Working Conditions and Occupational Accidents: Focus on Indicators of Non-Standard Work Arrangements in Belgium and Europe

Arbeidsomstandigheden en arbeidsgerelateerde ongevallen: focus op indicatoren van niet-standaard arbeidsvormen in België en Europa

Hanan Alali

Promotoren: prof. dr. ir. M. Abdel Wahab, prof. dr. L. Braeckman

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Promoters:

Prof. dr. ir. Magd Abdel Wahab

Prof. dr. Lutgart Braeckman

Examination Committee:

Prof. dr. ir. Daniël De Zutter (Chair): Department of Information Technology, Ghent University.

Prof. dr. ir. Magd Abdel Wahab: Department of Electrical energy, systems and automation, Ghent University.

Prof. dr. Lutgart Braeckman: Department of Public Health, Ghent University.

Prof. dr. Guy Vanderstraeten: Department of Rehabilitation Sciences and Physiotherapy. Ghent University.

Prof. dr. ir. El-Houssaine Aghezzaf: Department of Industrial Systems Engineering and Product Design. Ghent University.

Prof. dr. Marc Du Bois: Department of Environment and Health, KU Leuven.

Dr. ir. Phuc Phung Van: Department of Electrical energy, systems and automation, Ghent University.

Research Institute

Ghent University
Faculty of Engineering and Architecture
Department of Electrical Energy, Metals, Mechanical Construction and Systems (EEMMeCS)
Laboratory Soete
Technologiepark Zwijnaarde 903
B-9052 Zwijnaarde
Belgium

Tel: +32 9 331 04 82
Fax: +32 9 331 04 90
Email: Hanan.Alali@UGent.be, hanan2ali@hotmail.com.

http://www.soetelaboratory.ugent.be/

Dedicated to my parents, husband and my lovely daughters, Mais & Mira

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Summary

Work plays a considerable role in workers' life; it is very beneficial for workers because it provides a sense of purpose and self-worth, and it offers financial security and social status. On the other hand, work can be dangerous for the workers because of uncontrolled work accidents which occur in the work environment and cause occupational injuries, absence from work or even the death of the victim in some catastrophic cases. Occupational accidents and injuries result from doing something wrong at the workplace and making mistakes. Injuries and accidents can significantly affect the performance and workers' productivity. Therefore, the economic and social benefits of more safety at work are of great importance in every economic sector in the world.

Working conditions refer to the conditions in which a person or staff works. Unhealthy working conditions address the presence of hazards during a usual working day e.g. exposure to loud noise, vibrations from hand tools or machinery, high or low temperatures, breathing in vapors, fumes and dust, chemical and dangerous substances, radiation such as X rays, radioactive radiation, welding light or laser beams, handling of heavy loads, uncomfortable or tiring positions, performing repetitive tasks and also dangerous situations. Examples of the latter include working on a slippery or unstable surface, handling dangerous tools and machines, and risk of falling or electrocution. These poor and unsafe working conditions may cause serious accidents.

In addition, some aspects of employment quality such as working antisocial hours (usually work at least once a month either at night or on Sundays or work shifts or irregular hours or working long hours or doing multiple jobs or precarious temporary work) are also considered as risk factors for work-related accidents and occupational injuries.

The application of new technologies, the internationalization of investment and the globalization in industrialized countries resulted in the alteration of working conditions in these countries. The regular work contract has been reduced because of the presence of a more flexible labour market.

Universally, the number of non-standard workers is increasing rapidly. The fast growth of non-standard employment in developed countries highlights the importance of studying the influence of contract type on worker's safety and health. The purpose of our work was to investigate whether or not non-standard workers (temporary workers, those doing long working hours, those doing multiple jobs and shift workers) in Belgium are more injured and

more absent from work due to work-related accidents than the standard ones. A second purpose is to identify determinants of a higher risk of injuries.

The work presented in this thesis is based on two independent data sets namely 1) the Belgian surveys on work ability (VOW/QFT/QAW) and 2) the fifth European Working Condition Survey (EWCS). The VOW is a survey, conducted in Belgium in 2007, 2009 and 2011 by l'Association Professionnelle Belge des Médecins du Travail (APBMT). The VOW collects information about how workers perceive the balance between personal characteristics and job requirements. The VOW was used in this thesis to investigate our following aim: Are Belgian non-standard workers at a higher risk of having work accidents and injuries compared to standard workers or not? In 2009 and 2011, a total of 1886 individuals completed the questionnaire. All participants provided informed consent.

The second data source was based on data of the fifth European Working Conditions Survey (EWCS), carried out by Eurofound from January to June 2010 among 34 countries. This periodical survey is considered as a main source of comparable data and uses face-to face questionnaires at the participants' own home to gather information on working and employment conditions. A total of 43816 workers were interviewed. In this thesis only Belgian respondents were studied (n= 4001). For the purpose of our analysis, the analytical sample was restricted to a subgroup of 3343 employees.

The fifth European working condition survey was used to investigate the following aims: (1) What is the relationship between non-standard work arrangement indicators such as precarious work, long working hours, multiple jobs, shift work and work-related accident absence in Belgium? And (2) what is the relationship between non-standard work arrangements indicators and injuries in Europe 27?

For conducting our analysis using data from both surveys, firstly descriptive statistics were computed for all variables, including frequencies and proportions for categorical variables and the mean and standard deviation for continuous variables. Secondly, Chi-square tests were conducted to explore whether potential risk factors were univariately associated with occupational injuries and absence due to work- related accidents. And finally, a multiple logistic regression analysis investigated whether socio-demographic variables, work-related factors, and job exposures predicted the odds of self-reported occupational injury and work-related accident absence.

Results from the first survey (VOW) were that temporary workers did not have higher injury rates than permanent workers [OR 0.5, 95% confidence interval 0.2–1.2]. Low-educated, less-experienced workers and those exposed to dangerous conditions are more frequent victims of occupational accidents. For Belgium, the results from the fifth European working condition survey (EWCS) were the following: during the last 12 months, about 11.7% of the workers were absent from work because of work-related accidents. Multivariate regression model showed an increased injury risk for those doing shift work (OR 1.546, 95% CI 1.074-2.224). The relationship between contract type and occupational injuries was not significant (OR 1.163, 95% CI 0.739- 1.831). Furthermore, no statistical significant differences were observed for those doing long working hours (OR 1.217, 95% CI 0.638- 2.321) and those doing multiple jobs (OR 1.361, 95% CI 0.827- 2.240) in relation to work -related accident absence. Those who rated their health as bad, low educated workers, workers from the construction sector, and those exposed to biomechanical exposure (BM) displayed more work-related accident absence. No significant gender difference was observed. In addition, our results for Europe 27 from the 5th EWCS were the followings: About 8.44% of the workers suffered from an injury. Multivariate regression model showed an increased injury risk for those working long hours (OR 1.24, 95% CI 1.13–1.36), having multiple jobs (OR 1.25, 95% CI 1.07–1.45) and shift work (OR 1.23, 95% CI 1.09-1.38). The relationship between contract type and injuries was not significant (OR 0.92, 95% CI 0.79 - 1.07). No significant gender difference was observed.

So, the two surveys showed that in Belgium, there was no difference between temporary and permanent workers in term of work injuries or work-related accident absence. Furthermore, the indicators of non-standard work arrangements under study, except shift work, were not significantly associated with work- related accident absence. Only those doing shift work had an increased accident absence risk. Low-educated, less-experienced workers, those exposed to dangerous conditions, those who rated their health as bad, workers from the construction sector, and those exposed to biomechanical exposure are more frequent victims of a work-related injury and accident absence. In conclusion, educational strategies and better employment arrangements are strongly advised to prevent occupational accidents and injuries. At the individual and organizational level, we recommend the implementation of more safety measures and educational programs to improve in particular the knowledge and skills of low-educated and less-experienced workers. At the policy level, Belgian and European strategies should emphasize the importance of the development of more and better

jobs: further legislative initiatives should limit exposure to dangerous working conditions. To reduce the burden of occupational injuries, not only risk reduction strategies and interventions are needed but also policy efforts should be undertaken to limit shift work. A safe and healthy working environment is essential for the employee's safety and quality of life.

Samenvatting

Werk speelt een aanzienlijke rol in het leven van de werkende mens. Werken brengt positieve effecten met zich mee zoals het creëren van een doel, het verhogen van diens zelfwaarde en de voor de hand liggende financiële zekerheid en sociale status. Anderzijds is het ook potentieel gevaarlijk wegens het optreden van arbeidsongevallen leidend tot letsels, verzuim of zelfs de dood bij een catastrofe. Arbeidsongevallen en daaruit resulterende blessures zijn vaak het gevolg van onveilig gedrag op de werkvloer. Blessures en ongevallen kunnen de prestaties en productiviteit van het personeel aanzienlijk beïnvloeden. Daarom zijn de economische en sociale voordelen van een verbeterde veiligheidscultuur op het werk uiterst belangrijk in elke economische sector ter wereld.

Werkomstandigheden verwijzen naar de omstandigheden waarin een persoon of een ploeg werkt. Ongezonde werkomstandigheden omvatten de aanwezigheid van gevaren tijdens een normale werkdag en worden aangeduid als beroepsrisico's zoals bijvoorbeeld: blootstelling aan luide geluiden; trillingen van handgereedschap of machines; hoge of lage temperaturen; het inademen van damp, rook of stofpartikels; de aanwezigheid van en het omgaan met chemische & gevaarlijke stoffen; stralingen zoals röntgenstralen, radioactieve straling, laslicht of laserstralen; heffen en tillen van zware lasten; oncomfortabele of vermoeiende posities;het verrichten van repetitieve taken alsook inherent gevaarlijke situaties. Voorbeelden van die laatstgenoemde categorie zijn onder andere het werken op een glad of onstabiel oppervlak, het hanteren van gevaarlijke werktuigen of machines, valrisico en elektrocutiegevaar. Zulke ondermaatse en onveilige werkomstandigheden kunnen resulteren in zware ongevallen.

Bijkomend worden sommige aspecten van de arbeidsregeling zoals het werken op uren met een negatieve impact op het sociaal leven (doorgaans minstens een keer per maand 's nachts of op zondag werken, in ploegen werken, onregelmatige of lange uren kloppen, verschillende jobs combineren of onstandvastig tijdelijk werk) ook als risicofactoren voor arbeidsongevallen en werkgerelateerde blessures aanzien.

Het toepassen van nieuwe technologieën, de internationalisering van investering en de globalisering in geïndustrialiseerde landen resulteerden in de verandering van werkomstandigheden in deze landen. Het reguliere arbeidscontract komt minder vaak voor in de arbeidsmarkt met een toenemende focus op flexibiliteit.

In het algemeen stijgt het aantal " niet standaard" arbeidskrachten met rasse schreden. Deze snelle groei van "niet standaard" tewerkstellingen in ontwikkelde landen benadrukt het belang van het bestuderen van de invloed van het type arbeidscontract op de veiligheid en gezondheid van de werkbevolking. Het doel van onze studie is om te onderzoeken of "niet-standaard" arbeidskrachten (tijdelijke krachten, zij die lange werkuren kloppen, zij die verschillende jobs combineren en zij die in ploegen werken) in België vaker geblesseerd raken en vaker afwezig zijn omwille van arbeidsongevallen dan de klassieke werkkrachten. Een tweede doel is om de determinanten van een hoger risico op blessures te identificeren.

De studie, die in deze thesis wordt voorgesteld, is gebaseerd op twee onafhankelijke datasets, namelijk: 1) de Belgische bevragingen rondom arbeidsgeschiktheid (VOW/QFT/QAW) en 2) de vijfde Europese enquête naar arbeidsomstandigheden (European Working Condition Survey, EWCS). De VOW is een enquête die werd uitgevoerd in België in 2007, 2009 en 2011 door de Belgische Beroepsvereniging voor Arbeidsgeneesheren (l'Association Professionnelle Belge des Médecins du Travail, APBMT). Ze verzamelt informatie over hoe werknemers het evenwicht tussen persoonlijkheidskenmerken en functievereisten ervaren. De VOW werd in deze thesis gebruikt om het volgende doel te onderzoeken: lopen Belgische "niet-standaard" arbeidskrachten een hoger risico op werkongevallen en blessures dan standaard/klassieke werkkrachten of niet? In 2009 en 2011 vulden in totaal 1.886 personen de vragenlijst in. Alle deelnemers gaven hiervoor hun geïnformeerde toestemming.

De tweede databron was gebaseerd op gegevens van de vijfde Europese enquête naar de arbeidsomstandigheden (EWCS), uitgevoerd door 'Eurofound' van januari tot juni 2010 in 34 landen. Deze periodieke bevraging wordt beschouwd als de voornaamste bron van vergelijkbare gegevens en verzamelt informatie in over werk- en arbeidsvoorwaarden door middel van persoonlijke interviews bij de deelnemers thuis. In totaal werden 43816 werknemers geïnterviewd. Deze thesis bestudeert enkel Belgische respondenten (n = 4001). Met oog op het doel van onze analyse werd de uiteindelijke steekproefpopulatie beperkt tot een subgroep van 3343 werknemers.

De vijfde Europese enquête naar de arbeidsomstandigheden werd gebruikt om de volgende doelen te onderzoeken: (1) Wat is het verband tussen indicatoren van "niet standaard" werkregelingen zoals onzeker werk, lange werkuren, het combineren van verschillende jobs, ploegenwerk en het verzuim wegens arbeidsongevallen in België? And (2) wat is de relatie tussen niet-standaardwerkarrangementen indicatoren en verwondingen in Europa 27?

Om onze analyse uit te voeren met gegevens uit beide onderzoeken werd eerst beschrijvende statistiek uitgevoerd voor alle variabelen, waaronder frequenties en proporties van categorische variabelen en het gemiddelde met de standaardafwijking voor continue variabelen. Vervolgens werden chi-kwadraattesten uitgevoerd om na te gaan of potentiële risicofactoren univariabel geassocieerd waren met arbeidsongevallen en het gerelateerd verzuim. Ten slotte onderzocht een multivariabele logistische regressie analyse of socio-demografische variabelen, werkgerelateerde factoren en beroepsblootstelling de kans op zelfgerapporteerde arbeidsongevallen en verzuim voorspelden.

Resultaten van de eerste enquête (VOW) hielden in dat tijdelijke arbeidskrachten geen hoger percentage letsels vertoonden dan vaste werknemers [OR 0,5, 95% betrouwbaarheidsinterval (CI) 0,2–1,2]. Laaggeschoolde, minder ervaren arbeidskrachten en zij die blootgesteld worden aan gevaarlijke omstandigheden zijn vaker het slachtoffer van arbeidsongevallen. De resultaten van de vijfde Europese enquête naar de arbeidsomstandigheden (EWCS) voor België waren als volgt: tijdens de laatste 12 maanden was ongeveer 11,7% van de arbeidskrachten afwezig op het werk omwille van arbeidsongevallen. Het multivariabel regressiemodel toonde een toenemend blessurerisico voor wie in ploegen werkt (OR 1,546, 95% CI 1,074- 2,224). Er was geen significant verband tussen het type arbeidscontract en het voorkomen van arbeidsongevallen (OR 1,163, 95% CI 0,739- 1,831). Bovendien werden geen statistisch significante verschillen weerhouden betreffende verzuim wegens arbeidsongevallen bij lange werktijden (OR 1,217, 95% CI 0,638 – 2,321) of bij multi-jobs (OR 1,361, 95% CI 0,827- 2,240). Participanten met een slechte gezondheidsperceptie, laaggeschoolde arbeidskrachten, bouwvakkers en arbeiders met een biomechanisch blootstellingsrisico (BM) vertoonden meer verzuim wegens arbeidsongevallen. Er werden geen significante verschillen naar geslacht geobserveerd. Daarnaast bekwamen we volgende resultaten voor Europa uit de 5e EWCS: ongeveer 8,44% van de werknemers lijdt aan een blessure. Het multivariate regressiemodel toonde een verhoogd letselrisico voor degenen die vele uren werken (OR 1.24, 95% CI 1.13-1.36), met meerdere banen (OR 1,25, 95% CI 1,07-1,45) en op onregelmatige uren werken (OR 1,23, 95% CI 1,09 -1,38). De relatie tussen contracttype en verwondingen was niet significant (OR 0,92, 95% CI 0,79 - 1,07). Er werd geen significant verschil volgens gender waargenomen.

Beide studies toonden dus dat er in België geen verschil bestond tussen tijdelijke en vaste arbeidskrachten op het vlak van arbeidsongevallen of verzuim om die reden. Bovendien waren de bestudeerde indicatoren van “niet standaard” werkregelingen, met uitzondering van

ploegenwerk, niet-significant geassocieerd met verzuim wegens arbeidsongevallen. Allen wie in ploegen werkt liep een verhoogd risico op verzuim wegens arbeidsongevallen.

Laaggeschoolde, minder ervaren arbeidskrachten, zij die blootgesteld worden aan gevaarlijke omstandigheden, zij die hun gezondheid als slecht evalueerden, bouwvakkers en diegenen met biomechanisch blootstellingsrisico, zijn vaker het slachtoffer van arbeidsongevallen en verzuim om die reden.

Op basis van deze resultaten worden opleidingsstrategieën en betere arbeidsovereenkomsten sterk aanbevolen om arbeidsongevallen te voorkomen. Op het individuele en organisatorische niveau raden we aan om meer veiligheidsmaatregelen en opleidingsprogramma's te implementeren om in het bijzonder de kennis en vaardigheid van laaggeschoolde en minder ervaren arbeidskrachten te verbeteren. Op het beleidsniveau zouden Belgische en Europese strategieën het belang van de ontwikkeling van meer en betere jobs moeten benadrukken: verdere wetgevende initiatieven zouden blootstelling aan gevaarlijke werkomstandigheden moeten beperken. Om arbeidsongevallen te reduceren zijn naast risicoverlagende strategieën en interventies ook beleidsinspanningen nodig om ploegenwerk te beperken. Een veilige en gezonde werkomgeving is namelijk essentieel voor de veiligheid en levenskwaliteit van de werkende bevolking.

Contents

Chapter 1

General introduction

1.1 The global picture of work accidents

Work play a central role in people's lives, since most workers spend at least eight hours a day in the workplace, whether it is in an office, a factory, on a plantation, etc. Therefore, work environments should be safe and healthy. Yet, this is not the case for many workers. Every day, workers all over the world face a multitude of health hazards, such as hazardous exposures, poor work organization, unsafe workplaces and non-ergonomic process design, etc. As a result of these hazards and a lack of attention given to health and safety, work-related accidents and diseases are common in all parts of the world [1]. Globally, there are 2.3 million deaths annually for reasons attributed to work. The highest number of deaths is due to work-related diseases (2.0 million) and the rest is caused by occupational injuries (0.3 million) [2]. The main cause of death attributable to work is cancer (32 %): asbestos, carcinogenic chemicals, ionising radiation, silica, diesel engine exhaust emissions and passive smoking are the main contributing causes. Circulatory diseases are the second most common cause of death, accounting for almost a quarter of deaths. Accidents account for just under a fifth of death attributable to work (18%) [2-4].

According to the International Labour Organization (ILO), 160 workers have a work-related accident every 15 seconds and every 15 seconds, a worker dies due to a work-related accident or disease. Subsequently, 317 million accidents occur at work every year [5]. In Eu-28 in 2012, there were about 2487794 serious accidents, ranging from 709940 in Germany to 49 546 in Belgium while the lowest number was observed in Latvia (1213). In addition, there were around 2.5 million non-fatal accidents that resulted in at least four calendar days of absence from work and 3515 fatal accidents in the EU-28 in 2012 [6].

Per 100,000 workers, across a selection of European countries, incidence rates of fatal accidents ranged from less than one in the Netherlands, the United Kingdom, Germany, Slovakia and Denmark to over five in Poland (Health and Safety Exclusive (HSE), 2013). The overall rate in Great Britain (GB) of fatal injuries published by HSE for 2012/13 was 0.5 per 100,000 workers.

Within the EU-27 in 2009, in terms of industries, the construction sector alone accounted for 26.1 % of all fatal work accidents. In addition, more than two-thirds of all fatal accidents at work occurred in the transportation, manufacturing, storage, forestry, agriculture, fishing and construction sectors (Eurostat, 2012).

According to results from the Census of Fatal Occupational Injuries (CFOI) conducted by the U.S. Bureau of Labor Statistics, a total of 4679 fatal work injuries were recorded in the United States in 2014, an increase of 2 % over the revised count of 4585 fatal work injuries in 2013 [7]. During this same period, the US Bureau of Labor Statistics reported that, the overall incidence rate of nonfatal occupational injury and illness that involved lost workdays was 107.1 cases per 10000 full-time workers in 2014 [8].

In Belgium, 330281 workplace accidents were reported in 1969 but this figure was more than halved by 2010 (150944) [9, 10]. The Fund of Occupational Accidents (FAO), established by Royal Decree no 66 in 1967, keeps a register of all such accidents in the private sector, based on information provided by insurers. In 2004, the FAO registered 198861 industrial accidents, including 195 fatal accidents, 13760 accidents leading to permanent disability and 21370 on the road to and from work [11]. A total of 141865 work accidents in the private sector were registered in 2014 in Belgium, including accidents at work and on the way to and from work. This corresponds to a decrease of 5.7% compared to 2013. In addition, 46744 serious accidents and 63 fatal accidents were registered in Belgian employees of the public sector (Eurostat, 2016). In 2014, one-third of the fatal accidents occurred on public roads, while falls from height were the second cause of death in the last year. Between 2008 and 2014 the number of fatal work accidents decreased from 103 to 59 [12]. This can be explained by the structure of employment and the substantial changes in the industrial sector. The number of occupational accidents fell in line with the reduction of employment in high-hazard occupations, such as mining. Although, the number of jobs have increased (962000 more employees in 2010 than in 1960), tools upgrades such as protective equipment, safer machinery and processes, better prevention, greater adherence to regulations, labor inspections and accident prevention policies, have helped to ameliorate the situation [10]. In addition, a fixed amount between 3000 € and 15000 € financial penalties, depending on firm size, that was announced in 2006 by the Minister of Employment and Work for companies with high accident figures, has also helped to decrease the number of accidents in Belgium [9, 13].

In Belgium**,** concerning accidents at work and commuting accidents, data come from Accidents at Work Fund (FAO): http://fat.fgov.be/site_fr/home.html. Occupational diseases, data come from the Occupational Diseases Fund (FBZ): http://www.fmp-fbz.fgov.be/ [10]. In terms of State control and statistical setting up, at work and commuting accidents are under the responsibility of the Fonds des accidents du travail whereas occupational diseases'

responsibility falls under the Fund for occupational diseases. The Federal government has decided to merge various public institutions, in order to improve the efficiency of government services. The Fund for Occupational Accidents and the Fund for Occupational Diseases merged to become Fedris (Federal Agency for Occupational Hazards) on January 2017.

Fedris is a public institution of social security that ensures that the rights of the victims of occupational accidents and occupational diseases are being respected. Fedris will take over all tasks from the FAO and FBZ. Thus, there is now one public institution for all matters involving occupational hazards. Fedris takes over all the missions of the former Fund for occupational accidents and the former Fund for occupational diseases. These missions are related to the accidents on the way to and from work and the accidents at work and the occupational diseases in the private sector, the occupational diseases in the provincial and local administrations (PLA) and, to a lesser extent, the accidents on the way to and from work and the accidents at work in the public sector [14, 15].

Fedris' most important tasks are:

- Compensation of victims of occupational diseases and, in specific cases, victims of occupational accidents;
- The implementation and support of various preventive measures involving occupational diseases and occupational accidents;
- Checking compliance of insurance companies and employers in respect of occupational accidents.

1.2 Definitions of work accidents, occupational injuries and non-standard work arrangements indicators

1.2.1 Definitions of work accidents

European statistics on accidents at work (ESAW) gave a definition of work accident as follows: "a discrete occurrence in the course of work which results in occupational injuries, absence from work and in the worst case can cause death [16-18]. The phrase "in the course of work" means doing an occupational activity during the time spent at work. In this case, road traffic accidents in the course of work are included. This definition includes cases of

severe toxicity, the occurring accidents outside the worker's building, or on the premises of the company, the deliberated actions of other persons and cases of road accidents in the course of work. On the other hand, this definition excludes deliberate injury by the worker himself, heart attack (accidents from medical origin, occupational diseases and commuting accidents. Commuting accident refers to the trip from home to the workplace or from the workplace back home. This definition of accident at work in only used for collecting statistics and is not established on European legislation.

European statistics on accidents at work (ESAW) are the main data source for European statistics relating to health and safety at work issues. ESAW include data on occupational accidents that result in at least four calendar days of absence from work, including fatal accidents. Less than 4 days' absence is not considered as a work accident by the ESAW methodology. The accidents with less than 4 days' absence are covered by the compensation system in each member state [16].

A non-fatal work accident ranges from any work accident, whether it results in a minimum absence of more than three days to an interruption of work or not. Non-fatal accidents at work often involve considerable harm for the workers concerned and their families. They have the potential to force people, for example, to live with a permanent disability, to leave the labour market, or to change job. They can also result in a considerable number of days of work being lost [6]. Fatal accidents at work are those that lead to the death of the victim within a certain time limit after the occurrence of the accidental injury. This time limit differs across the member states. For example, in Germany the accident is registered as fatal in the statistics when the victim died within 30 days after the date of the accident. In the Netherlands the accident is registered as fatal when the victim died the same day. For the following states (GB, Greece, France, Italy, Luxembourg, Austria, Sweden and Norway) there are no time limits. For the other member states the time limit is within 1 year [6, 16].

There is no unique definition for work accidents. Therefore, each member state may have his own definition of an accident. For example, in France an accident at work covers any accident "resulting from work or occurring during work". It also includes accidents occurring during the journey to or from work, or between the workplace and the place where the individual usually has his meals [19]. Also, in France, commuting accidents are considered as work accidents and caused one out of five occupational accidents [20].

In the United Kingdom accidents at work occurring in road traffic (during work) are not covered by the reporting system; it is thought that these accidents may account for about half of all fatal accidents at work [6]. Whereas, in Belgium both accidents on the workplace and accidents on the way to and from work fall under the legislation on occupational accidents [21].

The Belgian Workplace [22] Accidents Act defines a 'work accident' as: A sudden occurrence; causing injury to a worker; during and as a result of the execution of the employment contract. An accident that occurs on the way to or from work is also considered a 'work accident' and will give rise to workers' compensation, provided that the accident occurred on the 'normal journey' to or from work (i.e. not necessarily the shortest route). The Act on Workplace Accidents provides a specific definition of the 'normal journey' to and from work. If an accident is considered a 'work accident' as defined above, the victim or his or her relatives (in the event of a fatality) will receive workers' compensation from the insurer of the employer of the victim. The Occupational Health and Safety Act of 4 August 1996 on the well-being of workers places a number of specific obligations on the employer in the event of a 'serious workplace accident', including an obligation to investigate the accident and to draft a detailed accident report, which must be submitted to the Health and Safety Inspectorate [22, 23].

