Attitudes toward working conditions: are European Union workers satisfied with their working hours and work-life balance?

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Original article

# Attitudes toward working conditions: are European Union workers satisfied with their working hours and work-life balance?

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ABSTRACT

*Objective:* To describe the satisfaction with working hours and satisfaction with work-life balance and their association in the European Union (EU-28).
*Method:* This is a cross-sectional study based on data from the Flash Eurobarometer 398 among workers of the EU-28 from 2014 (n = 13,683). We calculated percentages and their 95% confidence intervals (95%CI). We also applied a multi-level generalised linear model using the Poisson family, to calculate the adjusted prevalence ratios (aPR) of satisfaction with work-life balance based on working hours. All analyses were stratified by individual, employment and welfare regime country classification.
*Results:* The satisfaction with working hours and work-life balance was 80.62% and 74.48%, respectively, and was significantly higher among women. The highest percentages of satisfaction were found in the Nordic welfare regime countries (90.2% and 85.3%, respectively). There was a statistically significant association between satisfaction with working hours and work-life balance (aPR: 2.63; 95%CI: 2.28-3.04), and the magnitude of the association differed in individual, employment and welfare regime country classifications. The main reasons declared for dissatisfaction were "excessive working hours" (48.7%), "shift work" (27.9%), and "inability to influence the work schedule" (28.3%). Differences were observed according to sex and type of welfare regime.
*Conclusion:* The differences found in the association between satisfaction with work-life balance and working hours according to sociodemographic characteristics and welfare regime show that there are inequalities in the working conditions in the EU countries.



## Actitudes frente a las condiciones laborales: ¿está la población trabajadora de la Unión Europea satisfecha con sus horas de trabajo y su balance trabajo-vida?

*Palabras clave:*
Condiciones laborales
Satisfacción con el trabajo
Balance trabajo-vida
Horas de trabajo

RESUMEN

*Objetivo:* Describir la satisfacción con las horas de trabajo y la satisfacción con el balance trabajo-vida y su respectiva asociación en la Unión Europea (UE-28).
*Método:* Se trata de un estudio transversal basado en los datos del *Flash Eurobarometer 398* en población trabajadora de la UE-28 en 2014 (n = 13.683). Calculamos porcentajes e intervalos de confianza del 95% (IC95%). Se calcularon las razones de prevalencia ajustadas (RPa) de satisfacción con las horas de trabajo y el balance trabajo-vida mediante un modelo multinivel lineal generalizado con la familia Poisson. Los análisis se estratificaron por características individuales, del empleo y del estado de bienestar.
*Resultados:* La satisfacción con las horas de trabajo (80,62%) y el balance trabajo-vida (74,48%) fue significativamente mayor en las mujeres. Los porcentajes más altos de satisfacción se encontraron en los países nórdicos (clasificación de estado de bienestar), siendo del 90,2% y el 85,3%, respectivamente. La asociación entre satisfacción con las horas de trabajo y balance trabajo-vida (RPa: 2,63; intervalo de confianza del 95%: 2,28-3,04) difirió por características individuales, del empleo y de estado de bienestar. Excesivas horas de trabajo (48,7%), turnicidad (27,9%) e imposibilidad de influir en el horario laboral (28,3%) fueron las principales razones de insatisfacción.
*Conclusiones:* Las diferencias encontradas en la asociación entre la satisfacción con el balance trabajo-vida y las horas de trabajo según las características sociodemográficas y el estado de bienestar demuestran la existencia de inequidades en las condiciones laborales en los países de la UE.



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## Introduction

Neoliberal economic globalization has changed working conditions and the definition of standard employment.[1] The traditional standard employment characteristics (regular working hours, stability, and social standards linked with permanent full-time work) has lost importance and the increasing trend is characterized by a flexible labor market. The flexible labor market has created, on one hand, boundaryless jobs, which means that there are no limits on how long, when and how fast people work.[2,3] On the other hand, non-standard work arrangements have increased, usually associated with low wages and temporary conditions.[1] Although working at unconventional times is becoming popular, the social rhythm of the western societies remains largely unchanged. Therefore, the balance between work and personal life, or work-life balance, has been largely discussed and is considered a policy priority in the European Union.[4,5]

Time has been proposed as a social determinant of health, as it is a resource that people need for good health; accessing health services, partaking in healthy behaviors, resting, working and caring for dependents.[2] Working hours (long working hours, irregular or shift work, night work, etc.) may create a work-life imbalance due to lack of time to sustain a personal life. Poor work-life balance has been suggested to be an intermediate factor of the associations between working hours and health-related outcomes.[6] Lack of time is associated with unhealthy behaviors; unhealthy diets, alcohol consumption, smoking and/or not exercising.[7] Moreover, not having time to recover from work exhaustion may result in a poor mental health status and sleeping problems.[6] Also, rushing to trying to catch up with the out-of-work activities may create stress responses, such as elevated blood pressure, heart rate and cortisol levels.[8] Further, low wages due to few working hours and temporary jobs may create financial insecurities that also have an impact on health status.[9] Therefore, satisfaction with work-life balance is an indicator of well-being that is of public health interest.[8]

Current evidence on satisfaction with work-life balance is mostly based on studies of health and academic professionals,[10–14] with a focus on balance with family time rather than personal time in general, and therefore with little external validity for the general population. Furthermore, almost all the studies done on working hours and work-life balance are based on "long working hours", whereas, too few hours would also be a predictor of poor work-life balance due to the lower wages earned.[15] Next, there are just two studies describing satisfaction with work-life balance in European population and they date from 2010. Thus, as work-life balance is one of the European Union priorities, an update on satisfaction with work-life balance in European workers is necessary.

Therefore, the objective of this study is to examine the associations between satisfaction with working hours and work-life balance and to describe the main reasons for dissatisfaction with working hours.

## Methods

### *Study population and data collection*

This is a cross-sectional study. We used the data obtained from the flash Eurobarometer 398 survey about "Working Conditions" carried out by TNS Political & Social network between April 3rd and 5th, 2014, on behalf of the European Commission, DG Employment, Social Affairs and Inclusion.[16] The survey covers the resident population in each of the 28 Member States aged 15 years and over. To complete the questionnaire, the respondents were interviewed via telephone (landline and mobile phone) in their mother tongue. In each country, a multi-stage random sampling design was used. The survey includes information from 26,571 European citizens. For the present study, we excluded people who declared not to be working and participants < 16 years old and > 70 years old (not at working age). The final sample for this study was 13,683 current European workers. From those included, 54% were men, 69% were employees, 78% worked full-time, 83% had a permanent work contract and the mean age was 42 years.

### *Study variables*

*Satisfaction with working hours* was obtained from the question: "More precisely, how satisfied are you with your "working hours" in your current job?", with the possible answers "very satisfied", "satisfied", "not very satisfied", "not at all satisfied". These were dichotomized as "satisfied" (very satisfied and satisfied) and "not satisfied" (not very satisfied, not at all satisfied).

Main reasons for *dissatisfaction with working hours* were obtained from the question: "Which of the following are the main reasons for your dissatisfaction with working hours?", with the possible answers; excessive working hours, not enough working hours, constrained by shift work or other forms of irregular working time, working exclusively or mainly at night, constrained by on-call periods at home, constrained by on-call periods at the workplace, unable to influence your work schedule, lack of opportunities for flexible working, and other reasons. For each of these, three maximum answers could be given. All the workers were asked about main reasons of dissatisfaction with working hours; even if they answered that they were very satisfied with their working hours in the previous question.

*Satisfaction with work-life balance* was obtained from the question: "More precisely, how satisfied are you with your work-life balance in your current job?" with the possible answers "very satisfied", "satisfied", "not very satisfied", "not at all satisfied". These were dichotomized as "satisfied" (very satisfied and satisfied) and "not satisfied" (not very satisfied, not at all satisfied).

The questionnaire also included information about sex (men, women), age (16-24 years, 25-39 years, 40-54 years, ≥55 years old), age at the end of schooling (<15 years, 16-19 years, > 20 years, still studying), occupation (self-employed, employee, manual workers), working day (part-time, full-time), work contract (permanent contract, fixed term contract, temporary employment, apprenticeship), country typologies classification based on the welfare regime type[17] as follows: Continental welfare regime countries (Austria, Belgium, Germany, France, the Netherlands and Luxembourg), Anglo-Saxon welfare regime countries (Ireland and the United Kingdom), Eastern European welfare regime countries (Croatia, Czech Republic, Estonia, Hungary, Lithuania, Latvia, Poland, Rumania, Bulgaria, Slovenia and Slovakia), Southern European welfare regime countries (Cyprus, Greece, Spain, Italy, Malta and Portugal) and Nordic welfare regime countries (Denmark, Finland and Sweden).