This definition was further refined in a Royal Decree of 27 March 1998 as follows: a workplace accident leading to the death of a worker; or a workplace accident which has caused permanent injuries, the occurrence of which is directly linked to one of the following events, which are different from the normal performance of the work:

- an electrical breakdown, explosion
- the breaking, bursting, gliding, falling or collapsing of an object;
- loss of control over a machine, means of transportation, hand tool or other object;
- a person falling from a height;
- a person being caught or dragged by an object or by the fore of speed of an object; or with one of the following objects involved in the accident:
- scaffolding or overground construction;
- excavation works, trenches, pits, underground passages, tunnels or an underground water environment;
- installations;

- machines or instruments;
- systems for closed or open transport and storage;
- vehicles for transport over land;
- chemical substances, explosives, radioactive substances or biological substances;
- security systems and security equipment;
- animals, microorganisms or viruses; or a workplace accident that has caused temporary injuries, directly linked to one of the above-mentioned events or objects, where one of the following injuries has occurred:
- flesh-wounds with loss of tissue, resulting in incapacity of several days' duration;
- bone fractures;
- traumatic amputations (i.e. loss of limbs);
- surgical amputations;
- shaking and internal injuries that could be life threatening in the absence of treatment;
- harmful effects of electricity resulting in work incapacity of several days' duration;
- burns resulting in work incapacity for several days;
- chemical or internal burns or freezing;
- acute poisoning;
- suffocation and drowning;

So, in conclusion, work accidents in Belgium can be defined as a sudden occurrence which results in occupational injuries and the death of the victim in the most catastrophic cases. Also, commuting accidents which refer to the trip from home to work and vise versa are considered as work accidents.

European statistics on accidents at work (ESAW) gave a definition of work accident as follows: "a discrete occurrence in the course of work which results in occupational injuries, absence from work and in the worst case can cause the death of the worker". The phrase "in the course of work" means doing an occupational activity during the time spent at work. In this case, road traffic accidents in the course of work are included. So, the only difference between the two definitions that in the Belgium case commuting accidents from home to work and from work to home are considered as work accidents as well. While from the ESAW definition only road traffic accidents in the course of work are considered as work accidents.

We decided to put in this thesis the ESAW definition because it is universal for all the European countries so the Belgium case will be included within this definition. Another reason that this definition will be useful for the future work in case we want to do some comparison between work accidents between two European countries.

1.2.2 Definitions of occupational injuries

Occupational injuries are the result of work- related accidents and in many cases work accidents might occur without causing any types of injuries. An injury to a human being is defined as wound or trauma; harm or hurt; or damage inflicted on the body of the injured by an external force. An occupational injury is a suspected bodily lesion resulting from acute overexposure to energy interacting with the body in amounts or rates that exceed the threshold of physiological tolerance. These definitions are given by Webster, 2002 [24] and the International Classification of External Causes of Injuries (ICECI), 2004 [25], respectively.

1.2.3 Definitions of non-standard work arrangement indicators

Non-standard work arrangements refer in this thesis to occupations that fall outside of the field of standard work arrangements, including temporary work; long working hours; multiple jobs; shift work; and job insecurity.

1.2.3.1 Definition of temporary (non-standard) and permanent (standard) work

Eurostat defined “temporary” jobs as dependent employment of limited duration [26]. For convenience, all other jobs are referred to as “permanent” jobs. In most cases, these choices have been made by the national statistical offices (NSOs), who are most familiar with national data sources and employment practices. The list of job types classified as temporary employment typically includes many or all of the following: (1) fixed-term contracts: those have a specified duration or time limits; (2) temporary agency workers who are placed by a temporary work agency (TWA) include the following aspects as: replacement of permanent worker, unusual increase in the workload and for doing technical services; (3) contract for particular job, done to achieve a specific job; (4) replacement contracts, for example, a contract which is done to replace another worker whose work is broken because of one of the following reason: strike, weather, economic cause and family-related reasons; (5) seasonal

work taking place only at certain periods of the year; (6) on-call work, which is performed only when necessary: on-call employees are on standby until called to work; (7) daily workers, who are hired on a daily basis; (8) trainees, meaning apprentices and other workers with a training contract that qualifies them for a salary but does not guarantee them a permanent position at the end of the training period; and (9) persons in job creation schemes, individuals hired under public programmes to stimulate the employment of disadvantaged categories of workers (e.g. youth, the long-term unemployed, and the disabled), when these jobs are of limited duration [27].

The list of the subcategories of temporary jobs for any particular country will depend on the contracting forms that are in use in that country and identifiable in national statistics. Accordingly, these lists vary from country to country.

In the majority of the European Union countries most jobs are based on written work contracts. A job may be regarded as temporary if it is understood by both employer and the employee that the termination of the job is determined by objective conditions such as reaching a certain date, completion of an assignment or return of another employee who has been temporarily replaced. In the case of a work contract of limited duration, the condition for its termination is generally mentioned in the contract [27].

Temporary employment has been reported in previous research using different names as: non-standard work, contingent work, atypical work, and precarious employment. It is often characterized by lower income, insecurity, less knowledge of workplace risks and health hazards, lack of protection, social and economic vulnerability [28-30]. Non-standard employment is widely used to describe insecure and irregular work arrangements that have grown substantially in both poor and rich countries since the late 1970s [31].

1.2.3.2 Definitions of long working hours

Based on the European Working Time Directive, aiming to protect workers from health and safety risks associated with excessive and inappropriate working hours, long working hours are defined as working 48 hours a week or more [32, 33]. The Labor Standards Act introduces that overtime work includes extended work, night work, and holiday work.

1.2.3.3 Definition of multiple job holders

Multiple job holding engenders when individuals work in more than one job at the same time. Some workers take on an additional job to enable them to maintain their standard of living. Multiple job-holding can also be a technique used by the self-employed to minimize the impact of economic downturns on their income [34].

1.2.3.4 Definition of shift work

According to the International Labour Office (ILO), shift work is defined as a method of work organization under which groups or crews of workers succeed each other at the same workstations to perform the same operations, each crew working a certain schedule or shift so that the undertaking can operate longer than the stipulated weekly hours for any worker. Often the term is used when more than one work period is scheduled in a workday or when most of the working hours fall outside the standard daylight hours (7/8 am – 5/6 pm), such as evening, night or weekend shifts. In most cases, shift work is synonymous of odd, flexible, irregular, unusual, and non-standard working hours [35, 36].

1.2.3.5 Definition of job insecurity

Job insecurity or 'the threat of unemployment' is defined as the perceived threat of job loss and the worries related to that threat [37]. Also, job insecurity relates to people at work who fear they might lose their jobs (the workers' perception of fear of job loss) and become unemployed [38] or fear from job discontinuity [39]. Employees will be confronted with job insecurity and its consequences due to the fundamental transformation of the economy in most contemporary societies and the result of radical economic changes [37].

1.3 Costs of work accidents

Work-related accidents and injuries are very costly and can have many serious direct and indirect consequences for both workers and employers [1]. For employers, some of the direct costs are: (a) payment for work not performed; (b) medical and compensation payments; (c) negative effect on morale in other workers (those who witnessed the accidents); and (d)

production delays. Some of the indirect costs for employers are: (a) the injured worker has to be replaced, and a new worker has to be trained, it takes time before the new worker is producing at the rate of the original worker; (b) accidents often influence labour relations in a negative way. For workers, some of the direct costs of an injury are: (a) suffering injuries; (b) health-care costs; and (c) the loss of income or even the possible loss of a job. One of the most obvious indirect costs is the human suffering caused to workers' families, which is not easily to compensate with money [1, 40].

The direct and indirect costs associated with occupational injuries and accidents may rise substantially for the employees, the companies and for society as a whole. According to the ILO, medical expenses, interruption of production, lost working time and workers' compensation due to the direct and indirect costs of occupational accidents and diseases accounted for US 2.8 trillion $ or 4% of annual global Gross Domestic Product (GDP) [2, 41]. In Europe, the direct medical cost of injuries treated in accident and emergency rooms including hospitalization, rehabilitation and additional care facilities, is estimated at 78 billion € each year [42-45]. This is 7.8% of total curative care costs in the EU-27 of 1003 billion [46].

Indirect costs are even estimated to be much higher than the direct ones and include training replacement of employees, accident investigation and implementation of corrective measures, lost productivity, repairs of damaged equipment and property, and costs associated with lower employee morale and absenteeism [47-49].

Across a selection of European countries, the estimated economic costs in Finland was 3.8% of GDP; Denmark 2.7%; Italy 3.2%; Sweden 4.0%; New Zealand 3.4% (The European Agency for Safety and Health at Work 2013 [50]). The Netherlands made in 2010 an estimation for accidents of 276 million €, including direct medical costs (76 million €) and total absence costs (200 million €) [51] and the United Kingdom estimated that the economic damage caused by work-related injuries and ill health amounts to 13.4 billion £ (HSE, 2011, [52]). In 2008, only the social cost of road accidents was almost 14 billion of Euros in Belgium [53]. In addition, one study in the United States by Leigh [54] reported that the national cost of work-related injuries and diseases corresponded to 250 billion $ (1.8% of GDP).

As should become obvious from these statistics, the magnitude of the problem of inadequate health and safety at the workplace is large and needs to be treated in order to reduce the

associated accidents burden and increase the productivity of workers and the competitiveness of businesses.

1.4 Aim and objective of this doctoral dissertation

Accidents at work and the management of occupational safety risks still present a major problem in industrialized countries and in industries in the developing world. The globalization of the labor market and the recent financial crisis has led to a shift from the traditional standard employment relationship into an increasing number of jobs with insecure contract type or non-standard working time arrangements. Research suggests that non-standard work arrangements are related to a higher rate of occupational injuries. However, this relationship is not straight forward and has rarely been explored in large harmonized samples. Therefore, the focus of this doctoral thesis is to concentrate on aspects of poor working conditions in relation with occupational injuries and accidents.

From the point of view of workplace safety it is important to know whether temporary workers are more likely to suffer from workplace accidents and occupational injuries in Belgium, and this in turn will help to extend the existing literature with the specific situation of Belgian work force due to lower number of existing research that describing the association between non-standard workers and work-related accidents and injuries.

In this doctoral thesis, we focus on four non-standard work arrangements indicators namely: temporary contract, those doing long working hours, multiple jobs and shift work (this will be explained later in chapter 2).

The following set of research questions has been formulated to achieve this aim:

1. Are Belgian non-standard workers at a higher risk of having work accidents and injuries compared to standard workers or not?
2. What is the relationship between non-standard work arrangements indicators such as non-standard work, over time work, multiple jobs and shift work and work-related accident absence in Belgium?
3. What is the relationship between non-standard work arrangements indicators and injuries in Europe 27?

Chapter 2
Literature review: Working conditions and occupational accidents

2.1 Overview

Occupational accidents and injuries are a common problem at the workplace. The negative impact is not only on individual but also at the societal level. During recent years the work environment has undergone significant changes regarding working conditions such as type of employment contracts, working time and work organization. In this review consequences of these changes on worker's health and safety are reviewed focusing on some specific working conditions aspects such as non-standard work arrangements. At first, the association between temporary work and occupational injuries is reviewed based on the investigation of the differences between permanent and temporary workers in term of work injuries. Secondly, it presents the health and safety issues of workers doing long working hours and multiple jobs. Thirdly, it reviews the published scientific literature for studies analyzing the associations between shift work and work related injuries among workers. Finally, this review presents the literature on job insecurity. The consequences of job insecurity for the health and well-being of individuals are discussed. The overall goal of this review is to summarize the work that has been accomplished in these fields. A significant amount of published research has proved that workers in several risky types of non-standard work arrangements experience higher rates of work-related accidents and health problems compared to other working populations. There is a strong need to develop effective programs to address and improve the health and safety of this vulnerable population.

2.2 Working conditions

Working conditions refer to the conditions in which a person or staff works, and all the existing circumstances affecting labour market [55]. A wide range of information on working conditions is available from the several waves of the European working condition survey (EWCS) [56, 57]. Actually, several working condition factors have been described in these surveys: task-related, working environment-related factors, as well as human behavior-related factors.

The task-related and working environment-related factors include (1) weather and illumination; (2) working surface and layout conditions; (3) exposure to gas, liquid, and solids; (4) temperature, pressure, and noise level; (5) surrounding objects and structure; (6) action required to perform work tasks; (7) task assignment information either regularly or

irregularly assigned; and (8) required tools and equipment. Whereas, regarding the human behavior-related factors, these comprise worker competence-related and perception-related factors, more specifically (1) personal protective equipment (PPE) and safety devices; (2) operation procedure; (3) safety training; (4) supervision and engineering control; and (5) inspection [55].

In addition, many other aspects of poor working conditions have been addressed as the followings: (a) working antisocial hours (usually work at least once a month either at night or on Sundays or work shifts or irregular hours or working long working hours or doing multiple jobs or precarious temporary work); (b) limited working-time flexibility: cannot take a break when wanted and not free to decide when to take holidays or days off; (c) limited work autonomy: not able to choose or change either the order of tasks, work methods or work speed; (d) unpleasant working conditions: for between one-half to all of the time, exposed in main job to at least one of the following: vibrations from hand tools or machinery, loud noise, high or low temperatures, breathing in vapors, fumes, dust or dangerous substances, handling dangerous products, or radiation such as X rays, radioactive radiation, welding light or laser beams; and (e) monotonous work: main job involves monotonous tasks [55, 58-60].

In job evaluation literature, working conditions imply two dimensions: environmental conditions and hazards. Environmental conditions range from ordinary to extreme conditions in terms of the factors such as heat, humidity, noise, smell, light, and dust. Unpleasant environmental conditions have both direct and indirect effects on employee job performance. These conditions decrease employee concentration towards tasks which lead to low employee performance including productivity, quality, emotional stress, and in turn this causes high cost [61].

Occupational safety and health (OSH) research increases the productivity and competitiveness of enterprises by reducing costs resulting from occupational injuries, accidents and occupational diseases. A safe and healthy work environment contributes considerably to labour productivity and, as a consequence, promotes economic growth. These positive outcomes are also desirable from the perspective of workers [40].

2.3 Occupational accidents

Work-related injuries are commonly distinguished into three groups: (1) “workplace injuries” which refer to injuries that occur in the course of work; (2) "work-road injuries “which include the ones that occur in traffic incidents on public roads in the course of work; and (3) “commuting injuries” describing injuries that occur whilst travelling to or from work. Work-road and workplace injuries are usually combined into a single measure of work-related injuries of workers (“working injuries”).

A large body of literature is available on workplace safety, accident and injury research. A comprehensive review of the concepts of occupational injury and accident causation, intervention and prevention theories; injury risk assessment issues; hazard identification methods; and injury mechanism models is presented by Khanzode et al, 2012. Also the differences in injury and accident research are studied [62]. Khanzode et al, 2012 divided the accident causation theories which were examined by researchers over the years into four generations: (1) First, in the beginning of the twentieth century, unsafe behavior was considered to be the responsible factor for accidents (Greenwood and Woods, 1919) [63]; (2) domino theories were classified as the second generation theories [64], suggesting a series of sequential steps leading to an accident, and these events are called “dominos” (Heinrich, 1932). Elimination of any domino from the series would break the chain of accident events. This theory was widely used in industry for accident reduction; (3) the third generation of accident research originated in the 1960s (Haddon et al, 1964), and was called “injury epidemiology models” [65]. This approach focused on energy transfer implicated in injury incident, and tried to decrease it in order to decrease the damages. Also, this approach held that, in a work system, accident protection attempts did not necessarily lead to injury control; (4) the fourth generation emerged in the 1970s as a response to the challenge of protecting safety in increasingly complicated framework, and is known as a system approach to accident causation [66].

Most accident causation studies explain that unsafe acts of workers (e.g., misjudgement or inappropriate operation) and unsafe working conditions (e.g., work surface conditions or weather) are the major root causes of workplace accidents [55, 67].

To understand causes of occupational accidents and injuries, Jovica et al, 2004 identified two related approaches to human factors: (1) immediate causes as: (a) unsafe acts such as protective equipment or guard provided but not used, hazardous method of handling,

improper tools or equipment used despite availability of proper tools and hazardous movement; (b) unsafe conditions as the following: improper ventilation and illumination, exposure to hazard in the work place, improper clothes for work, utilizing of insufficient machines, tools and equipment, invalid safety instrument and no safety device. (2) Contributing causes as: (a) worker's physical condition: weakness of eyesight, ultimate fatigue, insufficiency of physical competence for job and hearing conditions; (b) worker's mental conditions: nervousness, negligence, slow mental reaction, improper behaviour, reduction of emotional stability and reduction of safety consciousness; and (c) safety management performance: safety equipment not provided, hazards not corrected, irregular employee contract, safety not guided as portion of the job, non-mandatory rules and inappropriate instructions [4].

Actually, both human and working conditions play an important role in the occurrence of work accidents and injuries. Previous studies showed that in general, work injuries occur more often in men, younger, less experienced and lower educated workers [6, 68-74]. Accidents and injuries are more prominent in the sectors of construction, agriculture, hunting and forestry, and manufacturing [75, 76]. Also, the statistics suggest that the risk of injury decreases as the size of the enterprise increases [77-81]. One obvious reason behind why the risk of injuries decreases as the size of the enterprise increases might be that small enterprises typically have fewer financial, human and technological resources available for organization and management of safety and health protection. Economic survival and economic competition concerns quite often might exceed basic health and safety concerns. Another reason is that SMEs often seem to be lacking the ability to perform proactive or high-quality risk management [82-86]. In addition, the owner's resistance towards state regulation of employees' health and safety issues seems to be crucial [87]. So in general large enterprises seem to most actively make an effort in ensuring a safe and sound working environment when compared to small and medium-sized enterprises. In addition, several studies concluded that the lower risk of injuries in large enterprise size might be explained by an increasing proportion of white-collar employees in large enterprises [80, 88, 89].

Several other studies have investigated the working conditions as a cause of occupational injuries and accidents. For example, de Castro AB et al demonstrated that potentially dangerous work (e.g. roofing, using power equipment), hazardous work site conditions (e.g. falling objects, electrical hazards, scaffolding), inadequate on-the-job training or site-specific information and a lack of adequate personal safety equipment were all factors contributing to

the occurrence of an injury among day laborers [90]. Exposures to loud noise, cold temperature, and the use of vibrating machinery were also found to be risk factors of injuries [58, 91]. Perceived physical demands are associated with announced back, neck, and shoulder cases in registered nurses, and the association is stronger in staff nurses. Actually, high and moderate perceived physical demands were significantly associated with reported muscular disorders [92]. The relative risk of a hand injury was increased when working with equipment, tools, or work pieces not performing as expected or when using a different work method to do a task. Other transient factors in decreasing order of relative risk were doing an unusual task, being distracted, and being rushed [93]. Several researchers have concluded that in the workplace suggesting that correcting poor movement patterns can provide some protection against injuries in physically demanding occupations. In addition to corrective exercises for those employed, pre-employment functional movement assessments may hold promise for reducing injuries in the workplace [94, 95]. Although physical training, mechanical work, and airborne activity were ranked as the leading causes of injury for both sexes, road marching and garrison activities produced the most injuries in women (Knapik et al. 2007) [96]. Women's injuries were more often a result of routine job tasks and of gradual onset [97, 98]. Fernandez 2015 concluded that exposure to on-the-job hazardous situations or conditions (slippery floors, extreme heat, loud noises, risk of cutting themselves, risk of falling, too much sun, too much cold, insufficient ventilation, lifting heavy things, breathing dust or gases, use of machinery that vibrates and risk of electrocution) were related to a higher rate of occupational injuries [58].

A growing number of studies focused on psychosocial work characteristics as possible sources of accidents. Swaen et al, 2004 concluded that, high psychological job demands, high levels of emotional demands, and conflicts with the supervisor and/or colleagues are indeed risk factors for being injured in an occupational accident [99]. In addition, other studies confirmed that job stress, high physical and mental workload were linked to workplace injuries [100-102]. Furthermore, working long hours and job insecurity are also associated with increased incidence of occupational injuries [103, 104]. Results from a cohort study of manufacturing workers found that workers with health problems, such as chronic heart disease, diabetes, and depression have a higher rate of acute occupational injuries than workers without coexisting conditions [105]. Lower Work Ability Index scores (a proxy for poor work ability) are also positively associated with work injuries [106]. Workers with less

than six months of experience showed higher relative risks compared with job tenure of more than two years [70, 107].

No matter how attentive and conscientious you are about observing health and safety rules on the job, the potential for workplace accidents is ever-present. Not only can these accidents put employees at risk of hospitalization or even death, it also can impact insurance rates, reduce productivity, increase workers' compensation claims and affect company morale. Team vigilance at all levels is critical in maintaining a safe environment and preventing accidents from happening.

2.4 Non-standard work arrangement indicators

Work accidents and injuries are a significant public health issue because of associated human, social, and economic losses. Multiple factors contribute to occupational accidents and injuries and most research has focused on identifying individual and workplace contributing factors. However, the globalization of the labor market and the recent financial crisis has led to a shift from the traditional standard employment relationship into an increasing number of jobs with insecure contract type or non-standard working time arrangements [31, 108, 109]. By consequence, the fast growth of non-standard working arrangements in advanced countries highlights the importance of studying the influence of non-standard work arrangements indicators on employee's health and safety, as well as on firms and labour market performance. Therefore, the associations between several measures of non-standard work arrangements such as precarious contracts, long working hours, multiple jobs, shift work and several health and safety outcomes have become the subject of more recent investigation.

In the last decade, legislators and employers in Europe became more and more aware that not only improving the working conditions will have beneficial effects on workers' health and safety, but also of the fact that employment quality is important to increase wellbeing and productivity [110]. Employment quality refers to the wage, working hours and other aspects of the mutual agreement with associated social protection systems and security.

2.4.1 Contract type and occupational injuries

2.4.1.1 Statistical data on non-standard work

The globalization of the labor market and the recent financial crisis have led to a shift from the traditional employment relationship into the growth of non-standard employment [108]. In general, women, workers without supervisory authority, those with fewer credentials, and those living in Eastern and Southern European countries suffer the highest levels of this type of employment [109].

Much of the concern about non-standard forms of employment relates to the considerable use of fixed-term contracts by European employers. The overall incidence of temporary work in the European Union has declined slightly since the start the start of the crisis, from 14.5% in the last quarter of 2007 to 14% in the third quarter of 2014 [111]. This means that in the European Union more than one in seven employed persons continues to be on a fixed-term contract. While, in 2015, 12% of the European workforces are temporary employees and the remainders (73%) are employees with a permanent contract or another arrangement [112].

In 2014, the incidence of fixed-term contracts was highest in Poland (28.6%), Spain (23.9%), Portugal (21.7%) and the Netherlands (21.5%). The incidence of fixed-term contracts was also relatively high in Sweden, Finland, France and Slovenia where it exceeded 15%. By contrast, the incidence of fixed-term contracts is relatively low in countries such as the United Kingdom (6.3%), Luxembourg (6.5%), Norway (7.9%), Estonia (3.4%), Denmark (8.2%) and Belgium (8.4%).

In the Convention on the Organization for Economic Co-operation and Development (OECD) countries, about one in five employed persons worked part-time in the third quarter of 2014 and the importance of part-time work is increasing almost across the world. Since the start of the crisis in the last quarter of 2007, the incidence of part-time work has increased by over 2 percentage points on average. The incidence of part-time work is highest in the Netherlands where more than half the working population is employed in part-time jobs (51.7%). More than one in three employees work part-time in Switzerland (36.8%) and over a quarter in Austria, Belgium, Denmark, Germany, Norway, Sweden and the United Kingdom. Conversely, in Central and Eastern European countries, as well as in Greece, Portugal, and Turkey, part-time employment is less widespread. Part time work has a gendered nature. A recent study estimates that two-thirds of part-time workers in OECD countries in 2014 were women [111, 113, 114].

On average only a fifth of the working-age population in EU member states holds a part-time job (8.7% of men and 32.2% of women); in the Netherlands 26.8% of men and 76.6% of women work less than 36 hours a week (Figure 1). Part of the reason is that Dutch women were relative latecomers to the labour market. Compared with other countries, few men had to leave to fight in the world wars of the 20th century, with the result that women did not labour in factories as they did in the US and Britain. Thanks to the country's wealth, a dual income was not a necessity for a comfortable life. And Dutch politics was dominated by Christian values until the 1980s: the focus was mainly on providing state aid (implicit subsidies in the fiscal system) so that women could stay at home with children. This changed in the late 1980s, when the state realized that it would be a good idea to mobilise women into the workforce. But the cultural conviction that families still needed mothers to be home for tea-time prevailed, so the state worked closely with employers to ensure that the new part-time jobs would enjoy similar legal status to their full-time equivalents. This has, to an extent, continued: in 2000 the right for women and men to ask for a job to be part-time was written into law [115].

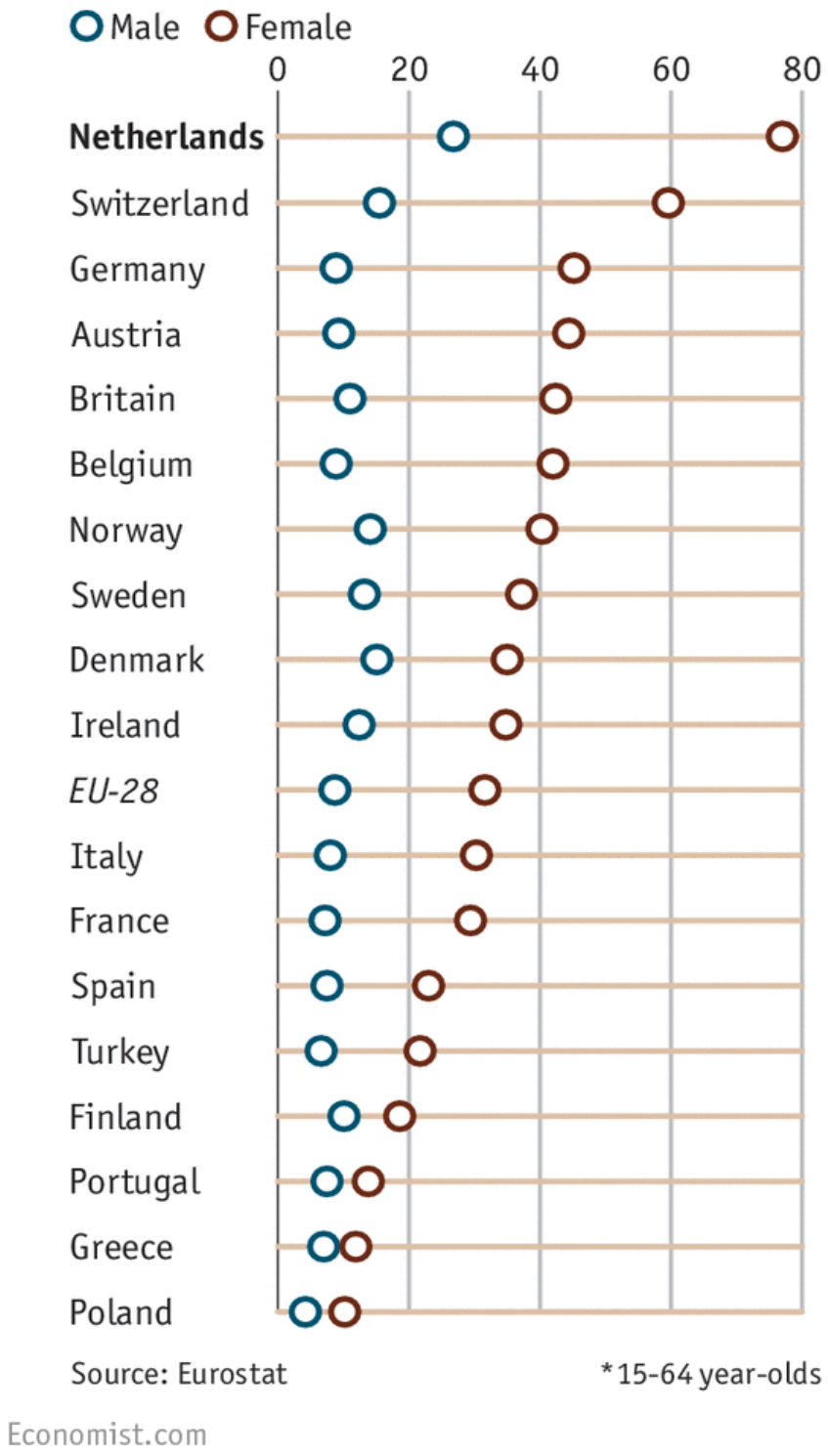

Figure (1): The Dutch are different. Part- time adult employees 2014 as a % of total employed

2.4.1.2 Non-standard temporary work and occupational accidents

A huge number of studies investigated the relationship between non-standard work and health [29, 116-124]. These studies showed that the health outcomes of non-standard workers are worse than that for standard workers. Backache, higher diffusion of fatigue, muscular pains and job resentment are more related to temporary employment rather than permanent employment. Furthermore, compared with permanent employees, a higher psychological morbidity rate was recognized among temporary workers. In a recent review, Inoue et al, 2010 identified 68 papers, which compared the health outcomes between non-standard and standard workers. It was concluded that: elevated mortality rate and slight degree of mental health were associated with non-standard workers [125]. However, studies investigating the association between occupational injuries and non-standard work are more limited. In addition, previous research on the association between temporary work and occupational accidents revealed inconsistent results. Some researchers concluded that temporary workers are more vulnerable to occupational accidents since accident incidence rate, accident frequency rate and accident severity rate were found to be significantly higher in temporary workers [103, 125, 126]. A study based on data systematically recorded from 160 factories and 4 employment agencies operating in Italy, and another study conducted in Finland on the basis of national statistics databases found a higher risk of occupational injury among temporary workers than among permanent employees [127, 128]. A more recent study confirmed that direct-hires and temporary agent workers (TWAs) had a higher risk of occupational injury compared with permanent employees [129]. In contrast, other studies examining the relationship between employment types and occupational injuries showed negative results. In a review of thirteen studies, Virtanen et al, 2005 reported that seven studies found a lower risk of occupational injury for permanent employees than for temporary workers, whereas the remaining six studies did not find such a difference [121]. Furthermore, the research of Saloniemi et al, 2010 concluded that fixed-term workers did not have a higher occupational injury rate than permanent workers [130]. Similar results arose from a study in which Garcia-Serrano et al, 2010 found a lower risk of occupational injury among temporary workers than among permanent employees [131].

The main reasons for the higher risk of injuries among non-standard workers can be summarized as follows from the aforementioned studies: (a) non-standard workers do not have absolute rights in employee unions, they will not be able to avoid allotment in unsafe jobs while standard workers utilize their powers to avoid hazardous tasks; (b) inadequate

training period, lack of experience and low levels of information among non-standard workers [132].

The above studies also presented measures how the higher risk of occupational injuries can be reduced. The first way to prevent the high risk of injuries among temporary workers, especially in the countries which have a high level of them, is by enhancing a higher level of permanent employment with all of its advantages or to exclude non-standard work but this solution is hard to realise. Another way to decrease occupational injuries risk among temporary workers is to enhance their knowledge about the workplace by pre-placed safety education, provide them with personal preventive equipment and force them to use these devices [28, 119, 121, 133].

2.4.2 Long working hours and occupational injuries

On average, 43% of self-employed workers without employees, 54% of self-employed workers with employees and 11% of European employees work long hours each week [60, 134]. In 2015, according to the 6th EWCS, about 15% of workers in the EU28 report working long hours, which represents an evident decrease from the 19% and 17% registered in both 2005 and 2010 respectively. Overall, the working time quality index has improved in the EU28 since 2005 [112]. A significant and growing number of people work long hours due to (a) management expectations, (b) career, and (c) money. Long working hours are controversial issues because of conflicts between health, safety, work-life balance, and productivity [135, 136].

The impact of long working hours on health has been emphasized by many researchers. According to the data of the Third EU Survey on Working Conditions which took place in 2000 in the EU15 and another country as Norway; in 2001 this survey was extended to cover EU27, and Turkey, longer and "irregular" working hours are in general linked to lower levels of health and well-being; and overtime has negative effects on stress, sleep, and social and mental health [137].

The effects of work long hours on health and safety, including sleep deprivation, injury, fatigue, stress and productivity were studied by Goldenhar, 2003 [138]. Several significant associations emerged between hours of work and measures of health and well-being, particularly for respondents in the higher overtime group (70+ hr/week) and overtime work was also characterized by higher levels of job stress and perceptions of overwork [139].

Socio-demographic characteristics of workers doing long working hours were also established by the research of Grosch, 2006: compared to full-time workers, overtime workers were more likely to be male, white, and middle-aged, with higher levels of education and income [139]. They were also more likely to be self-employed, salaried, work as independent contractors, have more than one job, and work split/irregular/on-call shifts. Overtime work was also associated with increased levels of participation in decision making and opportunities to develop special abilities. Johnson et al, 2006 found that extended and irregular hours are associated with acute reactions such as stress and fatigue, adverse health behavior such as smoking, and chronic outcomes such as cardiovascular and musculoskeletal disorders [140].

In a publication of Eurofound (2012), persons who work more than 48 hours a week reported more health problems, higher work intensity and problems in terms of work–life balance [60]. Schulz et al, 2013 concluded that the number of sites at which workers reported musculoskeletal symptoms was elevated for overtime workers [141]. Artazcoz et al, 2013 concluded that, in the European Union of 25 members (EU-25), working long hours were associated with poor health outcomes with different patterns depending on welfare state regimes. Long working hours have been associated with negative health and well-being outcomes such as cardiovascular disease [142, 143], and musculoskeletal disorders [144].

The association between long working hours (51-60 hours a week) and health (stress, work-related poor health status, and psychological distress) was stronger among women in Eastern European; similar among both sexes in Nordic countries; and stronger among men in countries with male breadwinner models, primarily in Anglo-Saxon countries [145]. Paterson et al, 2015 found that fatigue was identified as a significant problem by the majority of young workers and was associated with unpredictable working time arrangements, precarious employment, high workload, working overtime and limited ability to self-advocate [146].

The relationships between long working hours and work accidents and injuries have been also reported in the literature. For example, Dembe et al, 2005 reported that working in jobs with overtime schedules was associated with a 61% higher injury hazard rate compared to jobs without overtime [147]. Macedo et al, 2005 found that increasing labor flexibility and overtime working led to a significant increase of fatal accidents on Saturday and Monday, with a higher incidence in the 12-16 h working schedule [148]. Traumatism with contusion was the major type of injury recorded. Dong XW, 2005 found that long work hours and irregular work schedules were significantly associated with a higher work-related injury rate

after control for possible confounders [149]. Vegso et al, 2007 concluded that workers who worked more than 64 hr in the week had an 88% excess risk compared to those who worked 40 hr or fewer [150]. This study also provided evidence that control of overtime in manufacturing may reduce risk of worker injury. Wagstaff et al, 2011 provided a large review study on the effects of work hours on various safety outcomes and performance [151]. The results showed that work periods >8 hours carry an increased risk of accidents that cumulates, so that the increased risk of accidents at around 12 hours is twice the risk at 8 hours. The study conducted by Nakata, 2011 suggested that long work hours coupled with poor sleep characteristics were associated with increased risk of workplace injury [152]. Arlinghaus et al, 2012 found that long work hours and short sleep duration independently increased the risk of injury [153]. Wirtz et al, 2012 reported that injury rates were higher among men and increased with increasing working hours for both genders [154].

2.4.3 Multiple jobs holders and occupational injuries

The apparent increase in frequency of part-time employment and the holding of more than one job by an individual are considered as one of the dynamics that affects efforts to create employment opportunities for low-income individuals and families [155].

Information on multiple jobholding is available from the Current Population Survey (CPS). The Current Population Survey is a household survey conducted monthly by the U.S. Census Bureau for the Bureau of Labor Statistics. It is a nationwide sample survey of about 60,000 households, providing a comprehensive body of information on the employment and unemployment experience of the nation's population, classified by age (16 and over), sex, race, and a variety of other characteristics [156].

In 2014, the US national average of the multiple-jobholding was 4.9 percent a rate that has been unchanged since 2010 [157] and in July 2016 the rate was 4.7 [158]. In recent decades multiple job-holding sounds to have increased highly in a number of countries, particularly in the transition economies of Eastern Europe [34]. According to the sixth EWCS, nearly 8% of workers in the EU28 report having more than one job [112].

The effect of working multiple jobs on work and non-work injury has only been minimally explored. Dong et al, 2015 reported that those doing multiple jobs were among several other risk factors which accounted for the escalated risk for occupational injuries in construction industry [76]. The research of Marucci et al, 2014 in which data from the US National Health

Interview Survey (NHIS) were used, found that workers with more than 1 job in a 1-week period (multiple jobholders [MJHs]) had a higher risk of injury than single job holders (SJHs) and should be extra considered in injury surveillance [159]. This finding was consistent for both work and non-work injuries; the rate remained elevated even after control for hours worked [159].

Houston et al, 2013 aimed at examining whether certain personal and workplace factors increase the risk for work-related injuries among home health aides, using data from the 2007 National Survey of Home Health Aides among workers who provided formal care giving to older adults or people with disabilities and they found that having multiple jobs; white race; inappropriate workload; job dissatisfaction; higher hourly pay rate; and working in two locations were associated with occupational injuries [160].

Another recent study in the United States conducted by Bush et al, 2013 has also shown that, Kentucky multiple jobholder fatalities averaged 8.4 deaths per 100,000 employees compared to the total average occupational fatality rate of 6.5 [161]. Almost half of multiple jobholder fatalities (47%) occurred in the agriculture and management as the primary industry and occupation; 67% were tractor-related. The most prevalent secondary industry was the construction. One recent study in Wisconsin reported that youths aged 14 to 18 years who worked in multiple jobs had more injuries and more serious injuries than those who worked in only 1 job. This study, however, was limited to a specific population with a small sample size [162].

There are several potential reasons why work in multiple jobs may be associated with an increased risk of injury. Marucci et al, 2014 found that because of long work hours, long daily commutes, multiple shifts, and less sleep and leisure time, MJHs may be at heightened risk of fatigue and injury [163]. Dembe et al, 2005 and Lombardi et al, 2010, also reported that lack of sleep, fatigue due to the extra hours worked, and the additional physical and mental stress from alternating between different types of exposure, are some reasons that have been put forward as an explanation for the higher risk of work injury for MJHs [147, 164].

2.4.4 Shift work and occupational injuries

Shift working has become a routine characteristic and will be definitely inevitable in future because of the following reasons: (a) shift work is necessary for various sectors such as transport, public health, communication, media and security (both internal and external) to provide on-site 24-hour of work; (b) shift work determines dimension of the return on capital investment; and (c) modern industries depend upon expensive machines and continuity in their functioning is excessively mandatory and cost-effective. Therefore, these machines have to be manned by workers round-the-clock [165].

The past few decades have witnessed a tremendous growth in the population of shift workers, especially in developed and highly industrialized countries. Developing countries are also not free from experiencing this phenomenon [166]. Shift work is carried out by 17% of workers across the EU and in this regard there are no gender differences. Full-time workers do more shift work than part-time workers and younger workers more often than older workers. In 2010, 18% of the European workers report working a night shift – a slow decline since 1991[60]. According to the 6th EWCS, about 21% of workers in the EU28 report working shifts in 2015, which represents a robust increase from the 17% registered in both 2005 and 2010 [112].

A large body of research demonstrated that shift work is positively and significantly related to work-related injuries compared to regular daytime schedules. Muñoz et al, 2014 reviewed 262 injury reports between the years 2007 and 2009 to describe occupational injuries among workers at a tertiary level hospital in south-central Chile [167]. They found that injuries occurred more frequently during the morning shift. Another review was conducted by Zhao et al, 2010 in which the target populations were health care workers engaged in shift work [168]. The majority of study findings have shown that shift work is associated with a higher incidence or risk of sustaining work related injuries in the sector of health care. Parkes, 2012 focuses on offshore working time arrangements, and presents a systematic review of studies which examine offshore day/night shift patterns in relation to operational safety and individual health risks [169]. Analyses of survey data and accident/sickness records identify offshore night work as a risk factor for impaired sleep, health problems, and injuries. Wagstaff AS, 2011 aimed at providing a systematic review of empirical research regarding accidents in relation to shift work and long work hours [151]. The findings are most relevant to safety-critical activities such as the transport and health sectors. Both shift work and long working hours present a substantial and well-documented detrimental effect on safety and

shift work including nights carries a substantial increased risk of injuries and accidents. The review of Anderson et al, 2013 conducted in the rail industry in Australia, concluded that fatigue builds cumulatively with each sequential shift where rest in between is unsuitable (<12 h) as a results, shift durations >12h are associated with a doubling of risk for accident and injury [170]. A regulatory system for fatigue arrangement within the rail industry should define limits on hours of work and rest, including successive number of shifts and maximum shift period. Santos, 2011 concluded that the greatest risk of accidents occurs at night when compared to morning and noon shifts [171]. A recent study by Behrens 2017 identified increased risks for prostate cancer among men with employment in shift or night work [172]. The increasing age of the work force and increases in retirement age have given rise to considerable concern over the safety of aging shift workers [173]. The results indicate that there is reasonably clear evidence that injury rates are higher at night, and that they increase over successive night shifts more rapidly than over successive day shifts. Also, it is concluded that it seems possible, that older workers may be at greater risk both to injury and accident on the night shift [173].

2.4.5 Job insecurity and occupational injuries

In a comparative European study, about 75% estimated the chances of becoming unemployed as being ‘rather’ or ‘very’ small and 9.4% of the employed respondents declared having a ‘very’ or ‘rather’ large probability of becoming unemployed in the near future. These percentages vibrated between the participating countries, with 14.5% in Hungary and 5.1% of job-insecure workers in Belgium [174]. In the EU28, the level of job security remained unchanged between 2010 and 2015: 16% in 2010 and 17% in 2015 feel they might lose their job in the next six months. Conversely, 68% of workers disagreed with the statement that they might lose their job in the next six months [112].

Job insecurity is one of the components of the traditional psychological contract between employer and employee. As consequences, job insecurity affects organizational attitudes and behaviors. For example, due to the psychological contract with the employer, the employee reacts in a form of resentment because he or she experiences a violation of this contract [175, 176]. On the other hand, when less security is offered, the employee may attempt to overcome the resulting imbalance by lowering his or her performance and showing less motivation and involvement [177].

Factors influencing perceived job insecurity exist on different levels: (a) employees' individual and positional characteristics (e.g. age, gender, socioeconomic status); (b) employees' personality characteristics (e.g. optimism pessimism, locus of control, sense of coherence); and (c) specific organizational and environmental conditions (e.g. communication and organizational change) [177-179].

Job insecurity has received a considerable amount of research attention in past and recent years [37, 180-185]. For example, the causes and consequences of job insecurity were assessed by Ashford et al, 1989. The causes indicated that job insecurity was correlated with personal, job, and organizational realities associated with a perceived lack of control. Having job insecurity in turn led to attitudinal reactions-intentions to quit, reduced satisfaction, and reduced commitment [186]. Results from a study by De Witte H, 1999 showed that job insecurity was associated with lower well-being and this turned out to be one of the most distressful aspects of the work situation [187]. Ferrie et al, 2002 reported that those exposed to chronic job insecurity had the highest self reported morbidity [188]. Cole et al, 2005 used data from 4 waves of the Canadian National Population Health Survey (2806 working adults) for assessing predictors of work-related repetitive strain injuries [189]. The results showed that female gender, some college or university education, job insecurity, high physical exertion levels, and high levels of psychological demands were all positively associated with work-related repetitive strain injuries. Lund et al, 2006 concluded that prolonged time to first return to work was associated with high job insecurity and high emotional demands in work [190]. Ferrie et al, 2008 reported that job insecurity adversely affects psychological health and increases workplace injuries and accident [191]. A meta-analysis review by Cheng et al, 2008, examined the gender, age, tenure, and differences in the relationship between job insecurity and its job-related and health-related consequences [181]. A total of 133 studies, were included in the analysis. The results showed that; (a) the negative effect of insecurity on its health outcomes was more severe among employees with longer tenure than those with shorter tenure, and was more severe among older than younger employees; (b) the positive association between job insecurity and turnover intention was stronger among employees with shorter tenure than those with longer tenure, and was stronger among younger than older employees; and (c) the relationship between insecurity and the criterion variables was similar across gender [181].

The short term impact of economic crisis on health in Italy has been studied by Costa et al, 2012. The results demonstrated an association between the raise of mental health related

problems (suicides, substance misuse and depression) and the recession for the most disadvantaged groups due to their higher job insecurity [192].

Park et al, 2013 concluded from representative Korean workers, that those who experienced job insecurity at work had an increased risk of work-related sleep problems (WRSP) compared to their counterparts [193]. Loerbroks et al, 2015 conducted a prospective study among 1,791 female hospital nurses from China [194]. They found that needle stick and sharps injuries (NSIs) during the year preceding the follow-up were associated with worse ratings of job insecurity and other six seven psychosocial work characteristics. De Witte, 2016 in a recent review, presented an overview of the results of longitudinal studies on the consequences of job insecurity for health [184]. The results from a total of 57 longitudinal studies published since 1987 in a variety of countries throughout the world showed that job insecurity influences both psychological well-being and somatic health over time [184]. In a multi-country European study by Caroli et al 2016, it was found that job insecurity was associated with some specified health problems as headaches ,backache, depression, muscular pain, eyestrain, stomach ache, insomnia, and overall fatigue [195]. To estimate the effect of perceived employment insecurity on perceived health for a sample of Danish employees, Cottini et al, 2017 used register data for Denmark (IDA) merged with the Danish Work Environment Cohort Survey (1995, 2000, and 2005). They found that job insecurity increases the probability to develop severe mental health problems by about 6 percentage points, and uncertainty associated with the current job is important for mental health [196].

2.5 Concluding remarks

Work accidents and injuries are known to be multifactorial: both individual and work-related factors play an important role in their occurrence. Employment quality refers to the wage, working hours and other aspects of the mutual agreement with associated social protection systems and security. In this study non-standard work arrangements refers to occupations that fall outside of the field of standard work arrangements, including (1) precarious work: temporary work, fixed-term work, part-time employment, self-employment, telecommuting work, home-based work, and on-call work; (2) long working hours;(3) multiple jobs; (4) work in shifts; and (5) job insecurity.

A substantial part of the previous studies demonstrated that contract type, long working hours, working in multiple jobs and shift work, which were considered as a measure of non-

standard work arrangements in this study, were positively and significantly related to work-related injuries compared to standard workers. An overview table showing the type of the study (whether the relationship between aspects of non-standard work and work-related accidents and absence were established on prospective, retrospective or cross-sectional studies), has been added to this thesis at the end as appendix 1.

In conclusion, research suggests that non-standard work arrangements are related to a higher rate of occupational accidents and injuries. However, less research was found in the literature about the association between non-standard workers and work- related accidents and injuries. We have found studies in some specific and national setting as Korea, India, Italy, Spain, France and Finland. Due to the differences among countries regarding the employee's health and safety intervention systems and laws. The situations of Belgian non-standard workers might be different from that of other European and non-European countries (each country has her own system and laws). So, more studies are still needed in other country for the globalization of the findings. No previous studies were found about Belgium and also this relationship has rarely been explored in a large harmonized sample of the Belgian and European working population. Our aim is to extend the existing literature on work accidents and occupational injuries with Belgian and European data.

Chapter 3

Research methodology

3.1 Overview

This chapter presents two sources of data which were used in this thesis namely 1) the Belgian surveys on work ability (VOW/QFT/QAW) and 2) the European Working Condition Survey (EWCS). Some study questions were tested using the (VOW/QFT/QAW), which is a survey, conducted in Belgium in 2007, 2009 and 2011 by l'Association Professionnelle Belge des Médecins du Travail (APBMT). The VOW collects information about how workers perceive the balance between personal characteristics and job requirements. The "VOW/QFT/QAW" was used in this study to investigate the following aim: Are Belgian non-standard workers at a higher risk of having work accidents and injuries compared to standard workers or not?

The second data source was based on data of the fifth European Working Conditions Survey (EWCS), carried out by Eurofound from January to June 2010 among 34 countries. It was used to investigate our second and third aims: What is the relationship between non-standard work arrangements indicators such as non-standard work, over time work, multiple jobs and shift work and work-related accident absence in Belgium? And what is the relationship between non-standard work arrangements indicators and injuries in Europe 27?

Given the enormous costs and time investment associated with the collection of epidemiological data, there is a strong emphasis on increasing value of existing European and national cohorts to explore existing data further. Since it was not necessary to collect new data to answer the research questions of our study on work accidents and injuries, we used the freely accessible data from Belgium and Europe.

In this chapter, more information is given about these two datasets. For each study, the study population is first described. Second, an overview is given about the most important variables, which were used in this thesis.

3.2 The Belgian surveys on work ability (VOW/QFT/QAW)

The Federal Public Service Employment, Labour and Social Dialogue conducted a series of studies aiming to elaborate the concept of "work ability" in Belgium. A survey referred to as VOW/QFT/QAW (Vragenlijst Over Werkbaarheid/Questionnaire sur les Facultés de Travail/Questionnaire About Workability; acronym in Dutch, French and English

respectively) was developed. The VOW collects information about how workers perceive the balance between personal characteristics and job requirements.

In 2007 a first survey took place, followed by a second one in 2009 and another one in 2011.

The VOW questionnaire includes six modules: Module 1 measures job demands and psychosocial resources of the worker (29 questions); Module 2 assesses occupational physical requirements (10 questions); Module 3 measures work accidents and safety climate (9 questions); Module 4 includes questions about health status (19); Module 5 measures the perceived skills and the capacity (13 questions); and Model 6 inquires short and long-term job plans (7 questions) [197]. A new question about stress at work was added in the 2011 edition of this survey.

3.2.1 Study design and study population

In Belgium, occupational health care is compulsory. All contract workers (3.7 million), who are exposed to chemical, biological, or physical hazards, benefit from comprehensive occupational health care provided by occupational health services. About half of the Belgian workforce (2 million) undergoes an annual health examination and approximately 750,000 workers complete a health assessment every three to five years.

In 2009 and 2011, the Federal Public Service Employment, Labour and Social Dialogue commissioned occupational physicians who were members of the Belgian Professional Association of Occupational Physicians (APBMT) to conduct a study on work ability. Using a cross-sectional design, they recruited at both occasions a convenience sample of workers undergoing their annual medical examinations to complete a voluntary questionnaire on work ability (VOW). A total of 1886 individuals completed the questionnaires. All participants provided informed consent.

3.2.2 Measurements

3.2.2.1 Questionnaire Data

Dependent variable

Work accident was evaluated by the question: “During the past year, have you been involved in a work accident?” Workers responding “yes” were considered injured.

Socio-demographic variables

Measured socio-demographic variables were: age, sex and education level. Education was divided into three categories: low educational attainment (≤ 9 years of education); moderate educational attainment (12 years of education); and high educational attainment (> 12 years of education). Self-rated health was measured using the question “How would you rate your health in general the past two weeks?” Response categories were bad, fair, good, very good and excellent. This variable was dichotomized (good/very good and fair/bad/very bad). Work ability was assessed with the question: “To what extent do you agree with the following statement? I am well prepared to face the requirements imposed by my job.” Response categories included: strongly disagree, do not agree, partly agree, agree, and strongly agree. Those responding “strongly not agree and not at all agree” were categorized as “not agree”; those responding “partly agree, rather agree and strongly agree” were categorized as “agree.”

Work- related factors and work accidents victims

Contract type was determined from the question “What type of contract do you have?” Response categories were: statutory (civil servant), permanent contract, fixed-term contract, temporary contract, self-employee (someone performing a professional activity but who is not an employee or civil servant), and other. Workers with statutory and indefinite contracts were classified as standard workers and those with fixed-term, temporary, other, or self-employed contracts were classified as non-standard workers.

Occupation type was determined from the question: “Which description best fits your occupation?” Response categories included: blue-collar, white-collar and mixed occupation. A blue-collar worker primarily carries out manual work, whereas a white-collar worker carries out intellectual work.

Work time was assessed by this question: “What is your work time?” There were four possible responses categories as: full time, between full time and part time, half time and less than a half. Participants were classified as “full-time” workers if their answer on work time was full-time or between full-time and half-time; and they were classified as working “half-

time" if their answer was working half-time or less than half time. "full-time" workers work between 36 and 40 hours on average (as a result of the Belgian working time regulations, which are far stricter than the EU Directive in this regard) [198].

Work experience was based on number of years employed. Participants were classified as having "less experience" if they had worked less than two years or having "more experience" if they had worked two or more years. This cut-off was based on Belgian legislation concerning temporary work, which states if you work for one employer, temporary work is allowed to be repeated for a maximum period of two years, if the contract period is three months. If contracts are six months in length, then the contract can be repeated for a maximum of three years [199].

Job sector categorization was based on the instruction: "Select the job type in which you work" Answers were divided into: 1) the service sector comprising the wholesale and retail, hotel/restaurant/cafe, garage, teaching, transport, public transport company, post and telecommunications, banks and insurance, health and well-being, business services (cleaning, consultancy), public administration and other services; 2) the industrial sector consisting of production of textiles, clothing, metallurgy, construction, food industry, chemistry, wood and paper, gas, water, electricity, printing, publishing and other industry, and 3) the agriculture sector including agriculture / horticulture and forestry / fishing.

Work hours were divided into "long" (48+ hours/week) versus "normal" (47 or fewer hours/week) based on the European Working Time Directive[32].

Job insecurity was measured with the item: "I think that I am going to lose my job in the future". Response categories were never, sometimes, often and always. The variable was dichotomized into "no": never versus "yes": sometimes, often and always.

Safety climate was measured by asking (1) did you receive a good training concerning health and safety and (2) did you receive good personnel protective equipment? Workers who responded "yes" to these questions were categorized as having a good health and safety training and good personnel protective equipment in contrast to workers who responded "no".

Job exposure

Job exposure to hazardous situations or conditions included vibration, noise, extreme temperatures, chemical substances, dangerous conditions, physically demanding tasks,

uncomfortable or tiring positions, and repetitive tasks. All work-related exposures were assessed on a four-point response scale (never, sometimes, often and always) and responses were dichotomized ("no" versus "yes": never and sometimes; often and always). Socio-demographic and work- related factors were summarized in table 1. It is worth mentioning that the categories for the aforementioned variables were chosen based on previous research.

Table 1.Socio-demographic and work-related factors variables from the VOW database.

Measurements: VOW Database		
Dependent variable	**Socio-demographic variables**	**Work-related factors and work accidents victims**
Work accident victim	Age	Contract type
	Sex	Occupation type
	Education level	Work time
	Self-rated health	Work experience
	Work ability	Job sector
		Work hours
		Job insecurity
		Safety –climate
		Safety knowledge
		Personal protective equipments
		Job exposure: Vibration, Noise, Extreme temperatures, Chemical substances, Dangerous conditions, Physically demanding tasks, Uncomfortable or tiring positions, and Repetitive tasks.

3.3 European Working Condition Survey (EWCS)

Eurofound organizes the European Working Conditions Survey (EWCS) to study working conditions in Europe every five years. The (EWCS) addresses employees and self-employed workers about their work and employment. The topics of this survey prolonged over time. The first wave was conducted in 1990/1991 in the EU12. The second one was in 1995/1996 in the EU15. The third survey took place in 2000 in the EU15 and another country as Norway; in 2001 this survey was extended to cover EU27 and Turkey. The fourth wave of this survey was in 2005 which covered EU27, plus Turkey, Croatia, Norway, and Switzerland. The fifth edition was conducted from January to June 2010, with almost 44,000 workers interviewed in the EU27, plus another seven countries as: Kosovo, Turkey, Croatia, Albania, the Former Yugoslav Republic of Macedonia, Montenegro and Norway. The last edition was in 2015 and was conducted in the EU28, Norway, Switzerland, Albania, the Former Yugoslav Republic of Macedonia, Montenegro, Serbia and Turkey. In each wave a random sample of workers (employees and self-employed) has been interviewed face to face. Topics covered by this survey include work organisation, physical and psychosocial risk factors, working time duration and organisation, employment status, health and safety, work-life balance, learning and training and earnings and financial security.