### *Statistical analysis*

We calculated the percentages and the 95% confidence intervals (95%CI) of satisfaction with the working hours and work-life balance. We draw a bar graphic with the main reasons of dissatisfaction with work hours by welfare regime countries classification and sex. We fit a multi-level generalized linear model using the Poisson family and country as the aleatory factor, to calculate the crude (cPR) and adjusted (aPR) prevalence ratios with their 95%CI of satisfaction with work-life balance according to satisfaction with working hours. All analyses included sampling weights for each country. The associations between work-life balance and working hours were stratified by individual (sex, age, age at the end of



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**Table 1**
Satisfaction (%) with the work-life balance and working hours among European current workers (EU-28) stratified according to individual, employment, and welfare characteristics in 2014.

| | n | Satisfaction with working hours | | Satisfaction with work-life balance | |
|---|---|---|---|---|---|
| | | % (CI95%) | p-value[a] | % (CI95%) | p-value[a] |
| *Overall* | 13683 | 80.62 (79.32-81.85) | ... | 74.48 (73.05-75.85) | ... |
| *Sex* | | | 0.001 | | 0.001 |
| Men | 7364 | 78.44 (73.80-82.46) | | 72.65 (68.81-76.18) | |
| Women | 6319 | 83.15 (81.53-84.65) | | 76.61 (74.19-78.86) | |
| *Age* | | | 0.317 | | 0.113 |
| 16-24 years | 1097 | 82.69 (72.59-89.60) | | 75.13 (69.44-80.06) | |
| 25-39 years | 5056 | 78.99 (75.21-82.32) | | 72.59 (69.17-75.77) | |
| 40-54 years | 5458 | 80.89 (77.50-83.88) | | 74.76 (71.25-77.97) | |
| ≥55 years | 2071 | 82.79 (79.34-85.77) | | 78.04 (72.91-82.43) | |
| *Age at the end of the studies* | | | 0.153 | | 0.491 |
| < 15 years | 799 | 75.10 (69.05-80.31) | | 73.16 (66.49-78.92) | |
| 16-19 years | 5418 | 82.13 (77.28-86.13) | | 75.68 (72.13-78.92) | |
| > 20 years | 7093 | 79.99 (76.76-82.87) | | 73.71 (70.66-76.55) | |
| Still studying | 263 | 87.45 (79.96-92.40) | | 78.22 (62.19-88.69) | |
| *Occupation* | | | < 0.001 | | 0.025 |
| Self-employed | 2157 | 72.42 (67.34-76.98) | | 69.55 (64.09-74.5) | |
| Employee | 9439 | 82.55 (79.06-85.57) | | 75.34 (72.09-78.33) | |
| Manual workers | 2073 | 80.26 (76.46-83.58) | | 75.67 (71.97-79.02) | |
| *Work time* | | | 0.026 | | < 0.001 |
| Part time | 3015 | 83.07 (79.62-86.04) | | 82.93 (77.48-87.28) | |
| Full time | 10576 | 79.92 (76.58-82.89) | | 72.08 (69.34-74.66) | |
| *Work contract* | | | 0.660 | | 0.109 |
| Permanent contract | 9225 | 82.41 (79.67-84.85) | | 75.83 (73.05-78.42) | |
| Fixed term contract | 1438 | 81.67 (74.28-87.3) | | 73.75 (65.23-80.80) | |
| Temporary employment | 183 | 78.76 (64.86-88.16) | | 88.38 (81.47-92.94) | |
| Apprenticeship | 197 | 87.37 (71.52-95.01) | | 64.62 (55.07-73.12) | |
| *Country typologies*[b] | | | < 0.001 | | < 0.001 |
| Continental | 5082 | 83.05 (79.41-86.16) | | 77.92 (74.37-81.1) | |
| Anglo-Saxon | 2208 | 84.46 (83.48-85.4) | | 77.83 (77.61-78.06) | |
| Eastern European | 3033 | 79.60 (77.57-81.50) | | 72.14 (71.06-73.20) | |
| Southern European | 2738 | 71.95 (66.37-76.93) | | 65.51 (60.07-70.58) | |
| Nordic | 622 | 90.17 (87.63-92.24) | | 85.27 (82.43-87.72) | |

CI95%: confidence interval of 95%.
[a] Chi-square test.
[b] Country typologies: Continental area (Austria, Belgium, Germany, France, the Netherlands and Luxembourg), Anglo-Saxon area (Ireland and the United Kingdom), Eastern European area (Croatia, Czech Republic, Estonia, Hungary, Lithuania, Latvia, Poland, Rumania, Bulgaria, Slovenia and Slovakia), Southern European area (Cyprus, Greece, Spain, Italy, Malta and Portugal) and Nordic countries (Denmark, Finland and Sweden).

schooling), employment (occupation, working day, work contract) and welfare regime country classification (country typologies).

We construct a DAG for the associations between work-life balance and satisfaction with working hours and the relations with the covariates (see Figure s1. Supplemental Material) using DAGitty.[18] The possible confounding variables (work contract, working day, occupation, age, age at the end of schooling and sex) from the DAG were tested in a crude model and those that changed the cPR by 5% were considered confounders (work time & work contract), and also by sex and age.

Furthermore, as having children (<3 years old) could be a possible confounding variable[19] of which we did not have information, we calculated the aPR for men and women at 20-35 years old, since the average age of having the first child in European Union countries ranges between the 20s and 30s.[20] Further, being in charge of the elderly may be another possible confounding variable, and so we calculated the aPR for men and women older than 50 years old, since at these ages is more probably to be in charge of an older person.

The level of statistical significance was set to a two-sided p-value < 0.05. All analyses were conducted using Stata 14.0 statistical software.

## Results

Table 1 shows satisfaction with work-life balance and working hours, which were 74.5% and 80.6%, respectively. There were statistically significant differences in the satisfaction with work-life balance and working hours according to sex, occupation, work time and welfare regime country classification (Table 1). The main reasons declared for dissatisfaction were excessive working hours (48.7%), shift work (27.9%), and inability to influence the work schedule (28.3%) (Fig. 1). The percentage of women who declared being dissatisfied with excessive working hours was higher than in men in Continental (54.69%), Southern European (51.01%), and Nordic (45.75%) countries. Otherwise, dissatisfaction for being unable to influence the work schedule was higher among men, except in Southern European countries, as dissatisfaction due to shift work, except for Anglo-Saxon Countries (Fig. 1).

There was a positive association between working hours and work-life balance (cPR: 2.56; 95%CI: 2.29-2.85; and aPR: 2.63; 95%CI: 2.28-3.04) (Table 2). Workers who were satisfied with their working hours had higher probabilities of being satisfied with their work-life balance (Table 2). After adjustment for potential confounders, higher associations of satisfaction with working hours



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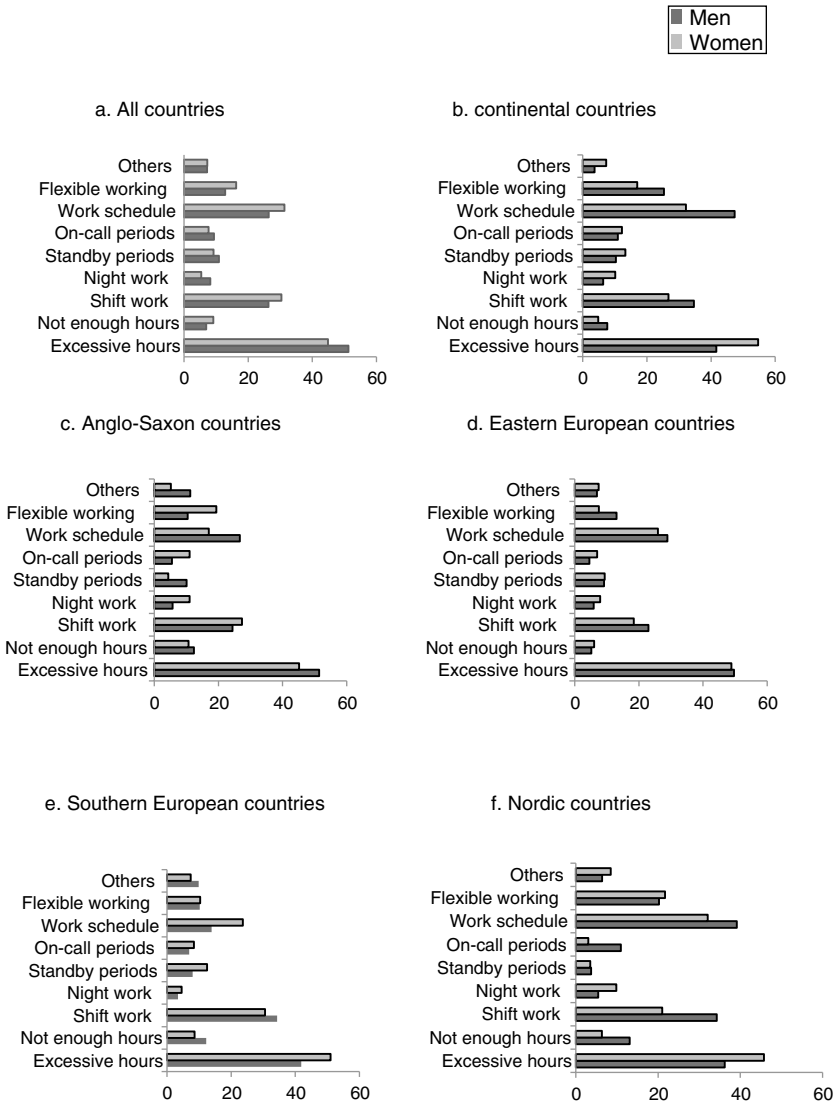


**Figure 1.** Main reasons of dissatisfaction with working hours by sex and country typology in the EU-28 at 2014.

and work-life balance were found among men, younger workers, in those that the age at the end of schooling was <15years, employees, full-time workers, apprenticeship contract workers and workers from Anglo-Saxon countries (Table 2). A similar pattern was observed among men and women at the age of having their first child (20-35 years old) and at the age of being in charge of the elderly (>50 years old) (Tables 3 and 4).

## Discussion

We found high satisfaction with working hours and work-life balance within European Union workers and a strong association between the two. Furthermore, the most prevalent reasons for dissatisfaction with working hours were excessive working hours, shift work, and inability to influence the work schedule.

Two previous studies have described work-life balance in the European Union. These studies found higher percentages of satisfaction with work-life balance (around 80%) than our figures (74.5%).[8,21] Moreover, Lunau et al.[8] found higher satisfaction with work-life balance among women and Scandinavian countries (10.8%) and lower satisfaction in Southern European countries (23.5%) of the EU-27 countries with a similar classification of welfare characteristics. Even though the patterns of the frequencies are the same, we show higher percentages of dissatisfaction with work-life balance. Those differences could be explained by the year the surveys where done (2005 and 2010 vs. 2014) and the potential effect of the economic crisis on satisfaction with working conditions (better to have a job than not). Greubel et al.[21] reported an association between working at unusual times (evenings, Saturdays and Sundays) and poor work-life balance. We find a similar association, but our main variable "satisfaction with working hours" can be understood from several perspectives; amount of time (i.e. long or few hours), work schedule (i.e. shift work or working at unusual times) and being able to influence the work schedule (i.e. flexible hours, on-call periods at home or standby periods at work).