The domain of the survey questionnaire has expanded strongly since the first edition, aiming to supply a global image of the everyday actuality of men and women at work.

The European Working Conditions Survey has provided an overview of working conditions in Europe, since its launch in 1990 in order to (a) estimate working conditions of both the self employed and employees across Europe on a harmonised foundation; (b) to distinguish groups at risk and issues of concern and progress; and (c) to analyse relationships between different aspects of working conditions.

The targets of these series of (EWCS) surveys are testing the relationships between different working conditions aspects in order to achieve intelligent strategy in 2020 to improve European working conditions in particular the firm’s performance, worker’s employment and work quality [56, 57, 60].

3.3.1 Study design and population

The study was based on data of the fifth European Working Conditions Survey (EWCS), carried out by Eurofound from January to June 2010 among 34 countries: EU27, Kosovo, Turkey, Croatia, Albania, the Former Yugoslav Republic of Macedonia, Montenegro and Norway. This periodical survey is considered as a main source of comparable data and uses face-to face questionnaires at the participants' own home to gather information on working and employment conditions. A total of 43816 workers from 34 European countries were interviewed giving an overall response rate of 44%. Among these responders, 4001 Belgian workers were selected. Details on sampling design, methods and questionnaire are available elsewhere [57]. For the purpose of this analysis, persons who were not employed, or were self-employed or with an apprenticeship were excluded and the analytical sample was restricted to a subgroup of 3343 employees from Belgium.

Likewise for Europe only employed workers were included in the analysis and the analytical sample was restricted to a subgroup of 26839 employees in the 27 countries from the European Union.

3.3.2 Measurements

3.3.2.1 Questionnaire Data

Dependent variable: occurrence of work-related accident absence (Belgium)

The outcome variable was evaluated by the following question on the EWCS "Over the past 12 months, of the days of absence, can you indicate how many days were attributable to an accident or accidents at work?" Those responding zero days were considered as having no work accident, and those responding more than one day of absence were considered as having a work accident which resulted in an injury.

Dependent variable: occurrence of injury (Europe)

The outcome variable was evaluated by the following question "Over the past 12 months, did you suffer from an injury?" There were two answer categories: "yes" and "no".

Independent variable: indicators of non-standard work arrangements (Belgium and Europe)

Four independent variables were first separately and then simultaneously examined in relation with occupational injuries.

The variable "contract type" was based on the answer on the question "What kind of employment contract do you have"? Workers with a fixed term contract or temporary employment agency contract were defined as having a precarious contract and compared to those with a permanent contract.

Long working hours were defined as working 48 hours/week and more [200].

The variable "multiple jobs" was assessed by one question: "Besides your main paid job, do you have any other paid job(s)?" There were four possible response categories: "no other paid job," "regular," "occasional," "other." Those who reported that they have regular, occasional and other paid jobs were categorized as category "yes" and those with no other paid job as "no".

Shift work was measured using the question "Do you have shifts?"with the response options "yes" and" no".

Covariates

Based on previous research, several covariates were taken into account in the multivariate analysis in order to control for potential confounding between precarious work, long working hours, multiple jobs, shift work and the dependent variable. Considered covariates are gender, age in years, self-rated health, educational background, work experience, company size, economic activity, overall fatigue, sleep difficulties, risk information, physical (PH), chemical (CH), biological (BL) and biomechanical (BM) exposure, stress, Sunday work, and work-life balance.

Self-rated health was assessed with the question "How is your health in general?" with the response options very good, good, fair, bad and very bad. This variable was treated as a dichotomous variable: "good" (very good and good) versus "bad" (fair, bad and very bad).

The participants were also asked about the highest level of education or training that they have successfully completed. The results were divided into 4 categories: (1) workers who had

no education or completed primary school, (2) workers who completed lower or (3) upper secondary school and (4) workers who additionally completed tertiary education.

Work experience included number of working years, evaluated by the question: “How many years have you been in your company or organization?”

The data included a question regarding company size: “How many people in total work at your workplace?” Responses were categorized as “small”: work alone, 2-4, 5-9; “medium”: 10- 49, 50- 99; “large”: 100- 249, 250- 499 and “very large”: 500 and over.

Economic activity of the company is coded according to the Statistical Classification of Economic Activities in the European Community, abbreviated as NACE: (1) construction (2) mining, quarrying, manufacturing, electricity, gas, and water supply (3) agriculture, hunting, forestry and fishing and (4) services.

Overall fatigue was measured using the question “Over the past 12 months, did you suffer from overall fatigue?” with the response options “yes” and “no”. Sleep difficulties were assessed with the question “Over the past 12 months, did you suffer from insomnia or general sleep difficulties?” This variable was also treated as a dichotomous variable with the response options “yes” and “no”.

Risk information variable was evaluated by the question “Regarding the health and safety risks related to the performance of your job, how well informed would you say you are?” Those responding “well informed and very well informed” were categorized as “well informed”; those responding “not very well informed and not at all well informed” were categorized as “not well informed”.

Finally, job exposure variable included four kinds of exposure [200]: (1)Physical exposure defined by exposure at work to the followings: (a) noise so loud that you would have to raise your voice to talk to people (b) high temperatures which make you perspire even when not working (c) low temperatures whether indoors or outdoors. (2)Biomechanical exposure: Exposed at work to: (d) vibrations from hand tools, machinery, etc (e) tiring or painful positions (f) lifting or moving people (g) carrying or moving heavy loads (h) repetitive hand or arm movements. (3)Biological exposure: Exposed at work to: (i) handling or being in direct contact with materials which can be infectious, such as waste, bodily fluids, laboratory materials, etc. (4) Chemical exposure consisted of (j) breathing in smoke, fumes (such as welding or exhaust fumes), powder or dust (such as wood dust or mineral dust) etc. (k) Breathing in vapours such as solvents and thinners. (l) Handling or being in skin contact with

chemical products or substances and tobacco smoke from other people. We introduced binary variables expressing the physical (PH), chemical (CH), biological (BL), and biomechanical (BM) exposure. The answers are dichotomized at the median of (PH), (CH), (BL), and (BM).

Stress at work was evaluated by the question “Do you experience stress in your work?” Those responding “always, most of the time and sometimes” were categorized as “yes”, having stress; those responding “rarely and never” were categorized as “having no stress”.

The answer to the question “How many times a month do you work on a Sunday?” was used to estimate Sunday work and dichotomized into “no work on Sundays” and “at least 1 Sunday per month”. Finally, subjects were asked how well their working hours fitted with their family or social commitments on a 4-point scale. For the analysis, we created a binary indicator work-life balance, where “good” was assumed if participants either reported ”very well” or “well” and “bad” if they answered “not very well” or “not at all well” (tables 2 and 3).

Table 2. Dependent, independent and covariates variables from the EWCS database for Belgium.

Measurements: EWCS Database Belgium		
Dependent variable	**Independent variable**	**Covariates**
Occurrence of work-related accident absence	Indicators of non- standard work arrangements	
	Contract type	Gender
	Long working hours	Age in years
	Multiple jobs	Self-rated health
	Shift work	Educational background
		Work experience
		Company size
		Economic activity
		Overall fatigue
		Sleep difficulties
		Risk information
		job exposure variable
		Physical (PH)
		Chemical (CH)
		Biological (BL)
		Biomechanical (BM) exposure

Table 3. Dependent, independent and covariates variables from the EWCS database for Europe 27.

Measurements: EWCS Database Europe		
Dependent variable	**Independent variable**	**Covariates**
Occurrence of injury	Indicators of non- standard work arrangements	
	Contract type	Gender
	Long working hours	Age in years
	Multiple jobs	Work experience
	Shift work	Educational background
		Company size
		Economic activity
		Self-rated health
		Stress
		Overall fatigue
		Sleep difficulties
		Sunday work
		Work-life balance

3.4 Statistical analysis

To investigate the study questions, two different statistical analysis techniques were used in this thesis namely 1) the Chi-square technique and 2) the multiple logistic regression analysis.

The statistical tools used to carry out our analysis are chosen to agree with the type of the research question being asked. A few fundamental considerations lead us to select the appropriate statistical test for hypothesis testing.

Statistical tools used: chi^2-test and the logistic regression analysis.

Why chi^2-test?

We used the chi-square test to determine whether the row criterium and the column criterium are independent based on a contingency table containing measured frequencies for the different groups.

Assumptions of chi^2-test:

The Chi-square test is a non-parametric (distribution free) which makes it robust with respect to the distribution of the data. Specifically, it does not require equality of variances among the study groups or homoscedasticity in the data.

a) The levels (or categories) of the variables are mutually exclusive. That is, a particular subject fits into one and only one level of each of the variables.

b) The value of the expected values for the cells in the contingency table should be 5 or more in at least 80% of the cells, and no cell should have an expected of less than one.

c) The observations are always assumed to be independent of each other. This means chi-squared cannot be used to test correlated data.

d) A sample with a sufficiently large size is assumed.

Why logistic regression?

Logistic regression analysis examines the influence of various factors on a dichotomous outcome by estimating the probability of the event's occurrence. It does this by examining the relationship between one or more independent variables and the log odds of the

dichotomous outcome by calculating changes in the log odds of the dependent as opposed to the dependent variable itself.

The log odds ratio is the ratio of two odds and it is a summary measure of the relationship between two variables. The use of the log odds ratio in logistic regression provides a more simplistic description of the probabilistic relationship of the variables and the outcome in comparison to a linear regression by which linear relationships can be drawn.

Logistic regression estimates the probability that a characteristic is present (e.g. estimate probability of "success") given the values of explanatory variables. There are two models of logistic regression to include binomial/binary logistic regression and multinomial logistic regression. Binary logistic regression is the best choice in our case as the dependent variable is dichotomous and the independent variables are either continuous or categorical variables.

Binary logistic regression analysis was used in this thesis because our output variable (dependent variable) is a binary variable. It is used to predict the odds of being a case based on the values of the independent variables (predictors). Since logistic regression assumes that P(Y=1) is the probability of the event occurring, it is necessary that the dependent variable is coded accordingly. That is, for a binary regression, the factor level 1 of the dependent variable should represent the desired outcome.

The output variable (occupational accident victim or work-related accident absence) were pulled to the dependent variable window in the SPSS program, while all the occupational accidents and absence risk factors were pulled to the covariates window. Reference category of each covariate was defined in the categorical covariates window to be the categories that had the lower risk of work accidents. Information about which category has the less or the higher probability of work-related accidents was found based on previous research. For example, gender has two categories as (men, women), previous studies concluded that women had less accident at work than men. So, in our analysis, women category from the gender variable was adjusted to be the reference category. Reference categories for the rest covariates were found in similar way and defined here using the first and last buttons in this window.

The enter-method with binary regression was used; it is the default method and generally accepted to introduce predictors. Other methods are stepwise variable selection methods and make considerations on the best subset of variables explaining the dependent variable. They

are less suited for our objectives as we determined in advance the variables we are interested in to include in our models.

More crucial to the interpretation of logistic regression is the value of the odds ratio (Exp (*B*)) in the SPSS output) which is an indicator of the change in odds resulting from a unit change in the predictor. As such, it is similar to the b coefficient in logistic regression but easier to understand (because it doesn't require a logarithmic transformation). The odds of an event occurring are defined as the probability of an event occurring divided by the probability of that event not occurring. For example, the odds of becoming work accidents victim are the probability of having a work accidents divided by the probability of not being involved in work accident.

Odds = *P* (event) / *P* (no event)

P (event Y) = $\frac{1}{1+ e^{-(b0+b1x1)}}$

P (no event Y)= 1- *P* (event Y)

So, the odds are defined as the probability that a particular outcome is a case divided by the probability that it is a non-case. It is a measure of association between an exposure (independent variable) and the outcome. If odds ratio =1, it means that the exposure does not affect odds of the outcome of interest.

This proportionate change in odds is the odds ratio, and we can interpret it in terms of the change in odds: if the value is greater than 1 then it indicates that as the predictor increases, the odds of the outcome occurring increase. Conversely, a value less than 1 indicates that as the predictor increases, the odds of the outcome occurring decrease.

The p-value is often used in hypothesis tests where you either reject or fail to reject a null hypothesis. When you do a hypothesis test, the key piece of output to concentrate on is the p-value. A P-value ranges from 0 to 1. It is the probability that measures the evidence against the null hypothesis. In the majority of analysis, an alpha of 0.05 is used as the cutoff for significance. If the p-value is less than 0.05, we reject the null hypothesis that there is no difference between the means and conclude that a significant difference does exist.

P > 0.05 (ns: not significant); P ≤ 0.05 (*); P ≤ 0.01 (**); P ≤ 0.001 (***).

3.4.1 Statistical analysis on the VOW database

Descriptive statistics were computed for all variables, including frequencies and proportions for categorical variables and the mean and standard deviation for continuous variables. Chi-square tests were conducted to explore whether potential risk factors were univariately associated with work accidents. This one-sided test judges about the null hypothesis of independency between two variables. A multiple logistic regression analysis investigated whether socio-demographic variables, work-related factors, and job exposures predicted the odds of self-reported occupational injury. It is also used to predict a binary categorical response from one or more predictor variables [201, 202].

First, socio-demographic items (age, gender, education, self-rated health and work ability) were entered as independent variables with injury status as the outcome. Work-related factors such as occupation type, work time, total work experience, sector of activity, working hours, job insecurity, safety knowledge, availability of personal protective equipment were entered in a second model. In the final model, job exposures were entered. In all analyses, adjustments were made for confounding variables, regardless of their univariate associations with the outcome. This was to prevent potentially important variables being rejected. All variables were entered in a single step. Data were processed and analyzed using SPSS version 21.0. All models were evaluated at 95% significance level ($p < 0.05$).

In the logistic regression analyses, the following dichotomous categories were created for the variables: 1) contract type (temporary versus permanent), 2) age groups (younger than 40 years versus older than 40 years), 3) gender (men versus women), 4) work experience ($\leq$ 2 years versus $>$ 2 years), 5) work time (full-time versus half-time), 6) occupation type (blue-collar versus mixed and white-collar), 7) education level (low versus high and medium), 8) self- rated health (bad versus good), 9) good work ability (not agree versus agree), 10) sector (industry and agriculture versus services), 11) working hours (long versus normal), 12) job insecurity (yes versus no), 13) safety knowledge (no versus yes), 14) availability of personal protective equipment (no versus yes), 15) job exposures (yes versus no).

3.4.2 Statistical analysis on the EWCS database for Belgium

This study used data collected from the fifth European Working Conditions Survey. First, descriptive statistics were computed for all variables, and Chi square tests were carried out to explore whether potential risk factors (independent variables and covariates) were

univariately associated with the dependent variable, i.e. work-related accident absence. Finally, in order to investigate the relation of non-standard work arrangements with work-related accident absence, multiple logistic regression modeling techniques were applied. A series of multivariate binary regression models were computed in two steps. First, 4 separate models (one for each work arrangement indicator) were fitted: (1) crude models were computed. (2), socio-demographic items (age (continuous), gender, self-rated health and education) were entered as independent variables with work-related accident absence as the outcome. (3)Work-related factors such as work experience (continuous), company size, economic activity, overall fatigue, sleep difficulties, risk information, physical exposure (PH), chemical exposure (CH), biological exposure (BL) and biomechanical exposure (BM) were entered in a third model. Second, all irregular work arrangements indicators were included simultaneously into a multivariate regression model. In all analyses, adjustments were made for confounding variables, regardless of their univariate associations with the outcome. This was to prevent potentially important variables being rejected. Models were screened for multicollinearity between the independent variables according to the calculation of Variance of Inflation Factors, which revealed no problems. The data were processed and analysed using SPSS version 21. All models were evaluated at 0.05 significance level.

3.4.3 Statistical analysis on the EWCS database for Europe

This study used data collected from the fifth European Working Conditions Survey. First, descriptive statistics were computed for all variables, and Chi square tests were carried out to explore whether potential risk factors (independent variables and covariates) were univariately associated with the dependent variable, i.e. occupational injury. Finally, in order to investigate the relation of non-standard work arrangements with occupational injury, multilevel modeling techniques were applied, which enables variance in the outcome to be analyzed at different levels of aggregation. In this study, two levels were considered: individuals (level 1) nested within countries (level 2). A series of 2-level binary regression models were computed in two steps. First, 4 separate models (one for each work arrangement indicator) were fitted. Second, all irregular work arrangements indicators were included simultaneously into a multivariate regression model. Since preliminary analyses showed no significant interaction effects between gender and the separate non-standard work arrangement indicators, the analyses were not stratified for gender. All models were adjusted for the aforementioned covariates.

To assess how much of the variance in the occupational injuries can be explained by difference between countries, Variance of Partition Coefficients (VPC) were calculated. Models were screened for multicollinearity between the independent variables according to the calculation of Variance of Inflation Factors, which revealed no problems. The data were processed and analysed using SPSS version 21. All models were evaluated at 0.05 significance level.

3.4.4 Power of the test

The power is the probability that the test will correctly reject the null hypothesis [203]. We can find a calculation tool for the power of a chi^2-test on:

https://www.anzmtg.org/stats/PowerCalculator/PowerChiSquare

That I can use to find the power for my analysis. If we look at the chi^2-test as it is used on chapter 4 (n = sample size = 1886), there are 2 types:

* 3 levels horizontally + 2 levels vertically e.g. education level + injured

Here the degrees of freedom = (3-1) * (2-1) = 2

* 2 levels horizontally + 2 levels vertically e.g. gender + injured

Here the degrees of freedom = (2-1) * (2-1) =1

The power = 1- beta is equal to 1 (which is the best we can get) in all cases where the effect size is medium or large. When we want to detect a small effect (i.e. effect size=0.1) we get power =1-beta = 0.9914 when degrees of freedom =1 and power =1-beta = 0.9798 when degrees of freedom = 2. That are very good results and can be explained by the large sample size of n = 1886. For all calculations alpha was set to 0.05.

If n is even larger (n= 3343) the power will even grow. When we do the calculations, we find power = 0.9999 with an effect size = 0.1. I would report the positive results in case of the lowest n, i.e. n=1886. The results are already very good in this case, and will only become better when n is larger, i.e. n=3343.

3.5 Concluding remarks

This chapter presented two sources of data which were used in this thesis as VOW/QFT/QAW conducted by the APBMT and the fifth European Working Condition Survey (EWCS).

The first data source "VOW/QFT/QAW" was used to investigate whether Belgian non-standard workers at a higher risk of having work accidents and injuries compared to standard workers or not. The second data source was based on data of the fifth European Working Conditions Survey (EWCS). This database was used to investigate the relationship between non-standard work arrangements indicators and work-related accident absence and injuries in Belgium and Europe.

In addition, in depth description of how the covariates were categorised in the analysis were presented in this chapter. These covariates were used in the multivariate analysis in order to control for potential confounding between non-standard work arrangements and the dependent variable (work accidents and occupational injures). They were chosen based on previous research which identified the possible risk factors of work accidents and injuries. Finally, the two statistical techniques such as the Chi-square test and the multiple regression analysis models which were used in this work to investigate our targets were explained in details as well.

Chapter 4

Results and discussion

4.1 Overview

Our literature review concluded that non-standard work arrangements are related to a higher rate of occupational accidents and injuries. However, this relationship has rarely been explored in a large harmonized sample of the Belgian working population. Our aim is to extend the existing literature on work accidents with Belgian and European data. Firstly, we hypothesize that the risk of having a work accident is higher among non-standard workers compared to standard workers. This study also explores the extent to which demographic and work related factors predict work accidents. To investigate this aim, the VOW database was used. Secondly, we aimed at examining the associations between contract type, long working hours, multiple jobs, shift work and work- related accident, taking into account several demographic and work-related confounding factors in a large dataset of Belgian employees using the EWCS database. Thirdly, the relationship between non-standard work arrangements indicators and injuries in Europe 27 was investigated using the fifth EWCS as well.

This chapter presents the results that we generated from the two data sets to investigate our study aims. So, for each study, the descriptive results and the univariate associations between workers' characteristics, work accident victims and absence will be explained in details. Secondly, the multivariate logistic regression results will be presented as well. Then, the discussion and interpretations of the results from the two databases will be deliberated in details and finally strengths and limitations of the data and our study approach will be given.

4.2 Research findings from the VOW data

Using the VOW database we aimed at exploring if Belgian non-standard workers are more injured at work than standard ones, and at identifying other relevant risk factors of work accidents. An overview of our results is presented below.

4.2.1 Descriptive results from the VOW database

A total of 1886 workers were included in the analyses including 1055 men (55.9%) and 831 women (44.1%) (Table 4). Average age was 39.8 years (± 11.0 SD) and 26.4% had a low educational attainment. The majority (86.7%) worked full-time and had normal working hours (94.2 %). A total of 87.5% of the respondents were permanently employed, whereas 12.5% (n

= 227) worked with a temporary contract. Of the whole sample, 8.7% (n = 159) reported being injured at work during the last year.

More than two-thirds of the workers (79.9%) reported their health as being either (very) good or excellent and they experienced no job insecurity (72.5%). Mean total seniority was 18.5 years (± 11.6 SD) and more than half of the subjects were working in the service sectors (58.0%). The most frequently reported job exposures were uncomfortable or tiring positions (66.3%), exposure to noise (59.7%) or physically demanding tasks (58.9%), and exposure to extreme temperature (53.3%).

Our results showed no significant interaction between each indicator of non-standard work arrangement separately with the gender. Also interactions with self-rated health variable were checked as well for the four indicators separately and still we did not find any significant interaction for the four indicators.

Table 4. Descriptive of the study population.

Variable	**Total study sample (n =1886)**	**Variable**	**Total study sample (n =1886)**
Socio- demographic factors		**Job insecurity: n** (%)[a]	
Gender: *n* (%)[a] n = (1886)		n= (1759)	
Male	1055 (55.9)	No	1276 (72.5)
Female	831 (44.1)	Yes	483 (27.5)
Mean age: year (SD)	39 (11.0)	**Safety-climate**	
Education level: n (%)[a] n = (1867)		**Safety knowledge: n** (%)[a] n= (1786)	
Low	493 (26.4)	No	492 (27.5)
Medium	638 (34.2)	Yes	1294 (72.5)
High	736 (39.4)	**Personal protective equipments: n** (%)[a]	

		n= (1747)	
Self- rated health: n (%)[a] n =(1855)		No	354 (20.3)
Bad	372 (20.1)	Yes	1393 (79.7)
good	1483 (79.9)	**Job exposure**	
Good work ability: n (%)[a] n =(1807)		**Vibration: n** (%)[a] n= (1833)	
Not agree	91 (5.0)	No	1059 (57.8)
Agree	1716 (95.0)	Yes	774 (42.2)
Work-related factors and work accidents victims		**Noise: n** (%)[a] n= (1842)	
Injured: n (%)[a] n = (1818)		No	742 (40.3)
No	1659 (91.3)	Yes	1100 (59.7)
Yes	159 (8.7)	**Extreme temperature: n** (%)[a] n= (1840)	
Contract: n (%)[a] n =(1814)		No	860 (46.7)
Permanent	1587 (87.5)	Yes	980 (53.3)
Temporary	227 (12.5)	**Chemical** substances**: n** (%)[a] n= (1845)	
Occupation type: n (%)[a] n = (1867)		No	1134 (61.5)
Blue-collar	700 (37.5)	Yes	711 (38.5)
Mixed occupation	635 (34.0)	**Dangerous conditions: n** (%)[a] n= (1827)	

White-collar	532 (28.5)	No	932 (51.0)
Work time: n (%)[a] n =(1832)		Yes	895 (49.0)
Full-time	1588 (86.7)	**Physically demanding tasks: n** (%)[a] n= (1854)	
Half- time	244 (13.3)	No	762 (41.1)
Total work experience: n (%)[a] n= (1849)		Yes	1092 (58.9)
Experience ≤ 2 year	126 (6.8)	**Uncomfortable or tiring positions: n** (%)[a] n= (1841)	
Experience > 2 year	1723 (93.2)	No	621 (33.7)
Sector: n (%)[a] n= (1811)		Yes	1220 (66.3)
Industry and agriculture	760 (42.0)	**Repetitive tasks**: **n** (%)[a] n= (1845)	
Service	1051 (58.0)	No	606 (32.8)
Working hours: n (%)[a] n= (1825)		Yes	1239 (67.2)
Long	106 (5.8)		
Normal	1719 (94.2)		

[a]Calculated according to the percentage of the valid count

4.2.2 Univariate associations between workers' characteristics and work accident victims

Table 5 shows that, univariate associations were observed between education level and injuries. Low educated workers were more injured at work than high educated workers and the difference was statistically significant. A univariate association was observed between self-rated health and injuries. Concerning the relation between occupation type and occupational injuries, the univariate association showed that blue-collar workers and mixed jobs had more accidents than white-collar workers. Further, the proportion with the occupational injuries was higher in the group of workers who have less work experience versus the workers having enough experience during their work. Industry and agriculture workers were more injured than those doing service work. Workers having job insecurity were more injured than those without job insecurity problem. Those exposed to vibration, noise, extreme temperature, chemical substances, dangerous conditions, those doing physically demanding tasks and uncomfortable or tiring positions and repetitive tasks were more injured than their counterparts. In contrast, no statistical significant differences were found between men and women and also between young and old workers in terms of being injured at work. Good work ability variable was not significant. Furthermore, no statistical significant differences were found between temporary and permanent workers in terms of being work accidents victims. Finally, no statistical significant differences were observed for other variables such as work time, working hours, safety knowledge and personal protective equipments.

Table 5. Univariate associations between worker's characteristics and work accident victims (n =1886).