A higher proportion of women were satisfied with their work-life balance. This could be explained by the fact that women more frequently work part-time to be able to take care of children and the household.[19] In our study, 15.96% of women and 6.23% of men had part-time work. Otherwise, the adjusted association between satisfaction with working hours and work-life balance was slightly higher among men. Our results, then, would support the idea that women take primary responsibility for managing the household while working part- or full-time.[22,23]

Associations between satisfaction with working hours and work-life balance were lower in the self-employed, in those with



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**Table 2**
Prevalence ratio of satisfaction in work-life balance from satisfaction in working hours among European current workers (EU-28) stratified according to individual, employment, and welfare characteristics in 2014.

| | cPR | CI95% | aPR[a] | CI95% |
|---|---|---|---|---|
| Overall | 2.56 | (2.29-2.85) | 2.63 | (2.28-3.04) |
| *Sex* | | | | |
| Men | 2.31 | (2.01-2.66) | 2.81 | (2.34-3.38) |
| Women | 2.76 | (2.41-3.15) | 2.41 | (2.02-2.89) |
| *Age* | | | | |
| 15-24 years | 2.49 | (1.76-3.53) | 2.99 | (2.09-4.29) |
| 25-39 years | 2.49 | (2.01-3.08) | 2.58 | (2.06-3.22) |
| 40-54 years | 2.59 | (2.23-3.01) | 2.53 | (2.28-2.80) |
| ≥ 55 years | 2.72 | (2.27-3.27) | 2.87 | (2.15-3.82) |
| *Age at the end of the studies* | | | | |
| <15 years | 2.96 | (2.05-4.27) | 3.71 | (2.59-5.29) |
| 16-19 years | 2.44 | (2.08-2.86) | 2.48 | (1.99-3.09) |
| >20 years | 2.67 | (2.31-3.08) | 2.76 | (2.36-3.23) |
| Still studying | 1.28 | (0.60-2.71) | 1.19 | (0.83-1.70) |
| *Occupation* | | | | |
| Self-employed | 2.30 | (1.93-2.74) | 2.24 | (1.87-2.70) |
| Employee | 2.72 | (2.39-3.09) | 2.69 | (2.34-3.08) |
| Manual workers | 2.35 | (1.98-2.79) | 2.39 | (1.99-2.89) |
| *Work time* | | | | |
| Part time | 1.73 | (1.45-2.07) | 1.71 | (1.45-2.01) |
| Full time | 2.91 | (2.51-3.36) | 3.05 | (2.49-3.75) |
| *Work contract* | | | | |
| Permanent contract | 2.72 | (2.32-3.20) | 2.70 | (2.31-3.15) |
| Fixed term contract | 2.48 | (2.05-2.99) | 2.42 | (2.02-2.91) |
| Temporary employment | 1.65 | (1.23-2.22) | 1.63 | (1.27-2.08) |
| Apprenticeship | 2.69 | (1.68-4.30) | 3.24 | (1.77-5.93) |
| *Country typologies*[b] | | | | |
| Continental | 2.53 | (2.29-2.80) | 2.56 | (2.33-2.80) |
| Anglo-Saxon | 2.97 | (0.59-14.99) | 3.63 | (0.59-22.37) |
| Eastern European | 2.19 | (1.65-2.91) | 2.24 | (1.54-3.27) |
| Southern European | 2.75 | (2.13-3.54) | 2.68 | (2.03-3.54) |
| Nordic | 1.97 | (1.26-3.09) | 2.03 | (0.91-4.52) |

CI95%: confidence interval of 95%; PR: prevalence ratio.
[a] PR: adjusted prevalence ratios for sex, age, work time and work contract.
[b] Country typologies: Continental area (Austria, Belgium, Germany, France, the Netherlands and Luxembourg), Anglo-Saxon area (Ireland and the United Kingdom), Eastern European area (Croatia, Czech Republic, Estonia, Hungary, Lithuania, Latvia, Poland, Rumania, Bulgaria, Slovenia and Slovakia), Southern European area (Cyprus, Greece, Spain, Italy, Malta and Portugal) and Nordic countries (Denmark, Finland and Sweden).

**Table 3**
Prevalence ratio of satisfaction in work-life balance from satisfaction in working hours among European current workers (EU-28) between 20 and 35 years old (ages of family beginning) stratified according to individual, employment, and welfare regime country classification in 2014.

| | Men 20-35 years old (n = 1803) | | Women 20-35 years old (n = 1900) | |
|---|---|---|---|---|
| | aPR[a] | CI95% | aPR[a] | CI95% |
| Overall | 2.65 | (2.14-3.27) | 2.79 | (1.90-4.10) |
| *Age at the end of the studies* | | | | |
| <15 years | 3.62 | (1.60-8.18) | 1.40 | (1.03-1.91) |
| 16-19 years | 2.82 | (1.34-5.93) | 2.93 | (1.89-4.54) |
| >20 years | 2.56 | (2.04-3.20) | 2.92 | (1.84-4.64) |
| Still studying | 2.74 | (0.40-18.71) | 2.12 | (0.52-8.72) |
| *Occupation* | | | | |
| Self-employed | 1.92 | (1.16-3.19) | 1.18 | (0.79-1.78) |
| Employee | 2.63 | (2.14-3.24) | 2.84 | (1.77-4.56) |
| Manual workers | 2.56 | (1.74-3.77) | 2.52 | (1.49-4.24) |
| *Work time* | | | | |
| Part time | 1.77 | (1.19-2.66) | 2.41 | (2.01-2.89) |
| Full time | 2.86 | (2.24-3.65) | 3.07 | (1.68-5.61) |
| *Work contract* | | | | |
| Permanent contract | 2.77 | (2.16-3.56) | 2.81 | (1.67-4.72) |
| Fixed term contract | 1.92 | (1.12-3.31) | 2.98 | (1.97-4.51) |
| Temporary employment | NC | NC | NC | NC |
| Apprenticeship | NC | NC | NC | NC |
| *Country typologies*[b] | | | | |
| Continental | 2.69 | (2.38-3.05) | 2.86 | (1.69-4.84) |
| Anglo-Saxon | 3.44 | (2.02-5.86) | 8.83 | (7.83-9.96) |
| Eastern European | 2.31 | (1.45-3.66) | 1.99 | (1.43-2.78) |
| Southern European | 2.17 | (1.62-2.90) | 2.16 | (0.89-5.23) |
| Nordic | 2.61 | (0.35-19.12) | 2.14 | (1.49-3.09) |

CI95%: confidence interval of 95%; NC: not converge; PR: prevalence ratio.
[a] PR: adjusted prevalence ratios for sex, age, work time and work contract.
[b] Country typologies: Continental area (Austria, Belgium, Germany, France, the Netherlands and Luxembourg), Anglo-Saxon area (Ireland and the United Kingdom), Eastern European area (Croatia, Czech Republic, Estonia, Hungary, Lithuania, Latvia, Poland, Rumania, Bulgaria, Slovenia and Slovakia), Southern European area (Cyprus, Greece, Spain, Italy, Malta and Portugal) and Nordic countries (Denmark, Finland and Sweden).

a temporary contract and also with part-time work. The same pattern was observed in workers at the age of having the first child and at ages of being at charge of the elderly. Previous studies have described a worse health status among the self-employed and higher risks for work-family conflict due to job demands.[24,25] Temporary employment has been associated with psychological morbidity mediated by job insecurity or erosion of income, among other factors.[26] Therefore, workers with temporary employment contracts, part-time or self-employed would experience economic-based work-life imbalance.

Workers from Nordic countries declare the highest satisfaction with working hours and work-life balance. This is coherent with the welfare regime of these countries; in Nordic countries, policies for compatibility of employment and private life are common, as is the promotion of employment for women.[17] For example, Nordic welfare states have large investments in publicly provided child care for preschool children,[27] also extensive services related to care for the elderly and the disabled, generous parental leaves (high compensation rates and long leave periods).[27] In the contrary, Anglo-Saxon countries are characterized by deregulated labor markets and men are still the main breadwinners, with low support for female participation in the labor force.[17] Despite Continental and Southern European countries having strong labor market regulations, few efforts are made to facilitate the work-life balance and there is little support to promote female employment.[17] Finally, Eastern countries are similar to Anglo-Saxon countries in terms of labor market; there is a traditional model of household labor division and dual-earner families are common.[17] We also observed lower disparities in the satisfaction with working hours and work-life balance in Nordic countries. Macrosocial policies may explain why satisfaction with working hours and work-life balance may not be as strongly associated as in other countries.[27] Similarly, we observed that the associations of satisfaction with work-life balance from satisfaction with working hours at ages of family beginning and at ages of being in charge of the elderly were higher in Anglo-Saxon welfare regime countries, showing greater disparities than in Eastern, Southern and Nordic welfare regime countries.

The most prevalent reasons for dissatisfaction with working hours were excessive working hours, shift work, and inability to influence the work schedule. Women from Southern, Nordic and Continental countries declared excessive working hours as the main reason for dissatisfaction. This could possibly be because during the economic crisis in Europe, men became unemployed and women extended their working hours.[28] The inability to influence the work schedule was declared more often by men in Continental, Eastern and Nordic Countries, as was shift work in those countries and in Southern European Countries. This is in line with the new employment definition which created boundaryless jobs with irregular working hours.[2,3] Moreover, we found associations



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**Table 4**
Prevalence ratio of satisfaction in work-life balance from satisfaction in working hours among European current workers (EU-28) older than 50 years old (elderly people in charge) stratified according to individual, employment, and welfare regime country classification in 2014.

| | Men > 50 years old (n = 1011) | | Women > 50 years old (n = 1122) | |
|---|---|---|---|---|
| | aPR[a] | CI95% | aPR[a] | CI95% |
| Overall | 3.19 | (2.41-4.22) | 2.82 | (2.04-3.90) |
| *Age at the end of the studies* | | | | |
| < 15 years | 5.42 | (2.39-12.30) | 3.38 | (1.27-8.98) |
| 16-19 years | 1.97 | (1.55-2.51) | 2.31 | (1.80-2.96) |
| > 20 years | 4.29 | (2.32-7.93) | 3.24 | (1.87-5.61) |
| Still studying | NC | NC | NC | NC |
| *Occupation* | | | | |
| Self-employed | 2.66 | (1.92-3.68) | 1.88 | (1.17-3.05) |
| Employee | 3.57 | (2.21-5.75) | 3.41 | (2.37-4.92) |
| Manual workers | 2.30 | (1.19-4.45) | 1.32 | (0.99-1.76) |
| *Work time* | | | | |
| Part time | 2.04 | (0.89-4.70) | 2.06 | (1.44-2.94) |
| Full time | 3.36 | (2.57-4.40) | 3.51 | (2.34-5.26) |
| *Work contract* | | | | |
| Permanent contract | 3.04 | (2.42-3.83) | 2.94 | (2.07-4.16) |
| Fixed term contract | NC | NC | 1.88 | (1.15-3.06) |
| Temporary employment | NC | NC | NC | NC |
| Apprenticeship | NC | NC | NC | NC |
| *Country typologies*[b] | | | | |
| Continental | 4.51 | (2.76-7.36) | NC | NC |
| Anglo-Saxon | 2.31 | (2.18-2.44) | 10.14 | (5.72-18.02) |
| Eastern European | 3.41 | (2.03-5.72) | 2.06 | (1.77-2.40) |
| Southern European | 2.82 | (2.04-3.92) | 2.95 | (1.37-6.36) |
| Nordic | 1.42 | (1.08-1.88) | 2.63 | (1.57-4.41) |

CI95%: confidence interval of 95%; NC: not converge; PR: prevalence ratio.
[a] PR: adjusted prevalence ratios for sex, age, work time and work contract.
[b] Country typologies: Continental area (Austria, Belgium, Germany, France, the Netherlands and Luxembourg), Anglo-Saxon area (Ireland and the United Kingdom), Eastern European area (Croatia, Czech Republic, Estonia, Hungary, Lithuania, Latvia, Poland, Rumania, Bulgaria, Slovenia and Slovakia), Southern European area (Cyprus, Greece, Spain, Italy, Malta and Portugal) and Nordic countries (Denmark, Finland and Sweden).

between the main dissatisfaction reasons with working hours and satisfaction with work-life balance (data not shown).

Poor work-life balance has been described as a predictor of sickness absence[29] and poor self-declared health status.[8] Also, inequalities in working conditions may create health inequalities[30] and we have observed differences in the reporting of work-life balance. Moreover, disparities observed in poor work-life balance across welfare regimes show that, even though EU legislation covers all the countries equally, country-specific measures for work-life compatibility[4] in some countries have improved work-life balance and, therefore, further measures should be applied. This study has some limitations. First, the main variable "satisfaction with work-life balance" was measured from a single question and therefore it may not assess the several perspectives of the work-life balance (i.e. work-life imbalance due to lack of time or lack of money). Future studies may measure the satisfaction with work-life balance by taking into account the several perspectives it has. In this study we could not adjust by having children, nor for caring for the elderly and disabled, which have been described predictors of poor work-life balance, especially among women[19]. Instead, we did a sub-analysis with the population group at the age of having the first child (20-35 years old) and at the age of being in charge of the elderly (>50 years old). Also, we cannot establish causality in the relationship between satisfaction with working hours and work-life balance due to the cross-sectional design of the study. Instead, we can infer associations. This is the first study examining the associations between satisfaction with working hours and work-life balance through several factors that explain well-being to the occupation; individual factors (i.e. sex, age, educational level), work and job conditions (i.e. occupation, work time and contract) and country characteristics (i.e. country welfare regime) and to describe the main reasons for dissatisfaction with working hours. Finally, we calculated the PR using the Poisson family, which gives us more robust associations.[31]

## Conclusions

Satisfaction with working hours and work-life balance was high in Europe, but we found differences between sex, age at the end of the studies, welfare regimes and work characteristics. Also, there are still differences in the main reasons for dissatisfaction between sexes and welfare regimes. Thus, the evidence shows that inequalities in working conditions are still present and that, even though one of the policy priorities of the EU is work-life balance, there is still a lot of work to be done.

## Editor in charge

Carlos Álvarez-Dardet.

## Transparency declaration

The corresponding author on behalf of the other authors guarantee the accuracy, transparency and honesty of the data and information contained in the study, that no relevant information has been omitted and that all discrepancies between authors have been adequately resolved and described.

## Authorship contributions

J.M. Martínez-Sánchez and N. Matilla-Santander conceived the study. N. Matilla-Santander prepared the database and analyzed the data with the support of all the authors (J.C. Martín-Sánchez, C. Lidón Moyano, A. González Marrón, K. Bunch, J.M. Martínez-Sánchez). N. Matilla-Santander drafted the manuscript, which was critically revised by J.M. Martínez-Sánchez. All authors contributed substantially to the interpretation of the data and to revising the manuscript. All authors approved its final version.

**What is known about the topic?**

Long working hours and low wages have been described as predictors of poor work-life balance. Time has been proposed as a social determinant of health and work-life balance is considered a policy priority in the European Union.

**What does this study add to the literature?**

This study gives an update of the satisfaction with working hours and work-life balance in the European Union workers. Satisfaction with working hours and work-life balance is high in Europe, but there are still differences in the main reasons for dissatisfaction between sexes and welfare regimes.

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## Conflicts of interest

None.

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## Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.gaceta.2017.10.006.

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# ANNEX X. Article. Use of electronic cigarettes in public and private settings in Barcelona (Spain).

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# Use of electronic cigarettes in public and private settings in Barcelona (Spain)

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ABSTRACT

*Objectives:* To describe the prevalence of e-cigarette users who use them in selected indoor public and workplaces, and private venues in Barcelona (Spain) in 2015.

*Methods:* This is a cross-sectional study of a sample of e-cigarette users (≥ 18 years) from Barcelona (n = 600). We calculated the proportion of e-cigarette users who used the device in public and private settings (in the last 30 days). We fit multivariate logistic regression models adjusted for sex and age to calculate the odds ratios (OR) with their 95% confidence intervals (CI) of e-cigarette use by socio-demographic factors, dual use and nicotine-containing e-cigarettes.

*Results:* The highest proportion of e-cigarette users who used them in public places was found at restaurants or bars (69.4%) and nightclubs or pubs (55.4%). Also being current conventional tobacco smokers (dual users) was significantly associated with lower use of e-cigarettes in workplaces (OR = 0.61, 95%CI:0.41–0.91), restaurants (OR = 0.66, 95%CI:0.45–0.97) and nightclubs (OR = 0.56, 95%CI:0.37–0.86). Moreover, being a nicotine-containing e-cigarette user was associated with higher odds of using the device in workplaces (OR = 2.01, 95%CI:1.34–3.01), and lower odds of using it in nightclubs (OR = 0.56, 95%CI:0.39–0.82). 96.8% of the included e-cigarette users declared to use the device at home. Being a current tobacco smoker was associated with increased odds of using e-cigarettes at home (OR = 3.17, 95%CI:1.22–8.22).

*Conclusions:* E-cigarette use in private settings and in public settings where their use is not regulated by law is high. Therefore, the public health administration in Spain should consider expanding the prohibition of e-cigarette use to indoor public places and should take into account the possibility of exposure to aerosol from e-cigarettes.

## 1. Introduction

According to data from the Institute for Health Metrics and Evaluation from 2015, 1.6% of total deaths (Institute for Health Metrics University of Washington, 2016a) and 1.2% of total disability adjusted life years (DALYs) were attributable to secondhand smoke (SHS) exposure worldwide (Institute for Health Metrics University of Washington, 2016b). For this reason, in the last few decades several countries have implemented smoke-free bans in order to protect non-smokers and vulnerable populations from SHS exposure, as noted by Article 8 of the World Health Organization Framework Convention on Tobacco Control (World Health Organization (WHO), 2015). These bans establish that smoking should be prohibited in all indoor workplaces, public places, public transport facilities, health care facilities, schools and universities, as well as retail stores and shopping centers. The health impact of these smoking restrictions has already been widely described (Frazer et al., 2016; World Health Organization, 2014; International Agency for Research on Cancer, 2009). Moreover, smoke-free legislation has played an important role in reducing social acceptability and the denormalization of smoking (The Community

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Guide, 2012).

However, since 2007, the new phenomenon of electronic cigarettes (e-cigarettes), also called Electronic Nicotine Delivery Systems (ENDS) has become popularized. Thus, the denormalization of tobacco consumption in public and workplaces, particularly at bars and restaurants, has been threatened around the world due to the ability to use e-cigarettes anywhere (Chapman et al., 2016). Furthermore, since the popularization of e-cigarettes, an intense debate has been created among researchers and the population about their potential advantages (Specialists in Nicotine Science and Public Health Policy, 2014) and harmful (Centre for Tobacco Control Research and Education, 2014) health effects.

There are various reasons for the current ongoing debate by health-care professionals and legislators about the regulation of the use of e-cigarettes in smoke-free environments (Specialists in Nicotine Science and Public Health Policy, 2014; Centre for Tobacco Control Research and Education, 2014). First, it is complicated to know whether or not e-cigarettes could represent a danger to public health since the evidence concerning e-cigarettes is limited (Kaisar et al., 2016). In addition, the risks and benefits particularly at mid- and long-term, are still unknown (Kaisar et al., 2016). Moreover, mixed findings on the effectiveness of e-cigarettes for smoking cessation can be found in the literature. On one hand, e-cigarettes could supplement nicotine intake in a less harmful way and thus decrease tobacco consumption (Adriaens et al., 2014). In 2015, Public Health England (PHE), an agency of England's Department of Health, recommended that health professionals advise the use of e-cigarettes to smokers who cannot quit smoking by traditional methods (Mcneill et al., 2015). This controversial recommendation has been criticized by many public health researchers (Centre for Tobacco Control Research and Education, 2014) and has been linked to interests of tobacco companies (Gornall, 2015). On the other hand, dual use of e-cigarettes and tobacco has been described as not helping to reduce tobacco consumption, but as promoting greater nicotine dependence (Manzoli et al., 2016; Wetter et al., 2002). Finally, evidence supporting e-cigarettes as a device for quitting smoking was rated as “low” by the GRADE standards (Hartmann-Boyce et al., 2016).