Variables	Where you injured at work?		
	Yes	**Yes**	**x^2 (P value)**
	n	**%**	
Socio- demographic factors			
Gender			1.24 (0.265)
Men	95	9.39	
Women	63	7.90	
Age group			0.50 (0.478)
≤ 40 year	82	9.18	
> 40 year	71	8.22	
Education level			18.01 (< 0.001)***
Low	59	12.82	
Medium	57	9.29	
High	41	5.71	
Self- rated health			4.95 (0.026)*
Bad	42	11.73	
good	115	8.01	
Good work ability			2.10 (0.14)
Not agree	11	12.94	
Agree	140	8.40	

Work-related factors			
Contract type			0.26 (0.605)
Permanent	137	8.97	
Temporary	17	7.90	
Occupation type			28.98 (< 0.001)***
Blue-collar	68	10.31	
Mixed occupation	70	11.45	
White-collar	16	3.07	
Work time			0.13 (0.718)
Full-time	134	8.79	
Half-time	19	8.08	
Total work experience			7.59 (0.006)**
≤ 2 year	19	15.32	
> 2 year	134	8.12	
Sector			11.44 (0.001)**
Industry and agriculture	81	11.17	
Service	67	6.58	
Working hours			0.55 (0.45)
Long	7	6.73	
Normal	146	8.85	
Job insecurity			4.93 (0.02)*

No	97	7.86	
Yes	52	11.30	
Safety-climate			
Safety knowledge			0.03 (0.85)
Yes	109	8.65	
No	42	8.93	
Personal protective equipments			0.51 (0.47)
Yes	125	9.23	
No	27	7.98	
Job exposure			
Vibration			14.73 (< 0.001)***
Yes	86	11.55	
no	66	6.39	
Noise			15.08 (< 0.001)***
Yes	113	10.63	
No	39	5.40	
Extreme temperature			15.85 (< 0.001)***
Yes	104	11.01	
No	48	5.73	
Chemical substances			7.99 (0.005)**

Yes	75	10.93	
No	78	7.08	
Dangerous conditions			34.67 (< 0.001)***
Yes	108	12.54	
No	43	4.72	
Physically demanding tasks			31.18 (< 0.001)***
Yes	124	11.80	
No	32	4.28	
Uncomfortable or tiring positions			34.24 (< 0.001)***
Yes	136	11.55	
No	20	3.29	
Repetitive tasks			25.76 (< 0.001)***
Yes	132	11.05	
No	23	3.87	

P value < 0.05 (*), P value <0.01 (**), P value < 0.001 (***)

4.2.3 Multivariate logistic regression results

In the first model (table 6), which consisted of the socio-demographic items, education was the only variable significantly associated with injury (OR 2.71, 95% confidence interval 1.70 – 4.31). However, the Model as a whole significantly predicted the odds of self-reported injury (Model 1: x^2= 24.16, p= 0.001). In the second Model (table 7), which included the addition of work-related variables (except job exposure), education and total work experience were significantly associated with injury (OR 1.97, 95% confidence interval 1.08 – 3.60) and (OR 2.49, 95% confidence interval 1.33 – 4.65), respectively. And the Model as a whole showed that the logistic regression model was significant (Model 2: x^2= 48.44, p < 0.001). In the third Model (table 8) which adjusted, in addition, for work-related factors and the total number of job exposures. Approximately 16.6% of the workers reported to be exposed to eight hazardous job conditions while only 11.2% reported not to be exposed to any bad job exposures. About 21.6% of the workers reported exposure to 6 or 7 hazardous working conditions, and 19% were exposed to 4-5 conditions. Therefore, we conducted also an analysis where a summative measure of total job exposures was added (continuous 0 -8) together with the other confounders. Education level and total work experience remained positively associated with injury (OR 1.92, 95% confidence interval 1.04 – 3.54), (OR 2.76, 95% confidence interval 1.46- 5.23), respectively. In addition, the total number of job exposures was positively associated with injury (OR 1.13, 95% confidence interval 1.008 - 1.27). The Model as a whole significantly predicted the odds of injury (Model 3: x^2= 56.21, p= > 0.001).

The 95 % was the widely used in previous research that is why I have used this confidence interval in accordance with previous research. So, 95% is a commonly accepted and popular reference value for the confidence. This can also be found on: https://www.medcalc.org/manual/referenceinterval.php

It is inspired by the fact that approximately 95% of the sample values out of a normal distribution can be found within [sample mean - 2* sample standard deviation, sample mean + 2* sample standard deviation].

Table 6. Odds ratios OR and 95% confidence intervals [95% CI] for occupational injury risk factors from multivariate logistic regression model with permanent contract as reference group.

Variables	Work accident victims
Model 1	**Adjusted OR [95%CI]**
Contract type	0.82 [0.47- 1.42]
Temporary Vs. permanent [c]	
Gender	1.03 [0.72- 1.49]
Men Vs. Women [c]	
Age group	1.34 [0.93- 1.92]
≤ 40 Vs. > 40 [c]	
Education	2.71 [1.70- 4.31]*
Low Vs. medium and high [c]	
Self- rated health	1.36 [0.90- 2.06]
Bad Vs. good [c]	
Good work ability	1.22 [0.58- 2.55]
Not agree Vs. agree	

[c] Reference category

The proportion of the explained variance of the multivariate model is 3.3 % R^2 = 0.033 (Nagelkerke R Square) for work injury.

Table 7. Odds ratios OR and 95% confidence intervals [95% CI] for occupational injury risk factors from multivariate logistic regression model with permanent contract as reference group.

Variables	Work accident victims
Model 2[b]	**Adjusted OR [95%CI]**
Contract type	0.56 [0.28- 1.12]
Temporary Vs. permanent [c]	
Gender	0.79 [0.47- 1.34]
Men Vs. Women [c]	
Age group	1.26 [0.82- 1.93]
≤ 40 Vs. > 40 [c]	
Education	1.97 [1.08- 3.60]*
Low Vs. medium and high [c]	
Self- rated health	1.38 [0.86- 2.22]
Bad Vs. good [c]	
Good work ability	1.25 [0.56- 2.80]
Not agree Vs. agree	
Occupation type	2.04 [0.99- 4.18]
Blue-collar Vs. mixed and white-collar [c]	
Work time	1.06 [0.56- 2.00]
Full-time Vs. half-time [c]	
Total work experience	2.49 [1.33- 4.65]*
≤ 2 year Vs. > 2 year [c]	
Sector	1.53 [0.93- 2.52]
Industry and agriculture Vs. services [c]	
Working hours	0.93 [0.38- 2.27]
Long Vs. normal [c]	
Job insecurity	1.46 [0.95- 2.25]

	Yes Vs. No [c]	
Safety knowledge		1.04 [0.61- 1.75]
	No Vs. yes [c]	
Personal protective equipments		0.92 [0.49- 1.71]
	No Vs. yes [c]	

[b] Adjusted, in addition, for work-related factors (except job exposure).
[c] Reference category
The proportion of the explained variance of the multivariate model is 8 % R^2 = 0.080 (Nagelkerke R Square) for work injury.

Table 8.Odds ratios OR and 95% confidence intervals [95% CI] for occupational injury risk factors from multivariate logistic regression model with permanent contract as reference group.

Variables	Work accident victims
Model 3[b]	**Adjusted OR [95%CI]**
Contract type	0.54 [0.26- 1.13]
Temporary Vs. permanent [c]	
Gender	0.71 [0.40- 1.26]
Men Vs. Women [c]	
Age group	1.21 [0.77- 1.90]
≤ 40 Vs. > 40 [c]	
Education	1.92 [1.04- 3.54]*
Low Vs. medium and high [c]	
Self- rated health	1.37 [0.85- 2.23]
Bad Vs. good [c]	
Work ability	1.42 [0.63- 3.20]
Not agree Vs. agree [c]	
Occupation type	1.51 [0.67- 3.40]
Blue-collar Vs. mixed and white-collar [c]	
Work time	0.99 [0.51- 1.91]
Full-time Vs. half-time [c]	
Total work experience	2.76 [1.46- 5.23]*
≤ 2 year Vs. > 2 year [c]	
Sector	1.28 [0.74- 2.19]
Industry and agriculture Vs. services c	
Working hours	0.92 [0.37- 2.25]
Long Vs. normal [c]	

Job insecurity	1.51 [0.97- 2.35]
Yes Vs. No [c]	
Safety knowledge	1.00 [0.58- 1.71]
No Vs. yes [c]	
Personal protective equipments	0.92 [0.48- 1.74]
No Vs. yes [c]	
Total number of job exposures	1.13 [1.008- 1.27]*

CI, confidence interval; OR, odds ratio.
[b] Adjusted, in addition, for work-related factors and total number of job exposures.
[c] Reference category
The proportion of the explained variance of the multivariate model is 9.7 % R^2= 0.097 (Nagelkerke R Square) for work injury.

We give also the results of an additional analysis (model 4) in which the eight job exposures variables were separately added (table 9). Among the exposure variables, injury was associated with exposure to dangerous conditions (OR 1.91, 95% confidence interval 1.08 – 3.39) and total work experience remained positively associated with injury (OR 2.78, 95% confidence interval 1.46 – 5.29). Model 4 significantly predicted odds of injury (Model 4: x^2= 65.99, p= <0.001).

Models 1 and 2 accounted for 3.3 and 8.0% respectively (Nagelkerke R^2) of the variance in the injury outcome, Model 3 predicted 9.7 % (Nagelkerke R^2) of the variance in the injury outcome. While, Model 4 predicted 11.3% of the variance in the injury outcome.

Since model 4 with all the exposures separately had the best prediction, and we had a special interest in the influence of each of these different conditions (e.g. noise, vibration) on work injury, we included this model in our final results.

Table 9. Odds ratios OR and 95% confidence intervals [95% CI] for occupational injury risk factors from multivariate logistic regression model with permanent contract as reference group.

Variables	Work accident victims
Model 4[b]	**Adjusted OR [95%CI]**
Contract type	0.58 [0.28- 1.20]
Temporary Vs. permanent [c]	
Gender	0.74 [0.41- 1.33]
Men Vs. Women [c]	
Age group	1.15 [0.73- 1.81]
≤ 40 Vs. > 40 [c]	
Education	1.97 [1.06- 3.67]*
Low Vs. medium and high [c]	
Self- rated health	1.36 [0.83- 2.22]
Bad Vs. good [c]	
Good work ability	1.37 [0.60- 3.09]
Not agree Vs. agree	
Occupation type	1.18 [0.49- 2.80]
Blue-collar Vs. mixed and white-collar [c]	
Work time	0.99 [0.51- 1.94]
Full-time Vs. half-time [c]	
Total work experience	2.78 [1.46- 5.29]*
≤ 2 years Vs. > 2 years [c]	
Sector	1.38 [0.78- 2.45]
Industry and agriculture Vs. services [c]	
Working hours	0.88 [0.35- 2.17]
Long Vs. normal [c]	
Job insecurity	1.55 [0.99- 2.41]

Yes Vs. No [c]	
Safety knowledge	0.98 [0.57- 1.70]
No Vs. yes [c]	
Personal protective equipments	0.90 [0.47- 1.71]
No Vs. yes [c]	
Vibration	0.80 [0.43- 1.52]
Yes Vs. No [c]	
Noise	1.17 [0.63- 2.16]
Yes Vs. No [c]	
Extreme temperature	0.89 [0.54- 1.45]
Yes Vs. No [c]	
Chemical substances	0.73 [0.44- 1.21]
Yes Vs. No [c]	
Dangerous conditions	1.91 [1.08- 3.39]*
Yes Vs. No [c]	
Physically demanding tasks	1.29 [0.68- 2.46]
Yes Vs. No [c]	
Uncomfortable or tiring positions	1.54 [0.77- 3.11]
Yes Vs. No [c]	
Repetitive tasks	1.40 [0.78- 2.51]
Yes Vs. No [c]	

[b] Adjusted, in addition, for all work-related factors.
[c] Reference category
The proportion of the explained variance of the multivariate model is 11.3 % R^2 = 0.113 (Nagelkerke R Square) for work injury.

4.2.4 Discussion and interpretations of the results from the VOW data

We surveyed a population of Belgian workers to investigate whether non-standard workers experience more injuries compared to standard workers. The prevalence of non-standard work in our study was 12.5%, comparable with the European statistics, indicating a 8.1% for Belgium in 2010 [60]. However, contrary to our expectations, we did not find that non-standard workers report increased occupational injuries compared to standard workers.

Comparisons between international studies are difficult due to the heterogeneity of job organization, employment arrangements, worker power, and efficacy of government regulation. There are important differences in the definitions of non-standard work. Some authors consider only casual and temporary employment (including agencies leasing workers) as non-standard whereas others also include self-employment and home based work [204, 205]. Our sample consisted of four types of non-standard workers: fixed-term contract, temporary contract, another type of contract and self-employed workers, which may have influenced results.

Another possible explanation for our finding is the fact that Belgian non-standard workers are mostly employed in the service sector such as education and socio-cultural work, retail, hotels/restaurants, post company, personnel care services, and cleaning [199]. In this study, the percentage of temporary workers who worked in the service sectors was 13.37% and 11.81% of the temporary workers were working in the industry and agriculture sectors. Overall, the service sector has better working conditions and less dangerous job conditions compared to industries such as metal and construction [206, 207]. Therefore, the number of observed work accidents may be lower than expected. In this respect, our results are in line with the research of Saloniemi et al, who found that fixed-term workers did not have a higher occupational injury rate than permanent workers [130]. The most important explanation for this finding was that, in Finland, fixed-term workers are concentrated in public services such as health care and education which contain a prevalence domination of female workers.

A second possibility to explain our results is the short contract period of many temporary workers (less than one year). Some may have suffered an accident while holding a temporary contract, but were no longer employed at the time of our survey, resulting in underreporting of work injuries in non-standard workers (healthy worker effect). On the other hand, non-standard workers with three or six-month temporary contracts were also, likely underrepresented in our study.

A plausible third explanation is the recent efforts and legal initiatives taken by the Belgian government to decrease workplace accidents. The Royal Decree of 15 December 2010 forbids temporary work agencies to offer the following jobs: gassing activities, demolition and removal of asbestos and removal of poisonous waste products [208]. Other measures include financial incentives for employers who improved the working conditions and implemented accident prevention strategies, including equipment upgrades. In the latest report of the Fund of Occupational Accidents, there was a 4.2% reduction in the number of occupational accidents between 2012 and 2013, and the number of accidents was halved between 1985 and 2013 [10, 207]. According to the 2014 annual report of Belgian Safe Work Information Center (BeSWIC), the number of accidents among temporary workers, declined to 8% in 2013 [209]. Our data included some questions regarding safety climate at work: (1) did you receive a good training concerning health and safety and (2) did you receive good personnel protective equipment? Regarding these questions, the percentage of temporary workers who responded yes was higher than among permanent workers (69.2% versus 63.2% and 75.8% versus 74.9% respectively). This indicates that non-standard workers are well trained and protected, possibly explaining the lower incidence of work related injuries compared to standard workers in our study.

In summary, recent report from Belgium concluded that temporary work percentages in decrease. In addition, non-standard workers in Belgium are well trained and protected in a way that they are forbidden from working in dangerous work environment. While the number of non-standard work in increase in several European countries. For example, the share of temporary jobs among total salaried employment is growing in Italy [210], particularly among young workers (figure 2). Furthermore, Amuedo-Dorantes [211] found that in Spain temporary employees experience worse working conditions than permanent workers. So, the case of Belgium are different from that of other industrialized countries which have an elevated number of non-standard workers and their situation are worse than their counterparts. Another reason might be that even in Belgium commuting accidents from home to work and from work to home are considered as work accidents and still work accidents in Belgium in decrease comparing with the other industrialized countries.

Recently, the Belgian National Strategy for Wellbeing at Work 2016-2020 as proposed by the Minister of Employment: Strategic and operational objectives, aims at continuing paying attention to the causes of occupational accidents and health problems caused by work and tackle these. Results from accident at work statistic (2016) showed that the number of accidents and fatal accidents in Belgium are smaller than that of other European countries as France, Italy, United Kingdom, Spain and Germany [212]. So, all these legal initiatives in Belgium can give us a demonstration that the conclusions reported in Belgium might be different for other studies (figures 3 and 4).

Actually previous studies also showed that, under some specific circumstances, the relationships between non-standard forms of employment and occupational injuries might be different. For example, the research of Amuedo-Dorantes (2002) found that in Spain temporary employees experience worse working conditions than permanent workers. However, once working conditions are accounted for, temporary workers are not more likely to have a workplace accident [211]. Also, Seok and Bena 2013 found that protective factors for occupational injury include implementation of occupational health and safety management system in the workplace and job tenure [70, 107, 213]. This also might support our findings in Belgium.

Another point of interest has been put forward in a recent article reporting that in the United States working population, those with non-standard work arrangements tend to work in multiple jobs and that multiple jobs increased the risk of injury [159]. In our study, we were unable to measure number of jobs and is an area for future research.

Our findings are similar to those reported by Benavides et al, who found that the higher rate of occupational injuries among non-standard workers was attributable to less work experience and poor knowledge of workplace hazards [214]. This finding is consistent with Bena et al, who found that injury rates decrease with increased time spent in the current job and those of Malliarou, which found that less working experience increased the probability of occupational injuries among military personnel[107, 215]. Other risk factors associated with injuries in this study were educational level and job exposure. In agreement with prior studies, higher-educated workers reported the lowest accident rate and were the most compliant with the safety process [72].

The relationship between exposure to chemicals, physical risk factors, poor ergonomics and work accidents was of interest in this study. Working conditions addressed the presence of

hazards during a usual working day e.g. exposure to noise, vibration, extreme temperatures, chemical substances, handling of heavy loads, uncomfortable or tiring positions, performing repetitive tasks and also dangerous situations. Examples of the latter include working on a slippery or unstable surface, risk of falling, handling dangerous tools and machines, and risk of electrocution. In comparison with other studies, we found that workers were exposed in the same magnitude to all these conditions but dangerous situations were the only statistical significant explanatory variable for having an accident or injury [58]. Previous research has found noise exposure to be a determinant of on-the-job injuries [58, 91, 104]. However, adverse effects of occupational noise exposure usually occur in the range 80-85 dBA and > 85 dBA. Noise exposure level data were not available in the present study, but it is possible that the average noise level among this sample was lower given the fact that many wore personal protective equipment and received occupational training. With regard to other possible causes of accidents e.g. vibration and cold temperature, the same reasoning may also apply: workers who are exposed to these hazards but who receive adequate information and dispose of efficient protective measures (gloves, warm clothing) will exhibit no excess risk in comparison with laborers who are not confronted with these adverse working conditions.

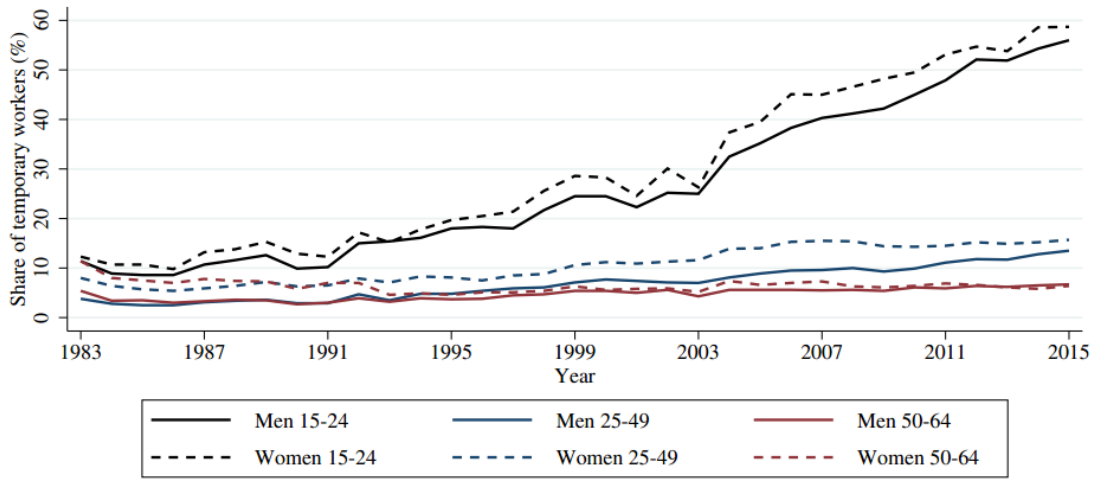

Figure (2): Share of temporary workers in employment in Italy by: age and gender; Source: Eurostat, Labor Force Survey, available on-line at http://ec.europa.eu/eurostat/web/lfs/data/database.

	Accidents at work involving at least four calendar days of absence from work			Fatal accidents at work
	Total	Men	Women	Total
EU-28	*3 176 640*	*2 183 494*	*992 870*	*3 739*
Belgium	65 587	46 812	18 771	52
Bulgaria	2 246	1 600	646	117
Czech Republic	42 306	29 797	12 509	118
Denmark	54 157	31 920	22 041	38
Germany	847 370	631 819	215 552	500
Estonia	6 288	4 097	2 191	16
Ireland	18 115	12 503	5 583	47
Greece	3 410	2 551	859	28
Spain	387 439	264 010	123 430	280
France	724 662	454 997	269 664	589
Croatia	11 669	7 686	3 981	26
Italy	313 312	226 263	87 049	522
Cyprus	1 613	1 145	468	5
Latvia	1 725	1 154	571	41
Lithuania	3 120	2 025	1 092	55
Luxembourg	7 183	5 701	1 482	10
Hungary	19 491	12 674	6 817	81
Malta	2 632	2 235	397	4
Netherlands	87 964	55 567	32 397	45
Austria	65 418	51 352	14 066	126
Poland	76 274	50 294	25 980	263
Portugal	130 153	93 003	37 150	160
Romania	3 396	2 629	767	272
Slovenia	12 314	9 312	3 002	25
Slovakia	8 552	5 910	2 642	40
Finland (*)	47 432	32 630	14 802	22
Sweden	35 296	19 596	15 700	40
United Kingdom	244 948	156 842	88 064	239
Iceland (*)	1 787	1 182	605	0
Norway	10 108	6 243	3 865	61
Switzerland	86 346	68 492	17 854	74

Note. Non-fatal accidents reported in the framework of ESAW are accidents that imply at least four full calendar days of absence from work (serious accidents).
(*) 2013.

Figure (3): Table showing accidents at work statistics (Eurostate-Statistics Explained). Data extracted in November 2016

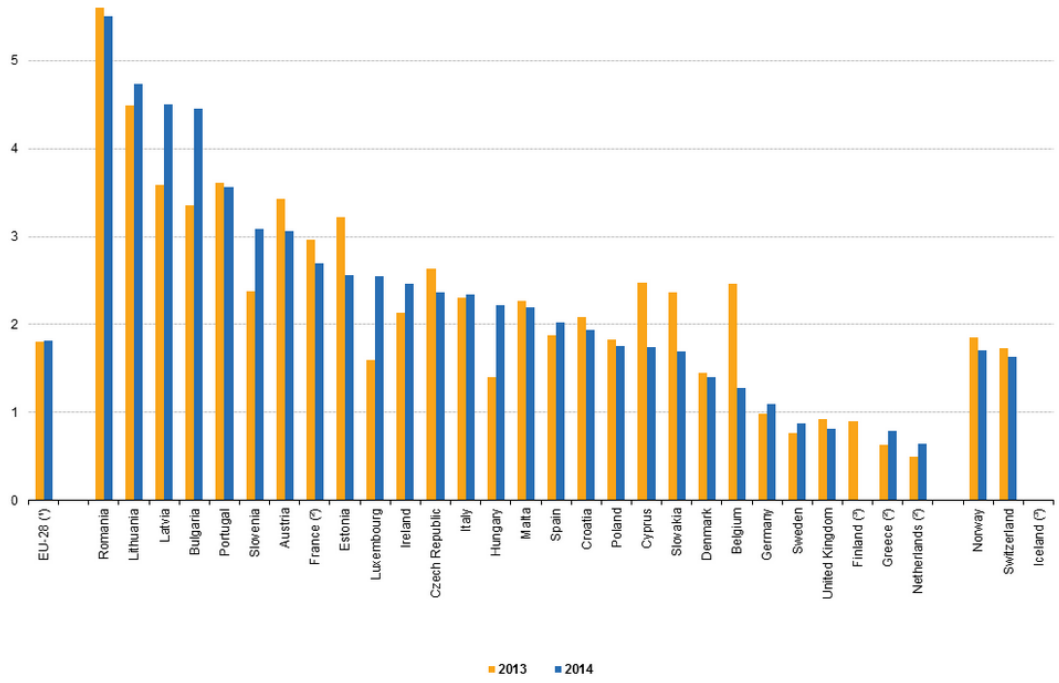

Figure (4): Fatal accidents at work, 2013 and 2014 (incidence rates per 100 000 persons employed) YB16.png (Eurostate-Statistics Explained).

4.2.5 Study strengths and limitations from the VOW data

Given the lack of available data on the relationship between employment type and occupational injuries, this study makes an important contribution to the literature. Furthermore, using self-reported injury as outcome may reduce possible injury underreporting based on data from employers and workers' compensation. This study is the first to investigate the situation of Belgian non-standard workers and the findings could advance worker health and safety. Interventions to enhance the quality and safety of jobs can be organized at several levels e.g. training and education of individuals, redesign of work places, legislation to limit poor working conditions.

However, also some limitations should be mentioned. Participants did not represent the Belgian workforce since physicians recruited workers from a range of companies and occupations to complete the survey at their annual health examinations. Consequently, some industries were underrepresented (for example: Production industry only 9 persons (1.2%); wood and paper only 14 persons (1.9%); printing, publishing only 8 persons (1.1%); gas water, electricity only 19 persons (2.6%)). Also, the present results cannot be generalized to other countries, since labor regulations and social care system vary widely. Further research should be performed in diverse occupational settings to investigate the external validity of our findings.

So, our conclusion from the VOW database states that the survey is not representative of the Belgian population. So how reliable are the conclusions of this study then?

First we selected the Belgium case to be as our research area, and then we searched about from where we can found the Belgian data (doing a self questionnaire needs enormous costs and time investment associated with the collection of epidemiological data). So, first we found the VOW survey from Belgium. After we studied these database based on our literature review about which variables will be included in the analysis. For example the industrial sector was very important to be included in our work because it generates a lot of work accidents. We found that some industries were under-represented. But we tried to find another sector that plays the same role of having a lot of possibilities of creating work accidents and injuries as it was about the work activity. So, in this way we overcome the under-representing of the industrial sector using a proxy measures. Then our results were that there were no difference between temporary and permanent workers in Belgium in terms of work accidents and injuries. Our results can be described by the recent efforts and legal

initiative taken by the Belgian government to decrease work place accidents as the Royal Degree of 15 December 2010 which forbids temporary work agencies to offer the following jobs as gazing activities, removal of asbestos and poisonous waste products. Also, the employers in Belgian decreased the employment in high-hazard occupations, such as mining. Other measures include financial incentives for employers who improved the working conditions and implemented accident prevention strategies, including equipment upgrades. On the other hand, better prevention, greater adherence to regulations, labor inspections and accident prevention policies; have helped to ameliorate the situation. But the result of this study may be caused by the unique situation of Belgium. For the generalization of the result, more study for the association between the nonstandard work and occupational injury is required in various countries.

However, we still can give one limitation to our results that it was generated from non-representative sample from Belgium. To overcome this problem now we searched to find the larger sample about Belgium. The fifth edition of the European Working Condition Survey was our solution and economic sector variable as the construction industry; manufacturing; mining; agriculture.etc was included in this time. Our results from this large survey still the same that there is no difference between temporary and permanent workers in Belgium in term of work accidents and injuries. So, both the representative and non-representative samples from Belgium gave the same results. So, our second finding from the EWCS can reinforce the results we obtained from the first survey (VOW). In addition, the prevalence of non-standard work from the VOW database was 12.5 %, comparable with the European statistics, indicating a 8.1 % for Belgium in 2010 might also reinforce the reliability of our database and our results.

4.3 Research findings from the EWCS data

Using the fifth European working condition survey database we aimed at examining the relationship between indicators of non-standard work arrangements including precarious contract, long working hours, multiple jobs, shift work, and work-related accident absence and injuries, using a representative Belgian and European sample, and taking into account several sociodemographic and work characteristics. The main results are presented in the following.

4.3.1 For Belgium

4.3.1.1 Descriptive results from the fifth EWCS database for Belgian workers

Descriptives of the sample studied are presented in table 10. A total number of 3343 workers were included in the analyses. The study population consisted of 1769 men (52.9%) and 1574 women (47.1%). Average age was 39.42 years (± 10.91 SD) and 43.4% of the participants were highly educated. The majority of the respondents (81.9%) rated their health as good. Workers, who reported work-related accident absence during the past 12 months, represented 11.7% of the sample. About 13.1% of the sample had a precarious contract, while 6.1% of the sample was working long hours. Almost 9.1 % of the sample had multiple jobs and 15.6% of the workers reported shift work. A third (35.4%) of the workers suffered from overall fatigue and 21.4% had sleep difficulties.

Table 10. Characteristics of the study population (n=3343).

Individual and work-related factors	Total study sample
Socio- demographic factors	
Gender: $\boldsymbol{n}$ (%)[a]	
Male	1769 (52.9)
Female	1574 (47.1)
Mean age/yr (SD)	39.42 (10.91)
Self-rated health: $\boldsymbol{n}$ (%)[a]	
Bad	606(18.1)
Good	2735(81.9)
Education level: $\boldsymbol{n}$ (%)[a]	
Primary level	80(2.4)
Low secondary	446(13.4)
High secondary	1361(40.9)
Tertiary level	1444(43.)
Work-related factors	
Work-related accident absence: $\boldsymbol{n}$ (%)[a]	
No	1973(88.3)
Yes	262(11.7)
Yes: Mean (Min/Max)	24.69 (1/365)
Contract type: $\boldsymbol{n}$ (%)[a]	
Precarious contract	428(13.1)
Permanent contract	2847 (86.9)
Long hours: $\boldsymbol{n}$ (%)[a]	
Long hours	202(6.1)
Normal hours	3087(93.9)
Multiple jobs: $\boldsymbol{n}$ (%)[a]	
No	3026(90.9)
Yes	303(9.1)
Shift work: $\boldsymbol{n}$ (%)[a]	
No	2815(84.4)
Yes	520 (15.6)
Mean work experience/yr (SD)	9.69(9.85)
Company size: $\boldsymbol{n}$ (%)[a]	
Small	813(25.9)

Medium	1397(44.5)
Large	556(17.7)
Very large	370(11.8)
Economic activity: n (%)[a]	
Construction	190(5.9)
Mining , quarrying, manufacturing, electricity, gas and water	432(13.3)
Agriculture, hunting, forestry and fishing	38(1.2)
Services	2587(79.6)
Overall fatigue: n (%)[a]	
No	2150(64.6)
Yes	1179(35.4)
Sleep difficulties: n (%)[a]	
No	2616(78.6)
Yes	713(21.4)
Risk information: n (%)[a]	
Well informed	2796(85.3)
Not well informed	482(14.7)
Physical exposure (PH): n (%)[a]	
No	1357(40.7)
Yes	1981(59.3)
Chemical exposure (CH): n (%)[a]	
No	1872(56.1)
Yes	1465(43.9)
Biological exposure (BL): n (%)[a]	
No	2587(77.9)
Yes	735(22.1)
Biomechanical exposure (BM): n (%)[a]	
No	1447(43.3)
Yes	1895(56.7)

[a] Calculated according to the percentage of the valid count.

4.3.1.2 Univariate associations between baseline measures and absence due to work injury

Descriptive statistics including frequencies and proportions for categorical variables and the mean and standard deviation for continuous variables were presented in details in chapter 3 for all variables which were included in this study. Table 11 shows the univariate associations between baseline measures and absence due to work injury.

A univariate association was observed between self-rated health and absence due to work accidents. Workers who declared having a bad health status were more absent from work due to work-related accidents than those declared having a good health statue. Concerning the relation between education level and absence due to work-related accidents, the univariate association showed that low educated workers had more absence due to work accidents than high educated ones and the difference was statistically significant. Furthermore, the univariate association showed that workers doing shift work had more absence due to work accidents than non shift workers. Construction workers were more absent due to work accidents than those doing other occupations. Workers having overall fatigue were more absent due to work accidents than their counterparts. Further, a univariate association was observed between sleep difficulties and absence due to work accidents; and between biomechanical exposure and absence due to work accidents.

In contrast, no statistical significant differences were found between men and women and also between permanent and precarious contract workers in terms of being absent due to work accidents. Long hours; multiple jobs; company size; and risk information variables were not significant. Finally, regarding job exposure variable, all types of exposure with the exception of biomechanical exposure (BM) variables were not significant.

Table 11. Univariate associations between baseline measures and absence due to work accident.

Variables	Absence due to work accident		
	Yes (%)	**No (%)**	**X^2 (P value)**
Gender			3.41(0.065)
Male	125(10.539)	1061(89.460)	
Female	137(13.060)	912(86.939)	
Self-rated health			38.814 (< 0.001)***
Bad	86(20.574)	332(79.425)	
Good	176(9.696)	1639(90.303)	
Education level			39.005 (< 0.001)***
Primary level	9(16.071)	47(83.928)	
Low secondary	58(19.269)	243(80.730)	
High secondary	122(13.555)	778(86.444)	
Tertiary level	71(7.304)	901(92.695)	
Contract type			0.052 (0.820)
Precarious contract	29(12.133)	210(87.866)	
Permanent contract	228(11.632)	1732(88.367)	
Long hours			0.063 (0.801)
Short	249(11.806)	1860(88.193)	
Long	12(11.009)	97(88.990)	
Multiple jobs			1.648 (0.199)
No	235(11.491)	1810(88.508)	
Yes	27(14.673)	157(85.326)	
Shift work			14.626 (< 0.001)***
No	196(10.509)	1669(89.490)	

Yes	64(17.534)	301(82.465)	
Company size			1.778 (0.620)
Small	54(10.364)	467(89.635)	
Medium	113(12.216)	812(87.783)	
Large	45(11.138)	359(88.861)	
Very large	36(13.090)	239(86.909)	
Economic activity			13.248 (0.004)**
Construction	27(21.428)	99(78.571)	
Mining , quarrying, manufacturing, electricity, gas and water	36(1.168)	272(88.311)	
Agriculture, hunting, forestry and fishing	2(7.142)	26(92.857)	
Services	187(10.903)	1528(89.096)	
Overall fatigue			11.695 (0.001)**
No	143(9.979)	1290(90.020)	
Yes	118(14.842)	677(85.157)	
Sleep difficulties			5.504 (0.019)*
No	191(10.889)	1563(89.110)	
Yes	70(14.799)	403(85.200)	
Risk information			1.617 (0.204)
Well informed	217(11.451)	1678(88.548)	
Not well informed	42(14)	258(86)	
Physical exposure (PH)			2.214 (0.137)
No	115(12.994)	770(87.005)	
Yes	147(10.921)	1199(89.078)	
Chemical exposure (CH)			0.588 (0.443)
No	139(11.273)	1094(88.726)	
Yes	123(12.324)	875(87.675)	

Biological exposure (BL)			1.340 (0.247)
No	212(12.176)	1529(87.823)	
Yes	49(10.251)	429(89.748)	
Biomechanical exposure (BM)			10.635 (0.001)**
No	97(9.344)	941(90.655)	
Yes	165(13.795)	1031(86.204)	

P value < 0.05 (*), P value <0.01 (**), P value < 0.001 (***)

4.3.1.3 Multilevel binary regression analysis results

The associations between the separate non-standard work indicator and work-related accident absence are presented in Table 12 (Step 1, with adjustment for covariates). An increased work-related accident absence was observed for those working shift works in the crude and the adjusted models (OR 1.546, 95% CI 1.074–2.224). However, the relationship between contract type; those working long hours; and those having multiple jobs and work-related accident was not significant in all three models (OR 1.163, 95% CI 0.739–1.831); (OR 1.217, 95% CI 0.638- 2.321); (OR1.361, 95%CI 0.827- 2.240) respectively.

Table 12. Results from the multivariate binary regression analysis for long hours, multiple jobs, precarious work and shift work separately in relation with work- related accident absence.

Non-standard work arrangement indicators	**Model 1**	**Model 2**	**Model 3**
Step 1	**Crude OR [95% CI]**	**Adjusted OR [95% CI]**	**Adjusted OR [95% CI]**
Contract type *Precarious Vs. permanent* [a]	1.049[0.695- 1.584]	0.952[0.617- 1.468]	1.163[0.739- 1.831]
Long hours *Long Vs. normal* [a]	0.924[0.500- 1.708]	1.113[0.595- 2.082]	1.217[0.638- 2.321]
Multiple jobs *Yes Vs. no* [a]	1.325[0.861- 2.037]	1.222[0.771- 1.937]	1.361[0.827- 2.240]
Shift work *Yes Vs. no* [a]	**1.811**[1.331- 2.463]	**1.611**[1.167- 2.225]	**1.546**[1.074- 2.224]

OR: Odds ratios, [95% CI]: 95% confidence interval.
Model 2: Adjusted for socio-demographic factors. Model 3: Adjusted, in addition, for all work-related factors.
Significant associations are in bold
[a] Reference category

Table 13 summarizes Odds Ratios (OR) and 95% Confidence Interval (95% CI) from the multivariate logistic regression analysis for those doing shift work. Shift work was significantly associated with work-related accident in the crude model (OR 1.811, 95%CI 1.331- 2.463). In the second model which adjusted for socio-demographic variables, shift work, gender, self-rated health and education were significantly associated with work-related accident: (OR 1.611, 95%CI 1.167- 2.225), (OR 0.756, 95% CI 0.577- 0.991), (OR 2.226, 95%CI 1.656- 2.992) and (OR 2.367, 95%CI 1.103- 5.080), respectively. In the third model, which included the addition of work-related variables, shift work, self-rated health and education, remained positively associated with work-related accident ((OR 1.546, 95%CI 1.074- 2.224, (OR 2.153, 95%CI 1.531- 3.028), (OR 2.420, 95%CI 1.044- 5.607), respectively). Furthermore, economic activity was significantly associated with work-related

accident (OR1.866, 95% CI 1.119- 3.111). Among the exposure variables, work-related accident absence was associated only with biomechanical exposure (BM) (OR 1.670, 95%CI 1.225- 2.277).

Including all non-standard work factors simultaneously in a model with adjustments for covariates, did not change the overall results.

Table 14 summarize the Belgian results from both databases (VOW and 5th EWCS). From this table, it is clear that contract type results are not significant from both databases. So, there is no statistical significant difference between Belgian temporary and permanent workers in terms of work-related accidents absence or occupational accidents. Also, education level results are significant from both surveys. So, low educated workers, less experienced workers, those exposed to dangerous conditions, shift workers, construction industry and those exposed to biomechanical exposure were found to be risk factors for work-related accidents absence and occupational accidents in Belgium.

Table 13. Odds ratios OR and 95% confidence intervals [95% CI] for work-related accident absence from multivariate logistic regression model with non shift workers as reference group.

Variables	Work-related accident absence
Model 1	***Crude OR [95%CI]***
Shift work *(Yes vs. no[c])*	1.811[1.331- 2.463]*
Model2	***Adjusted OR [95%CI]***
Shift work *(Yes vs. no[c])*	1.611[1.167- 2.225]*
Gender *(Men Vs. women [c])*	0.756 [0.577- 0.991]*
Age *(Continuous)*	1.005 [0.992- 1.017]
Self-rated health *(BadVs.good[c])*	2.226[1.656- 2.992]*
Education *(Low Vs. high [c])*	2.367[1.103- 5.080]*
Model 3	***Adjusted OR [95%CI]***
Shift work *(YesVs.no[c])*	1.546[1.074- 2.224]*
Gender *(Men Vs. women [c])*	0.752[0.561- 1.007]
Age *(Continuous)*	1.014[0.996- 1.032]
Self-rated health	2.153[1.531- 3.028]*

(BadVs.good[c])	
Education	2.420[1.044- 5.607]*
(Low Vs. high [c])	
Work experience	0.986[0.966- 1.006]
(Continuous)	
Company size	0.739[0.442- 1.236]
(Small Vs. large [c])	
Economic activity	1.866[1.119- 3.111]*
(Construction Vs. services[c])	
Overall fatigue	1.263[0.905- 1.763]
(YesVs. no[c])	
Sleep difficulties	0.896[0.614- 1.308]
(YesVs. no[c])	
Risk information	1.194[0.799- 1.784]
(Not well informed Vs. well informed [c])	
Physical exposure (PH)	0.748[0.535- 1.045]
(YesVs. no[c])	
Chemical exposure (CH)	1.211[0.857- 1.711]
(YesVs. no[c])	
Biological exposure (BL)	0.693[0.463- 1.037]
(YesVs. no[c])	
Biomechanical exposure (BM)	1.670[1.225- 2.277]*
(YesVs. no[c])	

Model 2: Adjusted for socio-demographic factors.
Model 3: Adjusted for socio-demographic factors and, in addition, for all work-related factors.
[c] Reference category
The proportion of the explained variance of the multivariate model is 10.7 % R^2 = 0.107 (Nagelkerke R Square) for work-related accident absence.

Table 14. Results summary from the first and the second research questions. Belgian risk factors of work-related accident absence and occupational accident.

Database	Variable	Model 1 Adjusted/Crude OR [95% CI]	Model 2 Adjusted OR [95% CI]	Model 3 Adjusted OR [95% CI]	Model 4 Adjusted OR [95% CI]
VOW	**Contract type**				
	Precarious Vs. permanent [a]	0.82 [0.47-1.42]	0.56 [0.28-1.12]	0.54 [0.26-1.13]	0.58 [0.28-1.20]
	Education				
	Low Vs. medium and high [c]	2.71 [1.70-4.31]*	1.97 [1.08-3.60]*	1.92 [1.04-3.54]*	1.97 [1.06-3.67]*
	Total work experience				
	≤ 2 years Vs. > 2 years [c]	-	2.49 [1.33-4.65]*	2.76 [1.46-5.23]*	2.78 [1.46-5.29]*
	Dangerous conditions				
	Yes Vs. No [c]	-	-	-	1.91 [1.08-3.39]*
	Total number of job exposures	-	-	1.13 [1.01-1.27]*	-
EWCS	**Gender**				
	Men Vs. women c	-	0.76 [0.58-0.99]*	0.75[0.56-1.01]	
	Contract type				
	Precarious Vs. permanent [a]	1.05 [0.70-1.58]	0.95 [0.62-1.47]	1.16[0.74-1.83]	-
	Long hours				
	Long Vs. normal [a]	0.92 [0.50-1.71]	1.11 [0.60-2.08]	1.22 [0.64-2.32]	-
	Multiple jobs				
	Yes Vs. no [a]	1.33 [0.86-2.04]	1.22 [0.77-1.94]	1.36 [0.83-2.24]	-
	Shift work				
	Yes Vs. no [a]	1.81 [1.33-2.46]	1.61 [1.17-2.23]	1.55 [1.07-2.22]*	-
	Self-rated health				
	Bad Vs.good[c]	-	2.23 [1.66-2.99]*	2.15 [1.53-3.03]*	-
	Education				
	Low Vs. high [c]	-	2.37 [1.10-5.08]*	2.42[1.04-5.61]*	-
	Economic activity				
	Construction Vs. services[c]	-	-	1.87 [1.12-3.11]*	-
	Biomechanical exposure				
	Yes Vs. no[c]	-	-	1.67[1.23-2.28]*	-

R: Odds ratios, [95% CI]: 95% confidence interval.
Model 2: Adjusted for socio-demographic factors. Model 3: Adjusted, in addition, for all work-related factors.
Model 3: Adjusted for socio-demographic factors and, in addition, for all work-related factors.
[c] Reference category
The proportion of the explained variance of the multivariate model is 10.7 % R^2 = 0.107 (Nagelkerke R Square) for work-related accident absence

4.3.1.3.1 Interaction results with the gender variable

In the beginning of our work, before conducting our models, we have searched about the presence of any interaction between the four indicators of non-standard work arrangements (contract type, long hours, multiple jobs, and shift work) with the gender variable from the EWCS database. Our results showed no significant interaction between each indicator of non-standard work arrangement separately with the gender. Also interactions with self-rated health variable were checked as well for the four indicators separately and still we did not find any significant interaction for the four indicators.

Regarding the interaction from the first study target using the VOW database, we have repeated the analysis over again and our new results showed no significant interaction between contract type with the age variables (OR 2.43, 95% CI: 0.27- 21.46).

Also, interaction between contract type and gender has been investigated using the VOW database. The results are shown in table (15). So, out of the output file, we can't get much more results than saying that there is interaction between contract type and gender ($p = 0.021$) and that there isn't between contract type and age ($p = 0.42$). Figure 5 below visualizes this interaction, i.e. the change in probability for injury is visualized by the line for men as well as for women. For men we see a decrease when comparing permanent contracts with temporary contracts, while for women we see an increase or the reverse effect.

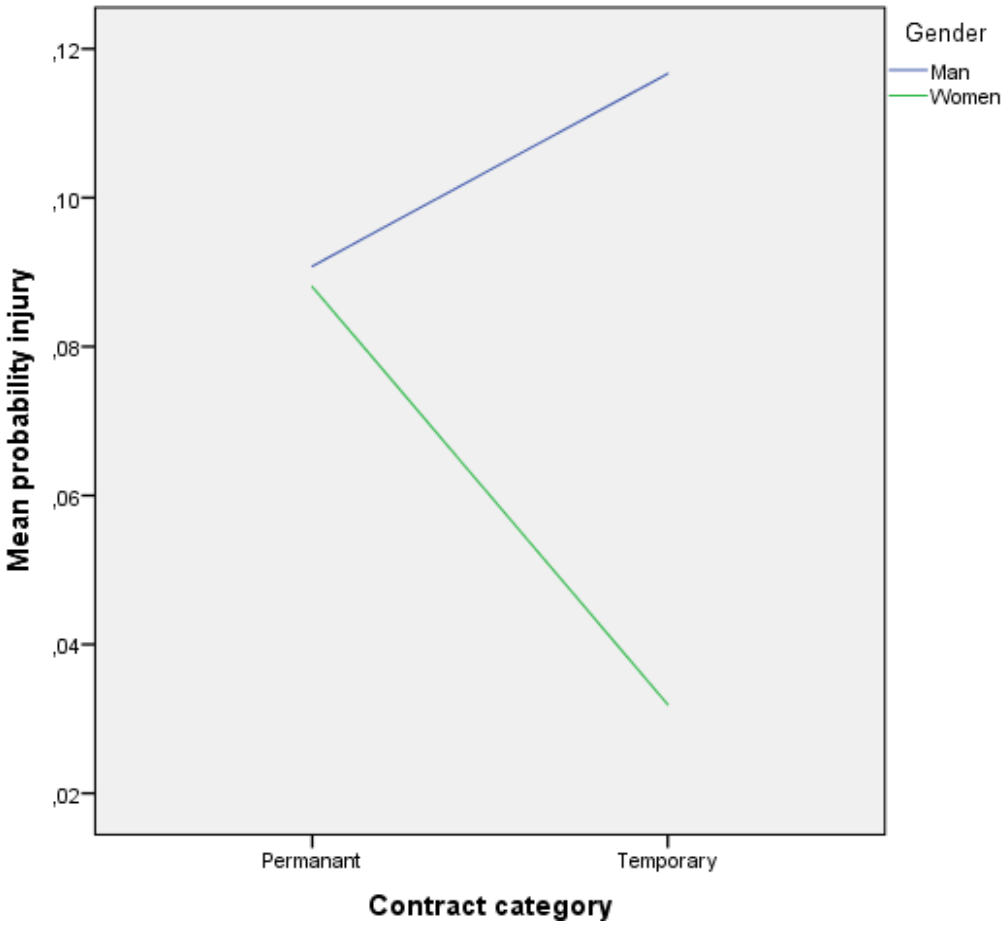

Figure (5): Interaction effect between gender and contract type

Table 15. Odds ratios OR and 95% confidence intervals [95% CI] for occupational accident risk factors from multivariate logistic regression model with permanent contract as reference group and with the interaction "contract type*gender".

Variables	Work accident victims
Model 1	**Adjusted OR [95%CI]**
Contract type Temporary Vs. permanent [c]	0.35 [0.10 - 1.17]
Gender Men Vs. Women [c]	0.92 [0.63- 1.35]
Age group ≤ 40 Vs. > 40 [c]	1.33 [0.92 - 1.91]
Education Low Vs. medium and high [c]	2.65 [1.67 - 4.23]*
Self- rated health Bad Vs. good [c]	1.37 [0.90 - 2.08]
Good work ability Not agree Vs. agree	1.21 [0.58 - 2.54]
Contract type*Gender	3.31 [0.86 - 12.75]
Model 2	**Adjusted OR [95%CI]**
Contract type Temporary Vs. permanent [c]	0.07 [0.01- 0.60]*
Gender Men Vs. Women [c]	0.64 [0.37- 1.10]
Age group ≤ 40 Vs. > 40 [c]	1.21 [0.80- 1.87]
Education Low Vs. medium and high [c]	1.98 [1.09- 3.62]*
Self- rated health Bad Vs. good [c]	1.38 [0.86- 2.21]
Good work ability Not agree Vs. agree	1.22 [0.54- 2.73]
Occupation type Blue-collar Vs. mixed and white-collar [c]	2.06 [1.01- 4.22]*

Work time	1.06 [0.56- 2.01]
Full-time Vs. half-time [c]	
Total work experience	2.90[1.54- 5.46]*
≤ 2 year Vs. > 2 year [c]	
Sector	1.55 [0.94- 2.56]
Industry and agriculture Vs. services [c]	
Working hours	0.96 [0.39- 2.35]
Long Vs. normal [c]	
Job insecurity	1.58 [1.02- 2.45]*
Yes Vs. No [c]	
Safety knowledge	1.03 [0.61- 1.75]
No Vs. yes [c]	
Personal protective equipments	0.93 [0.50- 1.74]
No Vs. yes [c]	
Contract type*Gender	14.66 [1.68- 127.55]*
Model 3	**Adjusted OR [95%CI]**
Contract type	0.08 [0.01- 0.70]*
Temporary Vs. permanent [c]	
Gender	0.60 [0.33- 1.10]
Men Vs. Women [c]	
Age group	1.12 [0.71- 1.76]
≤ 40 Vs. > 40 [c]	
Education	1.96 [1.06- 3.64]*
Low Vs. medium and high [c]	
Self- rated health	1.35 [0.82- 2.21]
Bad Vs. good [c]	
Good work ability	1.31 [0.57- 2.99]
Not agree Vs. agree	
Occupation type	1.22 [0.51- 2.90]
Blue-collar Vs. mixed and white-collar [c]	
Work time	0.96 [0.49- 1.90]
Full-time Vs. half-time [c]	

Total work experience	3.22 [1.67- 6.21]*
≤ 2 years Vs. > 2 years [c]	
Sector	1.38 [0.78- 2.44]
Industry and agriculture Vs. services [c]	
Working hours	0.91 [0.36- 2.25]
Long Vs. normal [c]	
Job insecurity	1.68 [1.07- 2.64]*
Yes Vs. No [c]	
Safety knowledge	0.98 [0.56- 1.70]
No Vs. yes [c]	
Personal protective equipments	0.92 [0.48- 1.75]
No Vs. yes [c]	
Vibration	0.83 [0.44- 1.56]
Yes Vs. No [c]	
Noise	1.23 [0.66- 2.29]
Yes Vs. No [c]	
Extreme temperature	0.88 [0.53- 1.45]
Yes Vs. No [c]	
Chemical substances	0.73 [0.44- 1.21]
Yes Vs. No [c]	
Dangerous conditions	1.87 [1.05- 3.32]*
Yes Vs. No [c]	
Physically demanding tasks	1.27 [0.67- 2.43]
Yes Vs. No [c]	
Uncomfortable or tiring positions	1.59 [0.79- 3.20]
Yes Vs. No [c]	
Repetitive tasks	1.29 [0.72- 2.33]
Yes Vs. No [c]	
Contract type*Gender	12.69 [1.40- 114.96]*

Table 16. Results variance: Comparison between the results of the three models before including the interaction between contract type and gender, and the results obtained after including the interaction effect.

Database	Variables	Adjusted OR [95% CI]	Adjusted OR [95% CI]
VOW			
		Model 1-Without interaction effect	Model 1- with interaction effect
	Education	2.71 [1.70-4.31]*	**2.65 [1.67 - 4.23]***
	Low Vs. medium and high [c]		
		Model 2-Without interaction	Model 2 –With interaction
	Contract type	NS	**0.07 [0.01- 0.60]***
	Temporary Vs. permanent [c]		
	Education	1.97 [1.08- 3.60]*	**1.98 [1.09- 3.62]***
	Low Vs. medium and high [c]		
	Occupation type	**NS**	**2.06 [1.01- 4.22]***
	Blue-collar Vs. mixed and white-collar [c]		
	Total work experience	2.49 [1.33- 4.65]*	**2.90[1.54- 5.46]***
	≤ 2 year Vs. > 2 year [c]		
	Job insecurity	NS	**1.58 [1.02- 2.45]***
	Yes Vs. No [c]		
	Contract type*Gender		**14.66 [1.68- 127.55]***
		Model 3_all-Without interaction	Model 3-all_ With interaction
	Contract type	NS	**0.08 [0.01- 0.70]***
	Temporary Vs. permanent [c]		
	Education	1.97 [1.06- 3.67]*	**1.96 [1.06- 3.64]***

Low Vs. medium and high [c]		
Total work experience	2.78 [1.46- 5.29]*	**3.22 [1.67- 6.21]***
≤ 2 year Vs. > 2 year [c]		
Job insecurity	NS	**1.68 [1.07- 2.64]***
Yes Vs. No [c]		
Dangerous conditions	1.91 [1.08- 3.39]*	**1.87 [1.05- 3.32]***
Yes Vs. No [c]		
Contract type*Gender	-	**12.69 [1.40- 114.96]***

NS: not significant results

Table 16 shows that the results for Model 1 did not change: only education type is significant variable before and after including the interaction between contract type and gender.

Regarding Model 2, as there is a significant interaction between contract and gender ($p=0.015< 0.05$) we cannot conclude in general (men and women in one group) if there is a significant dependence of work accidents on contract type. Due to the significant interaction we have to divide it into conclusions for men only and for women only which is visualized in the above figure.

Actually, Model 1 is an elementary and Models 2 and 3 are more advanced, which enables us to detect information about possible predictors for work accidents.

As an additional result with the new version of model 3 (with the interaction), we were able to detect the association of job insecurity and work accidents, which is in line with previous work. Also our results regarding contract type became significant, but the odds ratio value is less than one which mean that depending on our reference category in our study which is permanent worker, the probability of being victim of work accidents are higher between permanent workers compared to temporary workers. So, our results still that temporary workers in Belgium are not at increased risk of work accidents which is in contrast to previous research.

4.3.1.4 Discussion and interpretations of the results from the EWCS data

This study gives an overview of the associations between non-standard work arrangements and work-related accident absence in Belgian workers. Generally, the results show that shift work was significantly associated with work-related accident, which is in line with previous work in this field [216-218].

A plausible methodological explanation for our finding that shift work may contribute to the high risk of work- related accidents is the fact that shift work may disrupt the body's regular schedule and normal sleep styles, leading to increased fatigue due to sleep disturbance. Sleepiness and fatigue in the work place can lead to work accidents, injuries, errors, fatalities, poor concentration and absenteeism. For example, about one in three shift workers are affected by insomnia and up to 90 % of shift workers report regular fatigue and sleepiness at the workplace. Furthermore, shift work may cause lower levels of co-worker support and supervision during non-daytime work schedules. Another possibility to explain our results is that shift work can be more stressful mentally, physically, and emotionally and cause stress and lack of concentration [219, 220].

In the current study, we further investigated the reasons behind the susceptibility of shift workers towards work-related accidents. A positively significant correlation between shift work, job stress, work-life balance and self-rated health were found. The correlation coefficients between these covariates and shift work differ highly significantly from 0 as $p<0.01$ in all cases. So workers with shift work are also the workers that struggle more with the work-life balance and have more stress due to their job. Moreover, the workers with shift work evaluate their health as more bad. All these expressions of not feeling well can lead to work related accidents and injuries.

However, regarding contract type, no difference between precarious and permanent workers was observed in terms of work-related accident absence. This is in accordance with some previous work in this field [130, 131] but contradicts other research [103, 125]. A possible explanation for the inconsistent results in the literature concerning contract type might be that the group of workers with a precarious contract consists of a rather heterogeneous population. Some authors solely consider casual and temporary employment (including agencies leasing workers) as precarious [131] whereas others also include self-employment and home based work [117, 130]. Our sample consisted of only two categories of precarious workers: fixed-term and temporary employment contract, which may have influenced the results. Another

possible explanation is that workers in a precarious work arrangement may be hesitant to report injuries and accidents in order to increase their chances of getting a permanent contract and more job security. An additional reason can also be the voluntary aspect of choosing such a contract type of which we do not have information in the EWCS. It is possible that for several reasons, some persons (in particular women) have freely chosen for this type of contract while others are in an undesirable precarious employment.