The prevalence of e-cigarette use has increased rapidly in Europe and the United States (King et al., 2013; Filippidis et al., 2016), as well as the prevalence of e-cigarette ever use (King et al., 2013; Filippidis et al., 2016). The prevalence of e-cigarette use and ever use was 2% and 10.3% respectively in 2014 in Spain (Lidón-Moyano et al., 2016a). That same year, the use of e-cigarettes in specific Spanish public and workplaces was regulated. These places included public administration buildings, in and around schools, in universities and health centers, on public transport, and at children's parks (Spanish Government, 2014). The legislation also required the proper signage to be posted at the entrances of buildings and around the areas where e-cigarettes are banned.

Despite ongoing debate about the regulation of e-cigarettes and their use in public and workplaces, there is a lack of evidence about the prevalence of use of e-cigarettes in public places where e-cigarettes, conventional cigarettes or both are banned, and also in private settings where children are more exposed. Therefore, the objective of this study is to describe the prevalence of e-cigarettes users who use them in selected public and workplaces, and private venues in Barcelona (Spain) in 2015.

## 2. Methods

### 2.1. Study population and data collection

This is a cross-sectional study of a sample of adult e-cigarette (≥ 18 years) users, residents of Barcelona (n = 600) (Matilla-Santander et al., 2017). The market research technique known as ‘consumer panels’, which has been previously described elsewhere (Matilla-Santander et al., 2017), was used to enroll individuals who were e-cigarette users at the moment of the interview. Briefly, current e-cigarette users were recruited in all neighborhoods of the city of Barcelona between February and June of 2015 by sensors (specifically trained personnel for the recruitment of uncommon product consumers, in this case, e-cigarette users). A brief face-to-face interview was conducted with the participants who agreed to participate at that time and again in 2016. The final sample was of 600 adult e-cigarette users. The sample size for this study was calculated using the formula for simple random samples $(Z\alpha^*pq/e)^2$) for an expected prevalence of 50% (p = q = 0.5) to yield the maximum sample size and ensure statistical power. A 95% confidence level was used ($Z\alpha/2 = 1.96$) and absolute error 0.04. We used 50% as the expected prevalence because we did not know the prevalence of the patterns of use among e-cigarette users and this prevalence maximizes the sample size.

### 2.2. Study variables

The main variables used in this study were those referring to the use of e-cigarettes in public or private settings by e-cigarette users. Public places included workplaces, public transport, hospitals, schools and hospitality sector settings. Private places included homes and private cars. We asked e-cigarette users if they had used e-cigarettes during the last 30 days in their indoor workplaces, enclosed public transport (bus, train, tram, metro), taxis, airplanes, hospitals or other health care centers, schools or educational centers, bars or restaurants, nightclubs or pubs, their home and their private vehicles. The answers to those questions could be: “yes”, “no”, and “don’t know”. Those who declared that they had not been in those places in the last 30 days were excluded from the analysis. For each variable, we dichotomized the answers as “yes, I have used it” and “no, I have not used it”. We considered those who declared that they did not know if they had used e-cigarettes in these places as missing values. Moreover, for the variable “use of e-cigarette in the workplace”, we excluded those who were not working as they had not been in the workplace during the last 30 days (n = 101).

We also obtained information about sex, age (categorized as < 45 years old, 45–64 years old and > 65 years old), educational level (categorized as low (no qualification up to middle school diploma), intermediate (high school) and high (university degree)), smoking status (non-smokers and smokers), nicotine containing e-cigarettes (no and yes) and living with children from 0 to 17 years old (categorized as no and yes). These variables were used as covariates.

### 2.3. Statistical analysis

We calculated the proportion of e-cigarette users who used the device in public and private settings. We fit multivariate logistic regression models adjusted for sex and age to calculate the odds ratios (OR) with their 95% confidence intervals (CI) of e-cigarette use. Analyses of public places were stratified by sex, age, educational level, smoking status and use of nicotine-containing e-cigarettes. The analyses of private places were stratified for the same variables as for public places and also for living with children. Multivariate logistic regression models for the use of e-cigarettes in airplanes were not calculated due to the small sample size (n = 17). The level of statistical significance was set to a two-sided p-value < 0.05. All analyses were conducted using Stata 14.0 statistical software.

## 3. Results

63.5% of the e-cigarette users included in the study were women, the majority were under 45 years old (72.5%), 42.3% had a university education and 26% of them were living with children. Moreover, more than the half were smokers of tobacco (65.2%) and used nicotine-containing e-cigarettes (56%).

Table 1 shows the proportion of e-cigarette users who used them in

**Table 1**
Prevalence of electronic cigarette users who use them in selected public and workplaces according to sex, age, educational level, smoking status and nicotine-containing e-cigarette in Barcelona, Spain (2015).

| | Workplace n = 499 (83.2%) | | Public transport n = 549 (91.6%) | | Taxi n = 304 (50.7%) | | Plane n = 17 (19.5%) | | Hospital n = 139 (23.2%) | | School n = 217 (36.2%) | | Restaurants or bars n = 588 (98.2%) | | Nightclubs or pubs n = 469 (78.2%) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | % | p-value[a] | % | p-value[a] | % | p-value[a] | % | p-value[a] | % | p-value[a] | % | p-value[a] | % | p-value[a] | % | p-value[a] |
| **Overall** | 32.46 | – | 3.10 | – | 3.95 | – | 0.85 | – | 2.88 | – | 4.61 | – | 69.39 | – | 55.44 | – |
| **Sex** | | 0.809[b] | | 0.346[b] | | **0.031** | | 1 | | 1 | | 1 | | 0.472[b] | | 0.981[b] |
| ***Men*** | 33.15 | | 4.02 | | 7.34 | | 0 | | 2.04 | | 3.95 | | 67.59 | | 55.37 | |
| ***Women*** | 32.09 | | 2.57 | | 2.05 | | 1.41 | | 3.33 | | 4.96 | | 70.43 | | 55.48 | |
| **Age** | | 0.086 | | 0.158 | | **0.038** | | 0.359 | | 0.060 | | 0.227 | | 0.054 | | **0.001** |
| ***< 44 years old*** | 29.65 | | 2.26 | | 1.96 | | 0 | | 0 | | 3.13 | | 72.17 | | 59.29 | |
| ***45–64 years old*** | 38.56 | | 5.59 | | 8.42 | | 2.50 | | 6.90 | | 9.43 | | 62.18 | | 40.59 | |
| ***> 65 years old*** | 50.00 | | 0 | | 0 | | 0 | | 0 | | 0 | | 62.50 | | 100 | |
| **Educational level** | | 0.341[b] | | 0.440[b] | | 0.163 | | 0.513 | | 0.507 | | 0.393 | | 0.065[b] | | 0.092[b] |
| ***Primary or less*** | 36.84 | | 0 | | 0 | | 0 | | 0 | | 0 | | 79.25 | | 71.79 | |
| ***Secondary*** | 35.14 | | 3.41 | | 2.14 | | 1.82 | | 1.49 | | 3.39 | | 65.25 | | 53.04 | |
| ***University or more*** | 29.29 | | 3.36 | | 6.21 | | 0 | | 4.76 | | 7.41 | | 71.94 | | 55.00 | |
| **Smoking status** | | **0.010**[b] | | **0.043**[b] | | 1 | | 1 | | 0.334 | | 0.519 | | **0.046**[b] | | **0.009**[b] |
| ***Non-smokers*** | 40.12 | | 5.10 | | 3.74 | | 0 | | 4.69 | | 3.16 | | 74.52 | | 63.47 | |
| ***Smokers*** | 28.61 | | 1.98 | | 4.06 | | 1.49 | | 1.33 | | 5.74 | | 66.58 | | 50.99 | |
| **Nicotine-containing e-cig** | | **< 0.001**[b] | | 0.195[b] | | 0.392[b] | | 1 | | 0.644 | | 0.108 | | 0.288[b] | | **0.002**[b] |
| ***No*** | 23.65 | | 2.03 | | 2.90 | | 0 | | 1.75 | | 1.96 | | 71.65 | | 62.90 | |
| ***Yes*** | 38.51 | | 3.96 | | 4.82 | | 1.49 | | 3.66 | | 6.96 | | 67.58 | | 48.79 | |

[a] Fisher Exact test, except when indicated.
[b] Chi square test.

the selected indoor public places. The proportion of e-cigarette users who used them in workplaces was 32.5%; non-smokers of conventional tobacco used e-cigarettes more frequently compared with current smokers (40.1% vs. 28.6%, $p < 0.05$) (Table 1). Of e-cigarette users who used them in public places, the highest proportion reported using them in restaurants compared with other public settings (69.4%). Again, non-smokers of tobacco cigarettes declared using the device in these locations at a higher prevalence when compared to current smokers (74.5% vs. 66.6%, $p < 0.05$) (Table 1). Moreover, the public place where e-cigarettes users used most frequently after restaurants and bars was in nightclubs (55.4%); 59.3% of these users were under 44 years old and 63.5% non-smokers of tobacco (Table 1). Lower frequencies of e-cigarette users who used them in public transport (3.1%), taxis (4.0%), airplanes (0.9%), hospitals (2.9%) and schools (4.6%) were found (Table 1). Most of the e-cigarette users who declared having used the device in taxis were men (7.3%) and their age generally ranged between 45 and 64 years old (Table 1).

Table 2 shows the multivariate regression associations of e-cigarette users who used in the selected indoor public places. We found that being a current conventional tobacco smoker (dual user) was significantly associated with lower use of e-cigarettes in workplaces (OR = 0.61, 95%CI:0.41–0.91), restaurants (OR = 0.66, 95%CI:0.45–0.97), nightclubs (OR = 0.56, 95%CI:0.37–0.86), and, less strongly, in public transport (OR = 0.38, 95%CI: 0.14–1.01) (Table 2). Moreover, using nicotine-containing e-cigarettes was significantly associated with higher odds of use of the device in workplaces (OR = 2.01, 95%CI:1.34–3.01), and lower odds of use in nightclubs (OR = 0.56, 95%CI:0.39–0.82).

Table 3 shows the proportion of e-cigarette users who used them in indoor private places. 96.8% of the e-cigarette users declared using e-cigarettes in their home (Table 3). Moreover, the frequency of e-cigarette users who used at home was higher in those who did not live with children under 17 years old (98.0%) and in those who were current tobacco smokers (98.2%). 47.5% of the e-cigarette users declared smoking in their private vehicles (Table 3). Being a current tobacco smoker was associated with increased odds of using e-cigarettes at home (OR = 3.17, 95%CI:1.22–8.22) and, less strongly, of using e-cigarettes with nicotine (OR = 2.83, 95%CI:1.05–7.65) (Table 4).

## 4. Discussion

To our best knowledge, this is the first study in Spain and Europe that describes the use of e-cigarettes in specific indoor public smoke-free areas and private settings. Our study shows that the use of e-cigarettes was higher in private venues, particularly at home, than indoor public venues such as workplaces or restaurants and bars. Moreover, dual users (using both conventional cigarettes and nicotine-containing e-cigarettes) declared a higher use of e-cigarettes in public smoke-free areas and homes.

We found a similar pattern of e-cigarette use among those who used at work and in public places as a previous cross-sectional study, conducted in US in 2014, which assessed the current use of e-cigarettes (n = 952) in public places where smoking was not allowed (Shi et al., 2016). However, the proportions of use in workplaces (23.5%) and bars or nightclubs (30.7%) were lower than the ones found in our study. Those differences could be due to the data collection methods; firstly, they used a web panel while we conducted face-to-face interviews, and secondly, we asked about the use of e-cigarettes during the last 30 days and they asked about ever use of e-cigarettes in those places. Also, the compliance with the smoking bans could be different between the

**Table 2**
Adjusted OR of electronic cigarette users who used them in selected public and workplaces according to sex, age, educational level smoking status and nicotine-containing e-cigarette in Barcelona, Spain.

| | Workplace n = 499 (83.2%) | | Public transport n = 549 (91.6%) | | Taxi n = 304 (50.7%) | | Hospital n = 139 (23.2%) | | School n = 217 (36.2%) | | Restaurants or bars n = 588 (98.2%) | | Nightclubs or pubs n = 469 (78.2%) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OR[a] | 95%CI | OR[a] | 95%CI | OR[a] | 95%CI | OR[a] | 95%CI | OR[a] | 95%CI | OR[a] | 95%CI | OR[a] | 95%CI |
| **Sex** | | | | | | | | | | | | | | |
| ***Men*** | 1 | – | 1 | – | 1 | – | – | – | 1 | – | 1 | – | 1 | – |
| ***Women*** | 0.98 | (0.66–1.45) | 0.66 | (0.25–1.45) | 0.29 | (0.08–1.01) | – | | 1.37 | (0.34–5.52) | 1.10 | (0.76–1.58) | 0.96 | (0.66–1.41) |
| **Age**[b] | | | | | | | | | | | | | | |
| ***< 44 years old*** | 1 | – | 1 | – | 1 | – | – | – | 1 | – | 1 | – | 1 | – |
| ***> 44 years old*** | 1.49 | (1.01–2.23) | 2.35 | (0.89–6.25) | 3.88 | (1.13–13.39) | – | – | 3.05 | (0.85–11.02) | 1.10 | (0.76–1.58) | 0.95 | (0.65–1.38) |
| **Educational level** | | | | | | | | | | | | | | |
| ***Primary or less*** | 1 | – | 1 | – | 1 | – | 1 | – | 1 | – | 1 | – | 1 | – |
| ***Secondary and university*** | 0.76 | (0.52–1.11) | 1.12 | (0.42–2.96) | 3.47 | (0.91–13.41) | 3.61 | (0.35–37.03) | 2.23 | (0.59–8.44) | 1.26 | (0.88–1.80) | 1.02 | (0.70–1.79) |
| **Smoking status** | | | | | | | | | | | | | | |
| ***Non-smokers*** | 1 | – | 1 | – | 1 | – | 1 | – | 1 | – | 1 | – | 1 | – |
| ***Smokers*** | **0.61** | **(0.41–0.91)** | **0.38** | **(0.14–1.01)** | 1.32 | (0.37–4.70) | 0.45 | (0.04–4.65) | 2.43 | (0.58–10.26) | **0.66** | **(0.45–0.97)** | **0.56** | **(0.37–0.86)** |
| **Nicotine-containing e-cig** | | | | | | | | | | | | | | |
| ***No*** | 1 | – | 1 | – | 1 | – | 1 | – | 1 | – | 1 | – | 1 | – |
| ***Yes*** | **2.01** | **(1.34–3.01)** | 1.79 | (0.61–5.24) | 1.15 | (0.32–4.10) | 1.37 | (0.13–14.81) | 3.44 | (0.68–17.32) | 0.86 | (0.60–1.24) | **0.56** | **(0.39–0.82)** |

[a] OR: OR adjusted for sex and age.
[b] Variables age (44 years old) and educational level (primary/secondary and university) were dichotomized for maximize the sample size.

**Table 3**
Prevalence of electronic cigarette users who use them in private places (homes and cars) according to sex, age, educational level, smoking status, nicotine-containing e-cigarette and living with children in Barcelona, Spain (2015).

| | Home n = 600 (100%) | | Private car n = 528 (88%) | |
|---|---|---|---|---|
| | % | p-value[a] | % | p-value[a] |
| **Overall** | 96.83 | – | 47.54 | – |
| **Sex** | | 0.349 | | 0.810 |
| ***Women*** | 96.33 | | 47.93 | |
| ***Men*** | 97.72 | | 46.84 | |
| **Age** | | 0.465[b] | | 0.662[b] |
| ***< 45 years old*** | 97.22 | | 46.83 | |
| ***45–64 years old*** | 95.63 | | 48.59 | |
| ***> 65 years old*** | 100 | | 62.50 | |
| **Educational level** | | 0.612 | | 0.402 |
| ***Primary or less*** | 98.18 | | 56.25 | |
| ***Secondary*** | 97.25 | | 45.67 | |
| ***University or more*** | 96.06 | | 47.79 | |
| **Smoking status** | | **0.008** | | 0.519 |
| ***Non-smokers*** | 94.26 | | 45.60 | |
| ***Smokers*** | 98.21 | | 48.55 | |
| **Nicotine-containing e-cig** | | **0.029** | | 0.087 |
| ***No*** | 95.08 | | 43.35 | |
| ***Yes*** | 98.21 | | 50.85 | |
| **Living with children (< 17 years old)** | | **0.007** | | 0.427 |
| ***No*** | 97.97 | | 48.58 | |
| ***Yes*** | 93.59 | | 44.68 | |

[a] Chi Square test, except when indicated.

**Table 4**
Adjusted OR of electronic cigarette users who used them in private places (homes and cars) according to sex, age, educational level, smoking status, nicotine-containing e-cigarette and living with children in Barcelona, Spain (2015).

| | Home n = 600 (100%) | | Private car n = 528 (88%) | |
|---|---|---|---|---|
| | OR[a] | CI95% | OR[a] | CI95% |
| **Sex** | | | | |
| ***Men*** | 1 | – | 1 | – |
| ***Women*** | 0.59 | (0.21–1.67) | 1.05 | (0.74–1.51) |
| **Age**[b] | | | | |
| ***< 44 years old*** | 1 | – | 1 | – |
| ***> 44 years old*** | 0.59 | (0.21–1.66) | 1.11 | (0.74–1.51) |
| **Educational level** | | | | |
| ***Primary or less*** | 1 | – | 1 | – |
| ***Secondary*** | 0.63 | (0.08–5.11) | 0.65 | (0.35–1.21) |
| ***University or more*** | 0.43 | (0.05–3.42) | 0.71 | (0.38–1.33) |
| **Smoking status** | | | | |
| ***Non-smokers*** | 1 | – | 1 | – |
| ***Smokers*** | **3.17** | **(1.22–8.22)** | 1.14 | (0.79–1.64) |
| **Living with children (< 17years old)** | | | | |
| ***No*** | 1 | – | 1 | – |
| ***Yes*** | 0.33 | (0.13–0.83) | 0.86 | (0.58–1.26) |
| **Nicotine-containing e-cig** | | | | |
| ***No*** | 1 | – | 1 | – |
| ***Yes*** | **2.83** | **(1.05–7.65)** | 1.36 | (0.95–1.93) |

[a] OR adjusted for sex and age.

Spanish and American populations.

The users of e-cigarettes who used them in tobacco-free areas such as workplaces may imply a normalization of smoking behaviors (Chapman et al., 2016). This is evidenced by the relatively high prevalence of e-cigarette users who used in indoor workplaces (32.5%), restaurants (69.4%) and nightclubs (55.4%), thus, possibly indicating a latent risk of a regression of smoking-related social norms. For this

reason, we cannot rule out the hypothesis that using the device in smoke-free areas (where e-cigarette use is not regulated) could have a negative impact on smoking behaviors and increase use of the device among smokers and former smokers. This, consequently, could undermine the benefits of smoking restrictions (World Health Organization, 2014; International Agency for Research on Cancer, 2009). Furthermore, our results show that being a user of e-cigarettes exclusively is associated with a higher use of e-cigarettes in workplaces than dual users (around 64% more). This could be explained by the fact that dual users may smoke conventional tobacco during working hours outside their workplace and, therefore, may not use the e-cigarette there.

A potential study limitation that could have contributed to the under- or overestimation of the proportion of e-cigarette use in the settings studied is that we did not ask about the frequency of e-cigarette use (daily or occasional) nor nicotine dependence among dual users with conventional cigarettes. Therefore, we do not have information on whether or not the frequencies and associations reported vary depending on users' frequency of e-cigarette use (i.e. we would expect that daily users of an e-cigarette may use the device more inside public and private places compared with occasional users) and nicotine dependence. Other potential explanations could be that dual users prefer to go outside their workplace to have a "cigarette break" with colleagues who are conventional tobacco smokers, or that they are socially pressured to use their e-cigarette outdoors because of disapproval of indoor use. By sharing the same outdoor space with conventional tobacco users, there may be greater risk of relapse in e-cigarette users who are trying to quit conventional tobacco use.