Our results regarding the two other indicators of non-standard work arrangements "long working hours" and " multiple jobs" did not confirm earlier studies that found an excess risk of occupational injuries among workers having these employment conditions [147, 159, 164, 221, 222]. Probably, due to the low numbers of precarious workers, those doing long hours, and those doing multiple jobs in the present study, results were not significant. Therefore, these data are not shown. For example if n is the size of your total population that is used in the analysis, a factor k that is required to have significant odds ratios was calculated. This means that at least k*n participants are required to have a 95% C.I. where the value 1 is not part of with the same proportions and the same value for the estimation of the odds ratio. The calculated values for k were all greater than 1 for these three aforementioned indicators, indicating that the sample size is too small to have significant results with the current data. So, in case of working long hours as predictor, a sample of at least k*n with k>60.36 for model 1 (k>34.22 for model 2 and k>10.81 for model 3) is required to have significant odds ratios with alpha=0.05.

Regarding the intrinsic factors of the employees in the results such as gender, age, general physical and psychological condition, all these factors were included in our models because previous research found them to be important risk factors for work accidents and injuries. From our results we can't conclude that these factors in Belgium might be risk factors of being work accidents victim because the regression analysis results were not statistically significant. Furthermore, regarding the underlying diseases, we did not include it in our models because we were concentrating about accidents and occupational injuries more that about the health problem. Our dataset did not have any question regarding the underlying diseases. However, our models included self-rated health evaluated by the following question" how you rate your health in general: bad vs. good. Those who rated their health as bad were found to be at higher risk for accidents in Belgium.

4.3.1.5 Study strengths and limitations from the EWCS data

Although this study which was based on the EWCS data adds evidence to the existing knowledge about work-related accident, there are several limitations that should be considered when interpreting the results. One possible shortcoming is that due to the cross-sectional nature of this study, an association between two variables can be established, but it is not possible to determine the causality of this relationship. Actually, it is worth mentioning that the associations between aspects of non-standard work and work-related injuries and accidents from most of previous studies have been also established by cross-sectional studies and reviews (Appendix-1).

It is necessary to study the relation of specific job contents of shift-work which are related to occupational accidents. However, this information about specific job contents of shift-work (Workload, job stress related job contents and accident risks at work, etc.) is lacking in the present study. In addition, the results are based on self-reports and the respondents were only asked whether they were absent due to a work-related accident or not. They were not questioned about the total number of accidents they had during the last year nor about the cause and severity of the accident. By consequence we cannot make a differentiation between acute and chronic injuries using the actually database. A reporting bias might be suspected related to common method variance. However, it should be noted that the questions are formulated in a general manner and are not specifically asking for the relationship between non-standard work arrangements and work-related accident. Therefore, we suppose that the common method variance bias may be limited**.**

Nevertheless, a number of particular strengths of the present study should be mentioned. The research was based on a big harmonized sample size of the Belgian working population. All responses were collected by face-to-face interview at home and the response rate was relatively high for such a large survey (44%). Furthermore, the 5th EWCS survey has been used in many published studies and the findings could advance worker health and safety [132, 223] and finally, several confounders (important factors in the context of work accidents) were included.

4.3.2 For Europe

4.3.2.1 Descriptive results from the fifth EWCS database for European workers

Descriptives of the sample studied are presented in table 17. A total number of 26839 workers were included in the analyses. The study population consisted of 14324 men (53.37%) and 12515 women (46.63%). Average age was 40 years (± 12 SD) and 30.55% of the participants were highly educated. Workers, who reported occupational injuries during the past 12 months, represented 8.44% of the sample. About 14% of the sample had a precarious contract, while 29.35% of the sample was working long hours. Almost 7 % of the sample had multiple jobs and 20.29% of the workers reported shift work. The majority of the respondents (79.11%) rated their health as good, and 67.69% experienced stress. A third (35.25%) of the workers suffered from overall fatigue and 18.19% had sleep difficulties.

Table 17. Characteristics of the study population (n = 26839).

Individual and work-related factors	Total study sample
Gender: $\boldsymbol{n}$ (%)[a] n = (26839)	
Male	14324 (53.37)
Female	12515 (46.63)
Mean age (SD)	40.00 (12.0)
Injured: $\boldsymbol{n}$ (%)^{a} n =(26799)	
No	24537 (91.56)
Yes	2262 (8.44)
Contract type: $\boldsymbol{n}$ (%)^{a} n =(26839)	
Precarious contract	3849 (14.34)
Permanent contract	22990 (85.66)
Long hours: $\boldsymbol{n}$ (%)^{a} n = (26271)	
Never	18561 (70.65)
Yes	7710 (29.35)

Multiple jobs: n (%)^a	
n = (26721)	
No	24868 (93.07)
Yes	1853 (6.93)
Shift work: n (%)^a	
n = (26653)	
No	21245 (79.71)
Yes	5408 (20.29)
Mean work experience: (SD)	9.78 (9.63)
Education level: n (%)^a	
n = (26660)	
Primary level	7983 (29.94)
Low secondary	9219 (34.58)
High secondary	1315 (4.93)
Tertiary level	8143 (30.55)
Company size: n (%)^a	
n = (25967)	
Small	7639 (29.42)
Medium	11552 (44.49)
Large	4316 (16.62)
Very large	2460 (9.47)
Economic activity: n (%)^a	
n = (26533)	
Construction	1895 (7.15)
Mining , quarrying, manufacturing, electricity, gas and water	5079 (19.14)
Agriculture, hunting, forestry and fishing	534 (2.01)
Services	19025 (71.70)
Self-rated health: n (%)^a	
n = (26769)	
Bad	5592 (20.89)
Good	21177 (79.11)
Stress: n (%)^a	

n = (26766)	
No	8647 (32.31)
Yes	18119 (67.69)
Overall fatigue: n (%)[a]	
n = (26767)	
No	17331 (64.75)
Yes	9436 (35.25)
Sleep difficulties: n (%)[a]	
n = (26783)	
No	21911 (81.81)
Yes	4872 (18.19)
Sunday work: n (%)[a]	
n = (26566)	
No work on Sunday	19934 (75.04)
At least one Sunday per month	6632 (24.96)
Work-life balance: n (%)[a]	
n = (26678)	
Poor	4755 (17.82)
Good	21923 (82.18)

[a] Calculated according to the percentage of the valid count

4.3.2.2 Univariate associations between baseline measures and injury

Table 18 shows univariate associations between gender and work injuries. The male subjects were significantly more injured at work than women. No significant differences were found between precarious and permanent workers in terms of being injured at work. The univariate association showed that those who declared doing long working hours had more injuries than those not doing long hours. Furthermore, workers doing multiple jobs and shift work were more injured than others.

Table 18. Univariate associations between baseline measures and work injury.

Variables	Over the past 12 month, did you suffer from an injury?		
	Yes (%)	**No (%)**	**X^2 (P value)**
Gender			352.04 ***
Male	2210 (11.43)	17125 (88.57)	
Female	914 (5.73)	15039 (94.27)	
Contract type			0.001 ^{ns}
Precarious contract	325 (8.45)	3520 (91.55)	
Permanent contract	1937 (8.44)	21017 (91.56)	
Long hours			161.99***
Never	1702 (7.34)	21461 (92.66)	
Yes	1270 (11.49)	9781(88.51)	
Multiple jobs			24.23***
No	2811 (8.65)	29691 (91.35)	
Yes	299 (11.50)	2301 (88.50)	
Shift work			27.38 ***
No	2471 (8.51)	26579 (91.49)	
Yes	634 (10.62)	5336 (89.38)	
Education level			131.84 ***
Primary level	1074 (9.89)	9788 (90.11)	
Low secondary	1221 (10.01)	10978 (89.99)	
High secondary	119 (6.71)	1657 (93.29)	
Tertiary level	631 (6.23)	9490 (93.77)	
Company size			9.75*
Small	1344 (9.41)	12938 (90.59)	
Medium	1117(8.76)	11632 (91.24)	
Large	410 (9.04)	4127 (90.96)	
Very large	195 (7.62)	2363 (92.38)	
Economic activity			366.25***
Construction	463 (16.71)	2308 (83.29)	
Mining , quarrying, manufacturing, electricity, gas and water	558 (9.45)	5346 (90.55)	
Agriculture, hunting, forestry	265 (15.21)	1477 (84.79)	

and fishing			
Services	1804 (7.39)	22617 (92.61)	
Self-rated health			293.22***
Bad	1051 (13.81)	6561 (86.19)	
Good	2070 (7.51)	25513 (92.49)	
Stress			152.11***
No	739 (6.23)	11109 (93.77)	
Yes	2374 (10.19)	20919 (89.81)	
Overall fatigue			605.05***
No	1372 (6.07)	21238 (93.93)	
Yes	1746 (13.83)	10879 (86.17)	
Sleep difficulties			458.26***
No	2117 (7.34)	26762 (92.66)	
Yes	1004 (15.75)	5373 (84.25)	
Sunday work			39.10***
No work on Sunday	2064 (8.24)	23010 (91.76)	
At least one Sunday per month	1006 (10.35)	8713 (89.65)	
Work-life balance			162.28***
Poor	835 (12.93)	5626 (87.07))	
Good	2268 (7.93)	26305 (92.07)	

P value < 0.05 (*), P value <0.01 (**), P value < 0.001 (***), ns: non-significant

4.3.2.3 Multilevel binary regression analysis results

Tables 19 and 20 summarize Odds Ratios (OR) and 95% Confidence Interval (95% CI) from the multilevel logistic regression analysis. The associations between the separate non-standard work indicator and occupational injuries are presented in Table 19 (Step 1, with adjustment for covariates). An increased occupational injury risk was observed for those working long hours (OR 1.24, 95% CI 1.13–1.36), having multiple jobs (OR 1.25, 95% CI 1.07–1.45) and shift work (OR 1.23, 95% CI 1.09-1.38). However, the relationship between contract type and work injuries was not significant (OR 0.92, 95% CI 0.79–1.07). These tables also summarize the calculated Variance of Partition Coefficients (VPC) for all four

non-standard work arrangements indicators. The calculated VPC value for contract type (first indicator) was equal to 6.29%, which means that 6.29% of the differences in occupational injuries are attributable to differences between countries (level 2) and 93.71% is due to differences between individuals (level 1).

When all non-standard work arrangements were studied simultaneously with adjustments for covariates and with an interaction term between gender and each irregular work arrangement, none of the gender interactions were significant (results are not shown).

Including all non-standard work factors simultaneously in the model with adjustments for covariates (Step 2, Table 20), did not change the overall results.

Table 19. Results from the multilevel binary regression analysis for long hours, multiple jobs, precarious work and shift work separately in relation with occupational injuries.

Non-standard work arrangement indicators	**Reference category: no injury**							
	Crude model				**Adjusted model [b]**			
Step 1	**OR**	**[95%CI]**	**P-value**	**VPC**	**OR**	**[95%CI]**	**P-value**	**VPC**
Contract type Precarious Vs. permanent [a]	1.01	[0.89- 1.15]	0.77	4.16%	0.92	[0.79- 1.07]	0.30	6.29%
Long hours Yes Vs. never [a]	**1.65**	[1.52- 1.79]	<0.001	2.48%	**1.24**	[1.13- 1.36]	<0.001	4.55%
Multiple jobs Yes Vs. no [a]	**1.32**	[1.15- 1.51]	<0.001	2.07%	**1.25**	[1.07- 1.45]	0.003	4.72%
Shift work Yes Vs. no [a]	**1.34**	[1.22- 1.48]	<0.001	2.72%	**1.23**	[1.09- 1.38]	0.001	5.02%

OR: Odds ratios, [95%CI]: 95% confidence interval, VPC: Variance of Partition Coefficient.

Significant associations are in bold

[a] Reference category

[b] Adjusted for gender, age, experience, education, company size, economic activity, self-rated health, stress, overall fatigue, sleep difficulties, Sunday work and work-life balance.

Table 20: Results from the multilevel binary regression analysis for long hours, multiple jobs, precarious work and shift work simultaneously, in relation with occupational injuries.

Non-standard work arrangement indicators	**Reference category: no injury**			
Step 2	**OR**	**[95%CI]**	**P-value**	**VPC**
Contract type Precarious Vs. permanent [a]	0.91	[0.78- 1.07]	0.27	
Long hours Yes Vs. never [a]	**1.29**	[1.15- 1.44]	< 0.001	
Multiple jobs Yes Vs. no [a]	**1.23**	[1.03- 1.47]	0.02	**6.85%**
Shift work Yes Vs. no [a]	**1.35**	[1.18- 1.54]	<0.001	

OR: Odds ratios, [95%CI]: 95% confidence interval, VPC: Variance of Partition Coefficient.
Significant associations are in bold
[a] Reference category
Adjusted for gender, age, experience, education, company size, economic activity, self-rated health, stress, overall fatigue, sleep difficulties, Sunday work and work-life balance.

4.3.2.4 Discussion and interpretations of the results

To the best of our knowledge, this study gives a first European overview of the associations between non-standard work arrangements and occupational injuries. Generally, the results show that long working hours, multiple jobs and shift work were significantly associated with occupational injuries, which is in line with previous work in this field [147, 154, 162, 164, 216-218, 222, 224]. However, regarding contract type, no difference between precarious and permanent workers was observed in terms of occupational injury risk. This is in line with some previous work in this field [130, 131] but contradicts other research [103, 125, 129]. Explanations for the inconsistent results in the literature concerning contract type have been explained in section (4.3.1.4) in details.

Our results regarding the three other indicators of non-standard work arrangements, "long working hours, multiple jobs and shift work", confirm earlier studies that found an excess risk of occupational injuries among workers having these employment conditions. Overall fatigue and sleeping difficulties are proposed as a plausible mechanism explaining the consistent association between these three indicators of non-standard work arrangements and occupational injury [147, 164, 217, 218, 221]. Although significant differences in fatigue and sleep were observed between workers with non-standard arrangements compared to their counterparts with regular work, adding these covariates in the analyses, only slightly changed the odds ratios.

Employees in non-standard work schedules have a higher need to recuperate from work-induced fatigue but have sometimes not enough time to recover from exhaustion [221]. In addition, the time left for private and family responsibilities is also decreased, which may lead to irregular lifestyles. This irregular lifestyle possibly results in (more) sleeping problems and influences health behavior.

Nevertheless, a number of particular strengths of the present study should be mentioned. The research was based on a big harmonized sample size of the European working population, covering 27 countries. All responses were collected by face-to-face interview at home and the response rate was relatively high for such a large survey. Furthermore, multilevel modelling was applied which allowed taking into account the hierarchical nature of the data and finally, several confounders (important factors in the context of occupational injuries) were included. Indeed, this study is the first to examine the relations between irregular work arrangements and occupational injuries for all 27 member states of the European Union.

4.4 Concluding remarks

This chapter presented the results and discussion of the three study questions: (1) Are Belgian non-standard workers at a higher risk of having work accidents and injuries compared to standard workers or not? (2) What is the relationship between non-standard work arrangements indicators such as non-standard work, long working hours, multiple jobs and shift work and work-related accident absence in Belgium? And (3) what is the relationship between non-standard work arrangements indicators and injuries in Europe?

Regarding the first aim, a population of Belgian workers was surveyed using the VOW survey to investigate whether or not Belgian non-standard workers experience more injuries compared to standard workers. However, contrary to our expectations, we did not find that non-standard workers report increased occupational injuries compared to standard workers. In addition, low educated workers and those exposed to dangerous situations were found to be other risk factors associated with work injuries in Belgium.

Regarding our second aim, a large dataset of Belgian employees was used via the fifth EWCS survey to investigate the relationship between non-standard work arrangements indicators such as non-standard work, long working hours, multiple jobs and shift work and work-related accident absence in Belgium. Our results gave an overview of the associations between non-standard work arrangements and work-related accident absence in Belgian workers. Generally, the results show that shift work was significantly associated with work-related accident absence, which is in line with previous work in this field. Using a representative European sample from the fifth EWCS and taking into account several sociodemographic and work characteristics, our results confirmed that indicators of non-standard work arrangements, except for precarious contract type, were significantly associated with occupational injuries. Finally, the interpretation of these findings as well as strengths and limitations of each study have been presented in details in this chapter.

Chapter 5

Conclusions and recommendations for future work

5.1 Conclusions from the VOW database

As was explained in depth in chapter 4, the VOW database has been used firstly to investigate whether or not Belgian non-standard workers are more injured at work than standard ones, and secondly for identifying other relevant risk factors of work accidents in Belgium. Our hypothesis was that the risk of having a work accident is higher among Belgian non-standard workers compared to standard workers.

Our results from the VOW data do not support the hypothesis that non-standard workers have more occupational accidents than standard workers. However, other characteristics related to non-standard employment such as low experience, educational attainment, and dangerous work sector were positively associated with a higher risk of occupational accidents. Therefore, educational strategies and better employment arrangements are strongly advised to prevent occupational injuries.

Our results can be described by the recent efforts and legal initiative taken by the Belgian government to decrease work place accidents as the Royal Degree of 15December 2010 which forbids temporary work agencies to offer the following jobs as gazing activities, removal of asbestos and poisonous waste products. Also, the employers in Belgian decreased the employment in high-hazard occupations, such as mining. Other measures include financial incentives for employers who improved the working conditions and implemented accident prevention strategies, including equipment upgrades. On the other hand, better prevention, greater adherence to regulations, labor inspections and accident prevention policies; have helped to ameliorate the situation.

Other research found an increased risk of accidents among non-standard workers, suggesting that they work in poor working conditions, including less availability of personal protective equipment and the absence of safety training. Also they are usually doing the more hazardous jobs and have the more insecure employment. In additions, non-standard workers have weaker bargaining power for working conditions than regular workers; they are more likely to work in workplaces with greater risks of occupational injury. It has been reported that companies tend to avoid spending money on improving working conditions. As a result, permanent workers through their unions are able to avoid the more dangerous jobs. This leaves only nonstandard to fill those positions, thus raising their likelihood of injury [103, 119, 121, 225]. By contrast, several other studies found that non-standard workers did not have a higher occupational injury rate than permanent workers. The most important

explanation for this finding was that fixed-term workers are concentrated in public services such as health care and education which contain a prevalence domination of female workers [130].

The result of our study may be caused by the unique situation of Belgium. For the generalization of the result, more study for the association between the nonstandard work and occupational injury is required in various countries.

At the individual and organizational level, we recommend the implementation of more safety measures and educational programs to improve in particular the knowledge and skills of low-educated and less-experienced workers. At the policy level, Belgian and European strategies should emphasize the importance of the development of more and better jobs: further legislative initiatives should limit exposure to dangerous working conditions.

Main differences between Belgium and Europe at the policy level are not existed. Because, Belgium is a member state from Europe and Europe aim at improving the European working conditions to decrease work accidents and injuries which in turn will decrease the enormous financial cost caused by these accidents. My results were about Belgian workforce, and in this work we described the recent efforts and legal initiative taken by the Belgian government to decrease work place accidents as labor inspections and accident prevention policies; the Royal Degree of 15 December 2010; and decrease the employment in high-hazard jobs etc...

Regarding the European policy level, we have searched more about it because we did not include it in our review. However, health and safety at work is one of the areas where the EU has had the biggest impact with a solid legal framework covering the maximum number of risks with the minimum number of regulations. The Commission also works with the European Agency for Health and Safety at Work and the European Foundation for the Improvement of Living and Working Conditions to disseminate information, offer guidance and promote healthy working environments particularly in small businesses.

Directive 89/391/EEC on measures to improve safety and health at work:

- Encourages improvements in occupational health and safety in all sectors of activity, both public and private.
- Promotes workers' rights to make proposals relating to health and safety, to appeal to the competent authority and to stop work in the event of serious danger.

- Seeks to adequately protect workers and ensure that they return home in good health at the end of the working day.

The European employment strategy (EES) dates back to 1997, when the EU Member States undertook to establish a set of common objectives and targets for employment policy. Its main aim is the creation of more and better jobs throughout the EU [226]**.**

Some highly dangerous substances such as asbestos, which causes lung cancer and other fatal respiratory diseases are now banned or under strict control [227]. However, other harmful substances are still widely used, and legislation is in place to ensure that the risks associated with them are properly managed. Dangerous substances any liquid, gas or solid that poses a risk to workers' health or safety can be found in nearly all workplaces. Across Europe, millions of workers come into contact with chemical and biological agents that can harm them. In fact, 15 % of EU workers have to handle dangerous substances as part of their job, and another 15 % report breathing in smoke, fumes, powder or dust at work.

Every EU worker has certain minimum rights relating to:

- **Health and safety at work**: general rights and obligations, workplaces, work equipment, specific risks and vulnerable workers
- **Equal opportunities for women and men**: equal treatment at work, pregnancy, maternity leave, parental leave
- **Protection against discrimination** based on sex, race, religion, age, disability and sexual orientation
- **Labour law**: part-time work, fixed-term contracts, working hours, employment of young people, informing and consulting employees.

Within this field, the European Commission's policy agenda for the period 2014–2020 was set out in a Communication titled EU strategic framework on health and safety at work for 2014–2020 (COM (2014) 332 final), which outlined three major challenges: to improve implementation of existing health and safety rules; to improve the prevention of work-related diseases by tackling new and emerging risks without neglecting existing risks; to take account of the ageing of the EU's workforce. This framework is designed to ensure that the EU continues to play a leading role in the promotion of high standards for working conditions within Europe (as well as wider afield), in keeping with the Europe 2020 strategy.

To better protect the more than 217 million workers in the EU from work-related accidents and diseases, the European Commission has adopted a Strategic Framework on Health and Safety at Work 2014-2020, which identifies key challenges and strategic objectives for health and safety at work, presents key actions and identifies instruments to address these.

This Framework aims at ensuring that the EU continues to play a leading role in the promotion of high standards for working conditions both within Europe and internationally, in line with the Europe 2020 Strategy.

The Strategic Framework identifies three major health and safety at work challenges [212]:

- To improve implementation of existing health and safety rules, in particular by enhancing the capacity of micro and small enterprises to put in place effective and efficient risk prevention strategies
- To improve the prevention of work-related diseases by tackling new and emerging risks without neglecting existing risks
- To take account of the ageing of the EU's workforce

By comparing these European legislatives with that of the Belgian stated in my thesis I can say that both strategies aiming at decreasing the work-related accidents and the resulting occupational injuries.

5.2 Conclusions from the fifth EWCS database

As was explained in depth in chapter 4, as well, the fifth European Working Condition Survey (EWCS) database has been used for examining the associations between four non-standard work arrangements indicators such as contract type, long working hours, multiple jobs, shift work and work- related accident absence, taking into account several demographic and work-related confounding factors in a large dataset of Belgian employees. Our results demonstrated that the indicators of non-standard work arrangements under study, except shift work, were not significantly associated with work- related accident absence.

In conclusion, despite the methodological considerations, the results of the present study have important implications for workers, employers and policy makers. The growing number of non-standard work arrangements has become a serious threat to the safety and health of workers. One indicator investigated in this study, such as shift work was significantly

associated with work- related accident absence. To promote health and safety, more attention should be paid in particular to those doing shift work. At the individual and organizational level, we recommend the implementation of more safety measures and educational programs that aim improving awareness about the deleterious effects of shift work. At the policy level, Belgian strategies should continue to emphasize the importance of the development of more and better jobs.

In general, the results show that shift work was significantly associated with work-related accidents, which is in line with previous studies in this field. Previous studies explained this association by the fact that shift work may disrupt the body's regular schedule and normal sleep styles, thereby leading to increased fatigue due to sleep disturbance. Sleepiness and fatigue at workplace can lead to work accidents, injuries, errors, fatalities, poor concentration, and absenteeism. In this study, our results were explained by the fact that workers with shift work are also workers who struggle more with the work-life balance and have more stress due to their job. Moreover, workers with shift work evaluate their health as poor. The findings will help in designing public policy effective in increasing shift workers' safety at work.

Our results for Belgian workers with regard to the two other indicators of non-standard work arrangements; "long working hours and multiple jobs" did not confirm the findings of previous studies that determined an excess risk of occupational injuries among workers with these employment conditions. Most likely, due to the lower number of precarious workers, those performing long hours, and those performing multiple jobs in this study. The lower number may be resulted from the implications for policies and measures that helped to ameliorate their situation in Belgium.

For those doing long hours and multiple jobs, other research explained these results by their higher time pressure, more sleeping disorders, subsequent fatigue due to extra working hours and mental stress from alternating between different types of exposures.

5.3 Recommendation for future work

In our work, the two datasets "the VOW and the fifth European Working Condition Survey", that we have used, have both the cross-sectional nature. Due to the cross-sectional design of any study, an association between two variables can be established but it is not possible to

determine the causality of this relationship. So, as future work I suggest a self developed questionnaire in which we can include all the questions about the reason of having more or less work accidents among Belgian non-standard workers. In addition, we can include a question about whether or not those doing temporary work tend to do multiple jobs in a similar way to a recent article reporting that in the United States working population, those with non-standard work arrangements tend to work in multiple jobs and that multiple jobs increased the risk of injury . In our study, we were unable to measure the number of jobs and this may be an area for future research.

Furthermore, to avoid the drawbacks of the cross-sectional design of our data, conducting a prospective study for a precise monitoring period (3-years or more) in the future (for example from 1 September 2017 to September 2020), is highly advised, in which the population will be followed up for the incidence of work-related injuries and accidents during the three years study period.

In the second chapter, we have summarized the work that has been accomplished regarding five indicators of non-standard work arrangements such as contract type, doing long working hour, doing multiple jobs, shift workers and having job insecurity in the work. In our present work, we have included only the first four indicators of non-standard work arrangement. A significant amount of published research has demonstrated that workers having job insecurity at work experience higher rates of work-related injuries and health problems compared to other working populations. Another idea for future research for those who are interested in this field is to investigate job insecurity in Belgian non-standard versus standard workers, in particular the association with work related accident.

In our work we investigated contract type at one point in time by asking whether or not Belgian temporary workers are more injured at work than permanents ones. Others can change temporary – permanent and vice versa. It would be useful to investigate if this has an effect on the occurrence of occupational accidents and injuries.

As the European Working Condition Survey provides a new survey each five years about working conditions in the European countries, new data collected in 2015 are becoming available. These new results can be used to investigate new risks factors and trends in work related accidents in temporary versus permanent workers; in young versus old workers; or in men versus women workers in Europe. Actually, when we started doing this work, only the 2010 edition of the EWCS was available that is why we have used the 2010 database to

investigate our research question in this thesis. Now the 2015 edition of the EWCS are available that is why the results of our third research question are under study and they will be presented as an article in the future using the recent edition of the European Working Conditions Survey (6^{th} edition).

Although many researchers have been performed in different European and non-European countries, additional studies are still needed for EU27. Since, the national strategies on occupational health and safety in the range of countries that make up the European Union resulted from the huge variation among these countries, in terms of culture, economy, politics, their history, the difference in reporting and recording systems, difference in the laws and regulatory practices. Even when such problems of this enormous variation have been accounted for, the question still remains whether it is meaningful to compare, work accidents among the different European regions, when their economies represent completely different stages in the evolution of industrialization. Therefore, future studies on this topic will be consequently an attempt to extend the existing literature with a large harmonized European sample covering 27 countries with (for example) the three objectives: firstly, to explore whether European non-standard workers are more injured at work than standard ones or not; secondly, to investigate the influence of making a mistake at work on other workers' safety; thirdly, to compare occupational injuries in a Western Europe country with that of an Eastern European country and finally, to compare between Western and Eastern European non-standard workers in term of work injuries.