A recent study in Barcelona, demonstrated a displacement of smoking areas from indoors to outdoors after the implementation of Spanish smoking legislation prohibiting indoor smoking (Sureda et al., 2015). In addition, we found that users of nicotine-containing e-cigarettes more frequently used e-cigarettes in workplaces. This could be associated with their dependence on nicotine. Despite this, we could not clearly assess users' nicotine dependence as our questionnaire was not designed to obtain this information (Foulds et al., 2015), nor did we differentiate between characteristics of e-cigarettes used (flavors, liquid used, shape) which has been associated with nicotine dependence (Glasser et al., 2016; Gartner and Hall, 2016).

The prevalence of e-cigarette users who used in public transport, hospitals and schools was low, in accordance with the Spanish ban existing in these settings (Spanish Government, 2014). This may indicate that the ban is known and respected by e-cigarette users. It has been previously described in different countries (Martínez-Sánchez et al., 2014; Majeed et al., 2015; Brose et al., 2016) that between 35–50% of the general population supported banning the use of e-cigarettes in smoke-free places, smokers as well as e-cigarette users being the ones least supportive of restrictions. Moreover, Spanish legislation mandates that there be signage posted around regulated places demonstrating that the use of e-cigarettes is banned; however, the enforcement of the regulation has not yet been described in Spain. For example, hospitals rapidly adopted the use of signage, but this has not been the case for areas such as in public transportation or at schools. We describe a lower use of e-cigarettes in hospitals (2.9%) than schools (4.6%), which could be partially attributed to hospitals complying with signage laws more often than schools.

We found higher frequencies of e-cigarette users who used in private settings compared to public places. Moreover, we found that dual users and those who used nicotine-containing e-cigarettes more frequently used e-cigarettes at home. Users' perceptions of the potential health risks related to these devices could explain these high frequencies of use. Based on previous studies, e-cigarettes are perceived as less hazardous than tobacco (Martinez-Sanchez et al., 2015; Tan et al., 2015, 2016) and one of the most common reasons for using e-cigarettes is to use a product that is healthier than tobacco (Pepper and Brewer, 2014; Patel et al., 2016). Furthermore, the risk perception of using e-cigarettes indoors between smokers and non-smokers would also be different. In accordance with this, a cross-sectional study conducted in the general population of the city of Barcelona found that the frequency of current smokers who believed that e-cigarettes were harmful for users and non-users (passively exposed) was much lower than that in non-smokers (Martinez-Sanchez et al., 2015). In order to examine the social stigma attached to smoking, it would be interesting to describe the use of e-cigarettes and conventional tobacco by dual users in indoor public and private settings.

We also observed that living with children was a protective factor against using the e-cigarettes at home. This follows a previous study which reported that, in relation to tobacco products, residents with children were more likely to support policies related to smoke-free housing (Schmidt et al., 2016) and found an increase of voluntary adoption of smoke-free rules among people living with children (Lidón-Moyano et al., 2016b). Likewise, individuals who live in smoke-free housing are less likely to be current alternative tobacco product users (including e-cigarettes) (Zhang et al., 2015). This could indicate that e-cigarettes are not considered completely harmless by some users and they may perceive passive exposure to aerosol from e-cigarettes as dangerous.

E-cigarette aerosol contains toxic chemicals similar to tobacco cigarettes (FDA Food and Drug Administration, 2010) that can be found in the air after using the device indoors (Fernández et al., 2015). Exposure to the aerosol has been linked with health-related outcomes (Kaisar et al., 2016; Wieslander et al., 2001; Fernández et al., 2016) and policymakers have been advised to ban the use of e-cigarettes in indoor environments (Fernández et al., 2016). Consequently, the high frequencies of e-cigarette use in the home, workplaces, restaurants and nightclubs found in our study may present both a danger to the benefits of smoking bans and cause direct health effects in e-cigarette users and the general population, including vulnerable populations,
through exposure to e-cigarette aerosol.

This study has some limitations. First, it was not possible to determine in which areas of the home e-cigarette users used the device, as they were merely asked if they used it inside their home or not. Information about specific areas of the home where they used it would provide us with important information in relation to their perceptions of e-cigarettes. For example, if they used the device next to an open window or in their private room, this could signify that they perceive e-cigarettes as harmful to others. On the other hand, if they use it in other common areas of the home, they may perceive e-cigarettes as harmless. We do, however, show the odds of using the device in the home, comparing those who live with children and those who do not. This can be applied as a proxy for users' perception of the harmful effects of e-cigarettes. It should also be taken into consideration that comparisons done between covariates in settings with low prevalence of e-cigarette use, such as on planes and in schools, may be under powered (high probability of type II error) due to small sample size. Moreover, we did not ask users about their frequency of e-cigarette use. Therefore, the frequencies and associations reported in this study may vary depending on the frequency of e-cigarette use (i.e. we would expect that daily users of e-cigarettes use the device inside public and private places more compared with occasional users). Next, data is self-reported so we cannot rule out the possibility of a recall bias, as we asked users if they had used the e-cigarette during the last 30 days, and reporting bias, as e-cigarette users could feel wrong to use the device in specific public places and, in turn, underreport having used in those places. Furthermore, the adjustment of the models using age as a categorical variable could introduce residual confounding, for example, younger age groups would not be represented by the age classification (< 44years old). We have also performed our models with age as a continuous variable and have not found differences in the direction nor the magnitude of the associations (data not shown). Nonetheless, this is the first study to estimate the real use of e-cigarettes in indoor work and

public places by using a face-to-face questionnaire. Compared to a previous study conducted in the US which used an online questionnaire, our study, in this sense, has greater internal validity (Shi et al., 2016). Furthermore, our sample size of current e-cigarette users is large and was recruited using the consumer panel technique, which, despite being a non-probabilistic sampling method, assures higher representativeness of the sample, compared with other non-probabilistic techniques (Matilla-Santander et al., 2017).

## 5. Conclusion

Our study shows that the prevalence of e-cigarettes users who used in indoor private venues, particularly at home, was higher than in public venues such as schools or public transportation. However, their use in other public settings where they are not regulated continues to be elevated. Therefore, the public health administration in Spain should consider expanding the prohibition of e-cigarette use to all indoor public settings and better inform the public about the health-related outcomes of the exposure to e-cigarette aerosol.

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## Conflict of interest

The authors have no competing interests to declare, financial or otherwise.

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# ANNEX XI. Methodological note. Using consumer panels in public health observational studies.

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Nota metodológica

# Uso de paneles de consumidores en estudios observacionales de salud pública

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RESUMEN

Los paneles de consumidores son una técnica de investigación de mercados de gran utilidad para obtener información sobre clientes poco frecuentes o de difícil acceso. El objetivo de esta nota de campo es exponer nuestra experiencia usando esta técnica para un estudio transversal de salud pública sobre el uso de cigarrillos electrónicos. Después de valorar diferentes técnicas de muestreo no probabilístico para obtener una muestra elevada de usuarios de cigarrillos electrónicos (n = 600), se ha optado por el uso del panel de consumidores debido al tiempo relativamente corto para obtener el gran tamaño muestral requerido para el estudio y una buena representatividad de la muestra.



## Using consumer panels in public health observational studies

*Keywords:*
Electronic cigarettes
Sampling
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Consumer panels
Observational studies

ABSTRACT

Consumer panels are a market research method useful for gathering information about low-frequency or difficult-access customers. The objective of this field-note is to explain our experience using this method in a cross-sectional public health study on the use of electronic cigarettes. After taking into account other non-probabilistic sampling techniques to obtain a huge sample of electronic-cigarette users (n = 600), in the end we decided to use consumer panels (recruiters) because of the relative short duration of the field work and the high representativeness of the sample.



## Introducción

En España, la prevalencia de uso del cigarrillo electrónico es de alrededor de un 2%[1,2]. Desde su popularización se ha generado un intenso debate sobre sus potenciales ventajas como herramienta para dejar de fumar[3,4] y sus efectos perjudiciales para la salud[5]. Por ello, se hace necesario aumentar la evidencia científica sobre el uso de estos dispositivos y su impacto en la salud.

En estudios con poblaciones de difícil acceso (baja prevalencia o penetración, dispersas geográficamente, estigmatizadas socialmente, consumidoras de sustancias ilegales, etc.) se recurre comúnmente a muestreos no probabilísticos, como muestreo por bola de nieve, muestreo conducido por el encuestado o muestreo dirigido a población diana[6–8]. Si bien estas técnicas permiten obtener muestras difíciles de reclutar, las principales limitaciones son la representatividad de la muestra, el elevado tiempo necesario para realizar el reclutamiento y el tamaño muestral obtenido[6–8].

Una técnica ampliamente utilizada en investigación de mercados son los paneles de consumidores. Consiste en obtener información de una muestra de consumidores de un producto concreto (comida, bebida, accesorio, etc.) cuando el mercado de clientes es pequeño o de difícil acceso. Para ello, los entrevistadores o captadores «captan» a estos consumidores en un área geográfica concreta. Se trata de una técnica de muestreo no probabilístico que evita realizar encuestas masivas a la población general[9], y además la tasa esperada de respuesta es muy alta. A pesar de las ventajas que presenta, esta técnica ha sido poco utilizada en investigación en salud pública.

El objetivo de esta nota de campo es exponer la experiencia en el uso de la técnica de mercado de paneles de consumidores aplicada a un estudio transversal de salud pública, concretamente para

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**Tabla 1**
Principales características de los muestreos no probabilísticos usados para la obtención de muestras de poblaciones de difícil acceso

| Técnica de muestreo | Descripción/características | Ventajas | Inconvenientes |
|---|---|---|---|
| Panel de consumidores | Los captadores obtienen información de una muestra de consumidores de un producto concreto en un lugar específico | Tiempo de reclutamiento corto<br>Facilidad en la obtención de grandes muestras<br>Tasa de rechazo muy baja | Técnica muy poco conocida en salud pública<br>Representatividad de la muestra reclutada |
| Bola de nieve | Se le pide a un participante reclutado que mencione a otra persona de su entorno a quien se intentará reclutar | Simple ejecución<br>Muy conocido y utilizado por los investigadores en salud pública | Sesgo de selección entre los sujetos más cooperadores<br>Tiempo de reclutamiento largo<br>Dificultad para incluir subgrupos predefinidos |
| Muestreo dirigido por el encuestado | Variante del muestreo de bola de nieve, en el que se recompensa económicamente por la participación, y se limita el número de personas que puede recomendar cada participante<br>Los participantes eligen ser conocidos o no por el investigador | Reduce el sesgo de selección, tanto de los sujetos más participativos como el sesgo debido al enmascaramiento<br>Las muestras son independientes de los sujetos iniciales por los que empieza el muestreo | Requiere un mayor presupuesto para compensar a los participantes<br>Tiempo de reclutamiento largo<br>Posibilidad de sesgo de selección |
| Muestreo dirigido a población diana | Identificación de subgrupos de la población de interés, que son tratados como estratos de la misma, a los cuales se les asigna un tamaño de muestra determinado | Acceso rápido a subgrupos de población conocidos<br>No se recluta a partir de instituciones y no necesita un listado de posibles participantes | Sobrer representación de sujetos más problemáticos y visibles (sesgo de selección)<br>Requiere un mayor presupuesto para compensar a los participantes |

**Tabla 2**
Características demográficas de los usuarios de cigarrillos electrónicos según las muestras obtenidas mediante paneles de consumidores y por muestreo aleatorio en población de España y de Barcelona

| | Técnica de muestreo | | | | | | |
|---|---|---|---|---|---|---|---|
| | Paneles de consumidores, Barcelona N = 600 % (IC95%) | Muestreo aleatorio, España N = 21[a] % (IC95%) | Muestreo aleatorio, Barcelona N = 12[b] % (IC95%) | p[c] | p captadores *vs.* España[d] | p captadores *vs.* Barcelona[e] | p España *vs.* Barcelona[f] |
| *Sexo* | | | | | | | |
| Mujeres | 63,5 (59,5-67,3) | 28,6 (12,2-52,3) | 50 (25,4-74,6) | 0,003 | 0,002 | 0,373 | 0,274 |
| Hombres | 36,5 (32,7-40,5) | 71,4 (47,7-87,8) | 50 (25,4-74,6) | | | | |
| *Grupos de edad* | | | | | | | |
| <45 años | 72 (68,2-75,5) | 81 (57,4-93,7) | 33,3 (11,3-64,6) | 0,012 | 0,708 | <0,001 | 0,009 |
| >45 años | 28 (24,5-31,8) | 19 (6,3-42,6) | 66,7 (35,4-88,7) | | | | |
| *Consumo de tabaco* | | | | | | | |
| Fumador/a | 65,2 (61,2-68,9) | 57,1 (34,4-77,4) | 75 (42,8-93,3) | 0,613 | 0,489 | 0,624 | 0,457 |
| No fumador/a | 34,8 (31,1-38,8) | 42,9 (22,6-65,6) | 25 (6,7-57,2) | | | | |

IC95%: intervalo de confianza del 95%.
[a] Datos obtenidos de Lidón-Moyano et al.[2]: estudio transversal de una muestra representativa de la población adulta de España del año 2014.
[b] Datos obtenidos de Martínez-Sánchez et al.[1]: estudio transversal de una muestra representativa de la población adulta de Barcelona de los años 2013-2014.
[c] Test exacto de Fisher para la comparación de las tres muestras.
[d] Test exacto de Fisher para la comparación de la muestra obtenida mediante paneles de consumidores en Barcelona *vs.* muestreo aleatorio en España.
[e] Test exacto de Fisher para la comparación de la muestra obtenida mediante paneles de consumidores en Barcelona *vs.* muestreo aleatorio en Barcelona.
[f] Test exacto de Fisher para la comparación de las muestras obtenidas mediante muestreos aleatorios en España y Barcelona.

el reclutamiento de una amplia muestra de personas usuarias de cigarrillos electrónicos en poco tiempo.

## Desarrollo de la experiencia

Nuestro equipo de investigación se planteó conocer el patrón de uso de cigarrillos electrónicos en la ciudad de Barcelona. En primer lugar, calculamos el tamaño muestral utilizando una prevalencia estimada de patrón de uso (motivo de uso, uso en espacios públicos, etc.) del cigarrillo electrónico del 50% (para permitir la realización de diversas comparaciones), un nivel de confianza del 95% y una precisión del 4% con la fórmula del muestreo aleatorio simple. Según el cálculo, se necesitaban a 600 usuarios/as de cigarrillos electrónicos entre la población adulta de la ciudad de Barcelona.

Para el reclutamiento de participantes se planteó como primera opción la realización de un estudio transversal en la población adulta de Barcelona. Este diseño nos permitía estimar la prevalencia de usuarios/as de cigarrillos electrónicos y diferenciar entre diversos tipos (actuales, pasados, etc.). Sin embargo, descartamos este diseño debido a la baja prevalencia de uso de cigarrillos electrónicos[1,2] y el gran tamaño muestral que necesitaríamos para obtener 600 usuarios/as.

Una segunda posibilidad era captar a los usuarios/as de cigarrillos electrónicos en tiendas especializadas en la venta de estos dispositivos, que también fue descartada, ya que el tiempo y el coste del reclutamiento se incrementarían debido a la incomodidad de los responsables de las tiendas por tener captadores alrededor, junto con la disminución de estas tiendas en los años 2014 y 2015. Por otra parte, se podría cometer un sesgo de selección, ya que el perfil del comprador en las tiendas podría ser distinto al de los compradores de cigarrillos electrónicos y líquidos de recarga a través de Internet[10].

Frente a las limitaciones del estudio transversal y de la escasa captación en los puntos de venta nos planteamos realizar un muestreo no probabilístico (tabla 1). Después de valorar las ventajas y

las limitaciones de los diferentes tipos de muestreo no probabilístico para poblaciones de difícil acceso, nos decantamos por los paneles de consumidores para reclutar la muestra de usuarios/as de cigarrillos electrónicos por una serie de razones: el menor tiempo de ejecución del trabajo de campo, no necesitar compensación económica para los participantes ni tener una lista previa de posibles participantes, la menor posibilidad de sesgo de selección y la facilidad de obtener una muestra de gran tamaño en relativamente poco tiempo (tabla 1).

Se contrató a una empresa externa para hacer el trabajo de campo (reclutamiento de usuarios/as de cigarrillos electrónicos) especializada en estudios de mercado. Los/las captadores/as recibieron una formación o *briefing* por parte de los/las investigadores/as del estudio, en la que se les explicaba en qué consistía el estudio y cuáles eran sus objetivos. El perfil de la persona captadora fue de mediana edad (alrededor de 30-40 años), mujer y con estudios secundarios o superiores. En la formación se describió cómo debían localizar a los/las usuarios/as de cigarrillos electrónicos para su captación y entrevista (personas que estaban usando un cigarrillo electrónico o bien lo llevaban a la vista). Tras identificar a un potencial usuario/a de cigarrillo electrónico, se dirigía a él o ella, presentándose e informándole de que el motivo de entablar contacto era la realización de un estudio sobre el uso de los cigarrillos electrónicos. Si la persona a reclutar estaba interesada, se le preguntaba si residía en Barcelona, nombre y apellidos, y fecha de nacimiento, además de registrar el sexo. Finalmente, se le decía que volvería a ser llamado/a en unos meses para ofrecerle participar en el estudio mencionado. Para reclutar la muestra de 600 usuarios/as de cigarrillos electrónicos se contactó con 665 personas (tasa de rechazo del 9,7%). No hubo diferencias estadísticamente significativas según edad y sexo entre quienes accedieron y no accedieron a participar en el estudio. Las personas reclutadas no fueron compensadas económicamente como en la técnica de muestreo dirigido por el encuestado. El reclutamiento de la muestra se llevó a cabo en 5 meses (febrero a junio de 2015) en la ciudad de Barcelona.

Una de las posibles limitaciones del uso de esta técnica es la representatividad de la muestra obtenida. Para evaluar su representatividad, comparamos las características demográficas de la muestra con las de otras dos muestras de usuarios/as obtenidas a partir de muestreo aleatorio simple en España en 2014[2] y en Barcelona en 2013-2014[1] (tabla 2). Se observaron diferencias según edad y sexo debido a las características de cada muestra (población más envejecida en la muestra aleatoria de Barcelona, y de origen rural y urbano en la muestra aleatoria de España), y no a la técnica utilizada. Creemos que es una limitación asumible, dada la gran diferencia en el tamaño muestral conseguido respecto al obtenido con técnicas de muestreo más representativas de la población diana, como indican los datos aportados.

Por último, cabe mencionar que estudios previos han utilizado anuncios en periódicos e Internet para captar usuarios/as de cigarrillos electrónicos, pero en nuestro caso no contemplamos esta opción.

## Conclusión

Nuestra experiencia muestra que la técnica de paneles de consumidores es de gran utilidad en comparación con otras técnicas de muestreo no probabilístico para la obtención de muestras grandes en un periodo de tiempo corto en estudios transversales, en los que los factores de riesgo presentan una baja prevalencia por ser muy novedosos, de difícil acceso o escondidos. Además, la tasa de rechazo de participación en el estudio fue muy baja. Por otro lado, la principal limitación de esta técnica es la representatividad de la muestra. Sin embargo, es una limitación que queda compensada por el gran tamaño muestral obtenido.

## Editora responsable del artículo

Cristina Linares Gil.

## Contribuciones de autoría

J.M. Martínez-Sánchez concibió el estudio. N. Matilla-Santander y J.M. Martínez-Sánchez escribieron el primer borrador del manuscrito. N. Matilla-Santander realizó los análisis. C. Lidón-Moyano y J.C. Martín-Sánchez colaboraron en el trabajo de campo. M. Fu, M. Ballbè, J.C. Martín-Sánchez, C. Lidón-Moyano y E. Fernández contribuyeron significativamente en sus versiones posteriores. Todos/as los/las autores/as han aprobado la versión final del manuscrito. J.M. Martínez-Sánchez es el investigador principal del proyecto.

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## Conflicto de intereses

Ninguno.

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