In Europe, there are several other sources of databases which provide data concerning work-related accidents and injuries. The European Statistics on Accidents at Work (ESAW) include case-by-case data on occupational accidents with more than three days of absence from work and fatal accidents. So, for those researchers who are interested in work-related accidents and injuries, these data sources can be useful to further investigate our hypotheses and other research questions. The European Working Conditions Survey (EWCS) asked respondents how many days off work due to health problems could be attributed to an accident. Therefore, only accidents with absence from work were reported in this survey. So, the EWCS gives information about total number of absence due to a work- related accident. Subsequently, future research can use the ESAW to study more severe accidents (> 3days absence) and EWCS for both minor and major accidents. Also, looking for data on accidents without absence can be an interesting issue too.

Another new interesting point for future work is research on being witness to a work accident. Work accidents engender costs to the employer which are substantial and rising. Therefore, accident analyses are conducted to discover the reasons why an accident occurred and to prevent future accidents. Witnesses are commonly a good source of information for explaining the course of events that led to the accident. In the literature, a substantial number of papers put emphasis on the follow-up of this issue. Many researchers demonstrated that higher levels of anxiety and depression were reported by witnesses and victims of work accidents than those without work accidents. About 17.5% and 14.3% of the work accident witnesses and victims, respectively, declare symptoms harmonious with PTSD (Post-traumatic Stress Disorder) [228]. Witness workers to fatal work accidents had a high rate of PTSD and depressive symptoms including insomnia, anxiety, somatisation, gastrointestinal symptoms, decreased interest in work and other activities, guilt and depressed mood [229].

Witnesses may be under severe emotional stress not only at the time and the scene of the accident but also in the long term (e.g. development of a post-traumatic stress syndrome) [228, 229]. Alongside these negative psychological effects, we could hypothesize that witnessing an incident may have some positive influence. We assume that such a personal experience affects a person's risk perception and his attitude and safety behavior will change in a more favorable way. After (witnessing) an accident, the worker will be more aware of the risks associated with a particular behavior and he will perform his tasks and activities with more care to prevent future accidents. In the literature, several studies can be retrieved that examined the risk perception, attitude or behavior of persons before and after accidents. The first example are the reports on the nuclear accidents in Chernobyl and Fukushima: these events dramatically changed the risks of nuclear power perceived by the public and has significantly decreased public acceptance [230, 231]. Unfortunately, serious accidents have to happen first before people consider acting safer and changing their behavior accordingly. On the basis of the exposure to more risks and hazardous work conditions, we could assume that the likelihood of witnessing a work accident is higher among persons in non-standard work compared with standard work arrangements. In future work, we could pursue these concerns by asking whether or not Belgian non-standard workers are more witness to a work accident than standard ones. To the best of the authors' knowledge, no studies have been conducted on the comparison between standard and non-standard workers in term of witness to work accident, an issue that so far is less investigated.

Furthermore, another point of interest for future research is to identify the influence of a person's job on another worker's safety or to identify workplace injuries caused by co-workers is also a rarely investigated subject. However, to the best of our knowledge, no studies have been conducted on injuries caused by fellow employee. Workplace injuries are the results of work accidents, can be caused by anything or anyone and at any time. Oftentimes, these workplace injuries are caused by co-workers. In contrast to occupational injuries of non-standard workers, the influence of worker's work on other worker's safety is an often-neglected subject. The huge majority of workplace injuries are covered by worker's compensation system. So, in the literature, a substantial number of reports put emphasis on the possibility to claim compensation for a work injury due to a mistake caused by co-workers [232-234]. Another study examined the communication of health care errors such as: verbal, written, or other form of communication to patients and their families. Not intentional acts of clinician performance that may eventually cause patients harm [235]. On the other hand, causing injuries to others might be sometimes intentional action. Some employees were victims of intentional action caused by co- worker assault, that resulted in occupational injuries (for example, one employee report about his permanent shoulder injury caused by co-worker assault [236], whereas many times causing injuries to others resulted from co-worker's dereliction.

Our current work concluded that less experienced workers, low educated workers, those who rated their health as bad, shift workers, workers from the construction sector, and those exposed to biomechanical exposure (BM) are more frequent victims of a work-related accident absence and occupational injuries and were positively associated with a higher risk of occupational accidents. So, the results of the present study have important implications for policy makers and employers in Belgium. Preventive measures should improve working conditions, especially for the aforementioned injury risk factors, provide knowledge through specific training periods for occupational hazard assessment from a worker's first years in a work, and help workers to be more aware of risks associated with their education level, years of employment and type of job.

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Appendix-1

An overview tables showing the type of the study (prospective, retrospective or cross-sectional studies) for the reviewed previous studies presented in chapter 2 which explained the associations between aspects of non-standard work and work-related injuries.

Long working hours and work-related accidents **Study title**	**Study type**
A. E. Dembe, J. B. Erickson, R. G. Delbos, and S. M. Banks, "The impact of overtime and long work hours on occupational injuries and illnesses: New evidence from the United States," *Occupational and environmental medicine,* vol. 62, pp. 588-97, Sep 2005.	A longitudinal study -Observational study
A. C. Macedo and I. L. Silva, "Analysis of occupational accidents in Portugal between 1992 and 2001," *Safety science,* vol. 43, pp. 269-286, 2005.	Official records in the decade 1992–2001
X. Dong, "Long workhours, work scheduling and work-related injuries among construction workers in the United States," *Scandinavian journal of work, environment & health,* vol. 31, pp. 329-35, Oct 2005.	A longitudinal study -Observational study
S. Vegso, L. Cantley, M. Slade, O. Taiwo, K. Sircar, P. Rabinowitz, et al., "Extended work hours and risk of acute occupational injury: A case-crossover study of workers in manufacturing," *American journal of industrial medicine*, vol. 50, pp. 597-603, Aug 2007.	A case-crossover design
A. Wagstaff and J. Sigstad Lie, "Shift and night work and long working hours: A systematic review of safety implications," *Scandinavian journal of work, environment & health*, vol. 37, pp. 173-85, May	A systematic review

2011.	
A. Nakata, "Effects of long work hours and poor sleep characteristics on workplace injury among full-time male employees of small- and medium-scale businesses," *J Sleep Res,* vol. 20, pp. 576-84, Dec 2011.	Cross- sectional study- A self-administered questionnaire during August-December 2002-
A. Arlinghaus, D. A. Lombardi, J. L. Willetts, S. Folkard, and D. C. Christiani, "A structural equation modeling approach to fatigue-related risk factors for occupational injury," *American journal of epidemiology,* 2012.	An annual survey of a representative cross-sectional sample of the US population- National Health Interview Survey (pooled across 6 years, 2004–2009).
A. Wirtz, D. A. Lombardi, J. L. Willetts, S. Folkard, and D. C. Christiani, "Gender differences in the effect of weekly working hours on occupational injury risk in the United States working population," *Scandinavian journal of work, environment & health,* vol. 38, pp. 349-57, Jul 2012.	A cross-sectional study

Multiple jobs injuries and work-related accidents Study title	Study type
X. S. Dong, X. Wang, and J. A. Largay, "Occupational and non-occupational factors associated with work-related injuries among construction workers in the USA," *Int J Occup Environ Health,* vol. 21, pp. 142-50, 2015.	A longitudinal study -Observational study
H. R. Marucci-Wellman, J. L. Willetts, T. C. Lin, M. J. Brennan, and S. K. Verma, "Work in multiple jobs and the risk of injury in the US working population," *Am J Public Health,* vol. 104, pp. 134-42, Jan 2014.	A cross- sectional survey: The National Health Interview Survey
A. Houston, Y. Young, and E. F. Fitzgerald, "Work-related injuries: An old problem revisited in the first representative US sample of home health aides," *Journal of aging and health,* vol. 25, pp. 1065-81, Sep 2013.	A cross-sectional analysis was conducted using data from the 2007 National Survey of Home Health Aides
A. M. Bush, S. E. McKee, and T. L. Bunn, "Multiple jobholder mortality patterns in Kentucky: An examination of occupational fatalities," *American journal of industrial medicine,* vol. 56, pp. 881-888, 2013.	A retrospective analysis using Kentucky Fatality Assessment and Control Evaluation (FACE) multiple jobholder fatality was analyzed to identify contributing injury factors from 2002 to 2010.
K. Zierold, S. Appana, and H. Anderson, "School-sponsored work programs: A first look at differences in work and injury outcomes of teens enrolled in school-to-work programs compared to other-working teens," *Occupational and environmental medicine,* vol. 68, pp. 818-25, Nov	A survey was conducted among 6810 teens in school districts in five public health regions in Wisconsin

2011.

H. R. Marucci-Wellman, T. C. Lin, J. L. Willetts, M. J. Brennan, and S. K. Verma, "Differences in time use and activity patterns when adding a second job: Implications for health and safety in the United States," *American Journal of Public Health,* vol. 104, pp. 1488-500, Aug 2014.	A cross-sectional survey: The American Time Use Survey 2003-2011
A. E. Dembe, J. B. Erickson, R. G. Delbos, and S. M. Banks, "The impact of overtime and long work hours on occupational injuries and illnesses: New evidence from the United States," *Occupational and environmental medicine,* vol. 62, pp. 588-97, Sep 2005.	A longitudinal study -Observational study
D. A. Lombardi, S. Folkard, J. L. Willetts, and G. S. Smith, "Daily sleep, weekly working hours, and risk of work-related injury: US National health interview survey (2004-2008)," *Chronobiology international,* vol. 27, pp. 1013-30, Jul 2010.	Across- sectional survey: The National Health Interview Survey (NHIS) 2004- 2008

Shift work and work-related accidents Study title	Study type
M. T. Muñoz, A. M. Brito, K. Bussenius Brito, and B. A. Lucero, "Accidents and temporarily unable to work in health care workers in a hospital of high complexity," *Workers' health*, vol. 22 pp. 7-18, 2014.	262 injury reports were reviewed at a hospital between the years 2007 and 2009.
I. Zhao, F. Bogossian, and C. Turner, "Shift work and work related injuries among health care workers: A systematic review," *Australian journal of advanced nursing*, vol. 27, p. 62, 2010.	A systematic review
K. R. Parkes, "Shift schedules on North Sea oil/gas installations: A systematic review of their impact on performance, safety and health," *Safety science*, vol. 50, pp. 1636-1651, 2012.	A systematic review
A. Wagstaff and J. Sigstad Lie, "Shift and night work and long working hours: A systematic review of safety implications," *Scandinavian journal of work, environment & health*, vol. 37, pp. 173-85, May 2011.	A systematic review
C. Anderson, R. R. Grunstein, and S. M. Rajaratnam, "Hours of work and rest in the rail industry," *Internal Medicine Journal*, vol. 43, pp. 717-21, Jun 2013.	Review
T. Behrens, S. Rabstein, K. Wichert, R. Erbel, L. Eisele, M. Arendt, *et al.*, "Shift work and the incidence of prostate cancer: a 10-year follow-up of a German population-based cohort study," *Scand J Work Environ Health*, Sep 07 2017.	A10-year follow-up of a German population-based cohort study

S. Folkard, "Shift work, safety, and aging," *Chronobiology international,* vol. 25, pp. 183-198, 2008.

Job insecurity and work-related accidents Study title	Study type
H. De Witte, "Job insecurity: Review of the international literature on definitions, prevalence, antecedents and consequences," *SA Journal of industrial psychology*, vol. 31, pp. 1-6, 2005.	Review
M. Sverke and J. Hellgren, "The nature of job insecurity: Understanding employment uncertainty on the brink of a new millennium," *Applied psychology*, vol. 51, pp. 23-42, 2002.	Review
G. H. L. Cheng and D. K. S. Chan, "Who suffers more from job insecurity? A meta-analytic review," *Applied psychology*, vol. 57, pp. 272-303, 2008.	A meta-analytic review
H. De Witte, "On the scarring effects of job insecurity (and how they can be explained," *Scandinavian journal of work, environment & health*, pp. 99-102, 2016.	Editorial: A short overview
Y. Griep, U. Kinnunen, J. Natti, N. De Cuyper, S. Mauno, A. Makikangas, et al., "The effects of unemployment and perceived job insecurity: A comparison of their association with psychological and somatic complaints, self-rated health and life satisfaction," *International archives of occupational and environmental health*, vol. 89, pp. 147-62, Jan 2016.	A cross-sectional study
H. De Witte, J. Pienaar, and N. De Cuyper, "Review of 30 years of longitudinal studies on the association between job insecurity and health	A review article: 57 longitudinal studies published since 1987 in a variety of countries throughout the world

and well-being: Is there causal evidence?," Australian psychologist, vol. 51, pp. 18-31, 2016.	
S. J. Ashford, C. Lee, and P. Bobko, "Content, cause, and consequences of job insecurity: A theory-based measure and substantive test," *Academy of management journal,* vol. 32, pp. 803-829, 1989.	A new theory-based measure incorporating recent conceptual arguments
H. D. Witte, "Job insecurity and psychological well-being: Review of the literature and exploration of some unresolved issues," *European journal of work and organizational psychology,* vol. 8, pp. 155-177, 1999.	Review of the literature
J. E. Ferrie, M. J. Shipley, S. A. Stansfeld, and M. G. Marmot, "Effects of chronic job insecurity and change in job security on self reported health, minor psychiatric morbidity, physiological measures, and health related behaviours in British civil servants: The Whitehall II study," *Journal epidemiol community health,* vol. 56, pp. 450-4, Jun 2002.	Prospective cohort study
D. C. Cole, S. Ibrahim, and H. S. Shannon, "Predictors of work-related repetitive strain injuries in a population cohort," *American Journal of Public Health,* vol. 95, pp. 1233-1237, 2005.	A cohort study
T. Lund, M. Labriola, K. B. Christensen, U. Bultmann, and E. Villadsen, "Return to work among sickness-absent Danish employees: Prospective results from the Danish work environment cohort study/national register on social transfer payments," *International journal of rehabilitation research,* vol. 29, pp. 229-35, Sep 2006.	Prospective results from a cohort study

J. E. Ferrie, H. Westerlund, M. Virtanen, J. Vahtera, and M. Kivimäki, "Flexible labor markets and employee health," *Scandinavian journal of work, environment & health supplements,* vol. 3, pp. 98-110, 2008.	Review
G. Costa, M. Marra, and S. Salmaso, "Health indicators in the time of crisis in Italy," *Epidemiologia & prevenzione,* vol. 36, pp. 337-66, Nov-Dec 2012.	A conceptual framework using the main international and national references on the measure of wellbeing and on the role of social determinants.
J. B. Park, A. Nakata, N. G. Swanson, and H. Chun, "Organizational factors associated with work-related sleep problems in a nationally representative sample of Korean workers," *International archives of occupational and environmental health,* vol. 86, pp. 211-222, 2013.	A cross –sectional study
A. Loerbroks, L. Shang, P. Angerer, and J. Li, "Psychosocial work characteristics and needle stick and sharps injuries among nurses in China: A prospective study," *International archives of occupational and environmental health,* vol. 88, pp. 925-932, 2015.	A prospective study

Temporary work and work-related accidents Study title	Study type
M. Inoue, M. Nishikitani, S. Tsurugano, and E. Yano, "The health of permanent workers and workers with precarious employment: A literature review," *Sangyo eiseigaku zasshi= Journal of occupational health* vol. 53, pp. 117-139, 2010.	A literature review
H. J. Im, D. g. Oh, Y. S. Ju, Y. J. Kwon, T. W. Jang, and J. Yim, "The association between nonstandard work and occupational injury in Korea," *American journal of industrial medicine*, vol. 55, pp. 876-883, 2012.	A case–control study
A. Saha, T. Ramnath, R. N. Chaudhuri, and H. N. Saiyed, "An accident-risk assessment study of temporary piece rated workers," *Industrial health*, vol. 42, pp. 240-5, Apr 2004.	An occupational injury surveillance study (record study of five years duration)
V. Patussi, P. Barbina, F. Barbone, F. Valent, R. Bubbi, C. Caffau, *et al.*, "Comparison of the incidence rate of occupational injuries among permanent, temporary and immigrant workers in Friuli-Venezia Giulia," *Epidemiologia & prevenzione*, vol. 32, pp. 35-8, Jan-Feb 2008.	160 factories and 4 employment agencies operating in Friuli-Venezia Giulia, Italy provided the requested information, starting from the archives of the secured INAIL companies provided in the framework of the project "
N. Hintikka, "Accidents at work during temporary agency work in Finland – Comparisons between certain major industries	Basis of national statistics databases: from the Federation of Accident Insurance

and other industries," *Safety science* vol. 49, pp. 473-483, 2011.	Institutions and Statistics Finland
K. Sakurai, A. Nakata, T. Ikeda, Y. Otsuka, and J. Kawahito, "How do employment types and job stressors relate to occupational injury? A cross-sectional investigation of employees in Japan," *Public Health,* vol. 127, pp. 1012-20, Nov 2013.	A cross-sectional investigation of employees in Japan
M. Virtanen, M. Kivimäki, M. Joensuu, P. Virtanen, M. Elovainio, and J. Vahtera, "Temporary employment and health: A review," *International journal of epidemiology,* vol. 34, pp. 610-622, 2005.	A review
A. Saloniemi and S. Salminen, "Do fixed-term workers have a higher injury rate?," *Safety science,* vol. 48, pp. 693-697, 2010.	The analysis presented here is based on three large independent assembled data sets: (1) the Work and Health Study (2) The Victim Survey (3) The Quality of Working Life Survey.
C. García-Serrano, V. Hernanz, and L. Toharia, "Mind the gap, please! The effect of temporary help agencies on the consequences of work accidents," *Journal of labor research,* vol. 31, pp. 162-182, 2010.	Individual files from the administrative registrations of work-related accidents made by employers (when the injured person is an employee) or by the worker herself (when the injured person is selfemployed)
N. Dragano, T. Lunau, T. A. Eikemo, M. Toch-	

Marquardt, K. A. van der Wel, and C. Bambra, "Who knows the risk? A multilevel study of systematic variations in work-related safety knowledge in the European workforce," *Occupational and environmental medicine,* vol. 0, pp. 1–7, 2014.	Across-sectional study
J. Benach, M. Amable, C. Muntaner, and F. Benavides, "The consequences of flexible work for health: are we looking at the right place?," *Journal of epidemiology and community health,* vol. 56, pp. 405-406, 2002.	Editorial
K. J. Cummings and K. Kreiss, "Contingent workers and contingent health: Risks of a modern economy," *The journal of the americal medical association,* vol. 299, pp. 448-450, 2008.	Commentary
J. Benach and C. Muntaner, "Precarious employment and health: Developing a research agenda," *Journal of epidemiology and community health,* vol. 61, pp. 276-277, 2007.	Research agenda

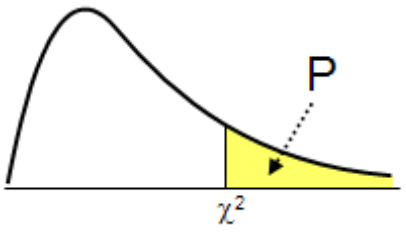
Appendix-2

Chi-square test

A chi-square goodness-of-fit test is used to test whether two categorical variables are related. The null hypothesis states that the two variables are mutually independent. The sample used to judge the validity of the null hypothesis, consists of observed frequencies for each combination of the levels of the first and for the second variable. This is organized in the following contingency table.

Factor A / Factor B	Level 1	Level 2	…	Level c
Level 1	O_{11}	O_{12}	…	O_{1c}
Level 2	O_{21}	O_{22}	…	O_{2c}
…	…	…	…	…
Level r	O_{r1}	O_{r2}	…	O_{rc}

To measure the fit between the observed frequencies O_{ij} and the theoretically expected frequencies E_{ij} in case of complete independency, $\chi^2 = \sum_{i=1}^{r}\sum_{j=1}^{c}\frac{(O_{ij}-E_{ij})^2}{E_{ij}}$ is used.



The test statistic χ^2 has a chi-square distribution (χ^2-distribution) with (r-1) (c-1) degrees of freedom where c is the number of columns and r is the number of rows in the contingency table. Only when $p > \alpha$ we will accept the hypothesis of independency of the row and the column criterion. Here α is the significance level (mostly 5%) and p is the area to the right of the observed chi-square value χ^2.

For the chi-square test it is assumed

- that each person, item or entity contributes to only one cell in the contingency table,
- that the observations are independent of each other and
- that the expected frequencies are greater than 5.
- The last assumption is necessary to maintain statistical power or it ability to detect a genuine effect [237].

Multiple logistic regression

A popular approach to model the behaviour of categorical dependent variables is logistic regression. We distinguish binary and multinomial logistic regression for the case where the dependent variable can take only two values and the case where it can take more than two possible outcomes respectively. The variable indicating whether property A is present or absent is such a binary response. The odd of success is defined as $\frac{p_A}{1-p_A}$, where p_A is the probability to have property A. The log-odds or logit is defined as the logarithm of that ratio and creates a continuous transformed version of the dependent variable. The logit of success is then fitted to the predictor x using linear regression analysis.

$$log\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1 x \text{ or } \left(\frac{p}{1-p}\right) = e^{\beta_0+\beta_1 x}$$

	A present	A not present
B present	a	c
B not present	b	d

With multinomial logistic regression we assume a low collinearity, as it becomes difficult to differentiate between the impact of several variables if this is not the case. The Variance Inflation Factor (VIF) defined as $\frac{1}{1-R^2}$, which is greater than 10 is a warning for collinearity. Here R^2 is the coefficient of determination, the square of the correlation coefficient.

An odds ratio (OR) is a measure of association between an exposure (independent variable) and an outcome. The OR represents the odds that an outcome will occur given a particular exposure, compared to the odds of the outcome occurring in the absence of that exposure. If OR =1, it means that the exposure does not affect odds of outcome. The odds ratio (OR) is equal to:

$$\frac{\left(\frac{p_B}{1-p_B}\right)}{\left(\frac{p_A}{1-p_A}\right)} = \frac{a/b}{c/d}$$

It expresses how strongly the presence or absence of property A is associated with the presence or absence of property B in a given population. It quantitatively describes the association between the presence/absence of A and the presence/absence of B for individuals in the population. Here A can be a standard group and B represents a distinct group. The value 1 is the reference value for the odds ratio. The $(1-\alpha)100\%$ confidence interval for the odds ratio is $[OR/\exp\left(z_\alpha\sqrt{\frac{1}{a}+\frac{1}{b}+\frac{1}{c}+\frac{1}{d}}\right), OR * \exp\left(z_\alpha\sqrt{\frac{1}{a}+\frac{1}{b}+\frac{1}{c}+\frac{1}{d}}\right)]$. The confidence coefficient z_α is from the standard normal distribution and is 1.96 for a 95% confidence interval [238]. The logistic regression offers the opportunity to consider an advanced model with multiple independent variables, while the Chi-square test only compares pairwise.

CURRICULUM VITAE

Hanan ALALI

Hanan Alali (PhD student)
Department of Electrical Energy, Metals, Mechanical Construction and Systems
Faculty of Engineering and Architecture
Ghent University
Technologiepark Zwijnaarde 903
B-9052 Zwijnaarde, Belgium
tel +32 9 331 04 82
E-mail: Hanan.Alali@ugent.be

Education

Sep, 1998-Jul, 2003

Bachelor and Master degree of Electromechanical Engineering from AL-Baath University in Syria

Oct, 2012-present

PhD Research Experiences

PhD in Industrial Engineering and Operations Research.

Professor: Magd Abdel Wahab Department of Electrical Energy, Metals, Mechanical Construction and Systems, Faculty of Engineering and Architecture, Ghent University.

Co-supervisor: Prof. Lutgart Braeckman. Department of public health, Faculty of Occupational and Environmental Medicine, Ghent University

Main Courses: Presentation Skills in English, Effective Scientific Communication, Doctoral Course on Personal Effectiveness (dealing with the media as a researcher and grow your future career); Experimental Validation Technique; and Statistical Data Analysis: 'Data Analysis' representation of data, parameters of distributions and their estimators, introductory statistics, basics of statistical inference, tests involving one or two samples, KS-test, analysis

of variance (one- and two-way anova),correlation coefficients (parametric, non-parametric), simple and multiple regression.

Employment

Sep, 2005-Oct, 2010

Al-Baath University of Electromechanically Engineering

Employeed as a teaching assistant in Albaath university in Syria: Engineering drawing

Sep,2004-June 2005

English teacher in an elementary school

Scientific Publications

Peer-Reviewed Journals- A1 publications

Hanan Alali, Magd Abdel Wahab, Tanja Van Hecke & Lutgart Braeckman (2016): Work accident victims: a comparison between non-standard and standard workers in Belgium, International Journal of Occupational and Environmental Health (2016), DOI: 10.1080/10773525.2016.1168588.

Hanan Alali, Lutgart Braeckman, Tanja Van Hecke, Bart De Clercq, Heidi Janssens and Magd Abdel Wahab. Relationship between non-standard work arrangements and work-related accident absence in Belgium. J Occup Health (2017); 59: 177-186.

Conference Proceedings- C3 Publications

Hanan Alali, Lutgart Braeckman, Magd Abdel Wahab, Tanja Van Hecke, Bart De Clercq,and Heidi Janssens (2017). Work-related accident absence: A comparison between shift and non-shift workers in Belgium. Findings from the fifth European working conditions survey. 13th edition of Knowledge for Growth (KFG) Flanders Bio's annual life sciences.

Hanan Alali, Magd Abdel Wahab, Tanja Van Hecke, Bart De Clercq, Heidi Janssens, and Lutgart Braeckman (2016). The relationship between non-standard work arrangements and injuries in Europe. 12th edition of Knowledge for Growth (KfG), Flanders Bio's annual life sciences conference.

Hanan Alali, Magd Abdel Wahab, Tanja Van Hecke, Bart De Clercq, Heidi Janssens and Lutgart Braeckman (2015). Relationships between irregular work arrangements and occupational injuries in EU 27: findings from the fifth European working condition survey. Archives of public health. 73(suppl. 1).

Hanan Alali, Magd Abdel Wahab, Tanja Van Hecke and Lutgart Braeckman (2015). Work Accident Victims and Witnesses: a Comparison Between Non-standard and Standard Workers in Belgium. 31th international congress on occupational health (ICOH) Seoul Korea.

Hanan Alali, Magd Abdel Wahab, Tanja Van Hecke and Lutgart Braeckman (2015). Occupational injuries: a comparison between temporary and permanent workers. Findings from the fifth European working condition survey.. 11th edition of Europe's leading regional life sciences convention Knowledge for Growth, organized by FlandersBio. Gent, Belgium.

Hanan Alali, Magd Abdel Wahab (2011). Numerical modeling of fatigue in adhesively bonded joint. UGent (2011) FEA PhD symposium, 12th.

Hanan Alali and Magd Abdel Wahab (2017). A review of some techniques for modeling crack initiation in adhesively bonded joints. 12th International Conference on Damage Assessment of Structures DAMAS, Japan.

C1 Publications

Hanan Alali and Magd Abdel Wahab (2012). Modelling of crack initiation in adhesively bonded joints. Sustainable construction & design. P.221-227.

Papers in Preparation

Short communication to be written in Dutch for a Belgian journal under the title: Studie rond factoren die het aantal slachtoffers van arbeidsongevallen in België significant verhogen

A journal paper which submitted on September 28/2017 to the International Journal of Occupational and Environmental Health.

The title is:

The association between shift work and occupational accident absence in Belgium: Finding from the sixth European Working Condition Survey

Skills

Computer skills

IBM SPSS (Statistical Package for Social Science)

Office: Microsoft Office; EndNote

Languages skills

Arab (mother language)

English (fluent)

French (good)

Dutch (4^{th} level)