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Radiographers' perceived workload and its association to work well-being factors in Western Switzerland

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Table of content

List of tables

List of figures

List of abbreviations

ANOVA	Analysis Of Variance
ASTRM	Association Suisse des Techniciens en Radiologie Médicale (Swiss Association of Radiographers)
CCTRM	Collège des Chefs TRM
CDS	Conférence suisse des directeurs de la santé (Swiss Conference of Cantonal Health Directors)
CT	Computed Tomography
EU-OSHA	European Agency for Safety and Health at Work
FSO	Federal Statistical Office (Switzerland)
GDPR	General Data Protection Regulation
HES-SO	Hautes Ecole Spécialisée de Suisse Occidentale (University Of Applied Sciences Of Western Switzerland)
HSE	Health and Safety Executive
HSE IT	Health and Safety Executive Indicator Tool
ILO	International Labor Organization
LRH	Loi sur la recherche relative à l'être humain (Law on human-related research)
MRI	Magnetic Resonance Imaging
NASA-TLX	NASA Task Load Index
NASA-RTLX	NASA Raw Task Load Index
NEF	New Economics Foundation
OdASanté	Organisation nationale faîtière du monde du travail en santé (Swiss National Health Work Organization)
PACS	Picture Archiving and Communication System
UNIL	University of Lausanne
SD	Standard Deviation
SECO	Secrétariat d'Etat à l'économie (Swiss State Secretariat for Economic Affairs)
STATA	Statistics/Data Analysis
SWWS	Satisfaction with Work Scale
WAW	Well-being at work
WDSS	Work Domain Satisfaction Scale
WHO	World Health Organization

Abstract

Aim

These past years, many departments have seen an increase in demands for radiological examinations and thus an increase in workload. Increased flow of patients and workload has been shown to be one of the causes of occupational stress and job dissatisfaction. The aim of this study was to determine diagnostic radiographers' perceived workload and its association to work well-being factors (stress and job satisfaction) in Western Switzerland.

Methods

Data was gathered via an online survey following a pilot study. The survey was composed of 56 items assessing participant's characteristics, perceived workload, stress and job satisfaction. Questions were used from validated translated questionnaires (two already validated and one for which a translation was necessary). Descriptive, group comparison and association statistics were done using appropriate tests.

Results

Response rate was 23.9% (n = 150/627). Cronbach's alphas ranged from 0.64 to 0.89 and validity and reliability of the study was established. Overall mean score of perceived workload was 6.48 ± 1.23 on a 0 to 10 scale and highest mean score was linked to "Temporal demand" (7.71). These results confirm that radiographers have high-perceived workloads, probably linked to short examination times and understaffing. Overall mean score for stress was 1.86 ± 0.28, being slightly under "neutral" and 19% of radiographers showed moderate to high levels of perceived stress. Overall job satisfaction mean score was also close to the "neutral" value, not showing any particular satisfaction or dissatisfaction with work (3.32 ± 1.29). Correlations between workload, stress, and job satisfaction were determined. Based on findings from this study, clinical recommendations were established.

Conclusion

Radiographers' perceived workload is high and many clinical implications must be considered, as it may result in increased errors, accidents, stress, and decreased job satisfaction. Ultimately, these negative outcomes will have an effect on quality of care and patient safety in radiology.

Key words: Radiographers, diagnostics, work well-being, workload, stress, job satisfaction.

Abstract in French

Objectif

En radiologie, une augmentation des demandes, induisant une augmentation de la charge de travail est constatée, pouvant augmenter le stress et diminuer la satisfaction des travailleurs. L'objectif de cette étude était de déterminer la charge de travail perçue des techniciens en radiologie médicale (TRM) et son association aux facteurs de bien-être au travail (stress et satisfaction) en Suisse romande.

Méthodes

Les données ont été recueillies par un questionnaire informatisé, composé de 56 questions, évaluant les caractéristiques des participants, la charge de travail perçue, le stress et la satisfaction au travail. Les questions étaient construites à partir de questionnaires traduits (deux validés et un pour lequel une traduction a été nécessaire). Des statistiques descriptives et d'association ainsi que des comparaisons de groupe ont été effectuées à l'aide de tests appropriés.

Résultats

Le taux de réponse était de 23,9 % (n = 150/627). Les alphas de Cronbach variaient de 0,64 à 0,89 et la validité et la fiabilité de l'étude a été démontrée. La moyenne globale de la charge de travail perçue était de 6,48 ± 1,23, confirmant que les TRM ont une perception de charge de travail élevée, probablement liée aux temps d'examens courts et au manque de personnel. La moyenne globale pour le stress était légèrement inférieure à la valeur "neutre" (1,86 ± 0,28) et celle de la satisfaction au travail n'a montrée aucune satisfaction ou insatisfaction des TRM au travail (3,32 ± 1,29). L'association de la charge de travail avec le stress et la satisfaction au travail a été déterminée.

Conclusion

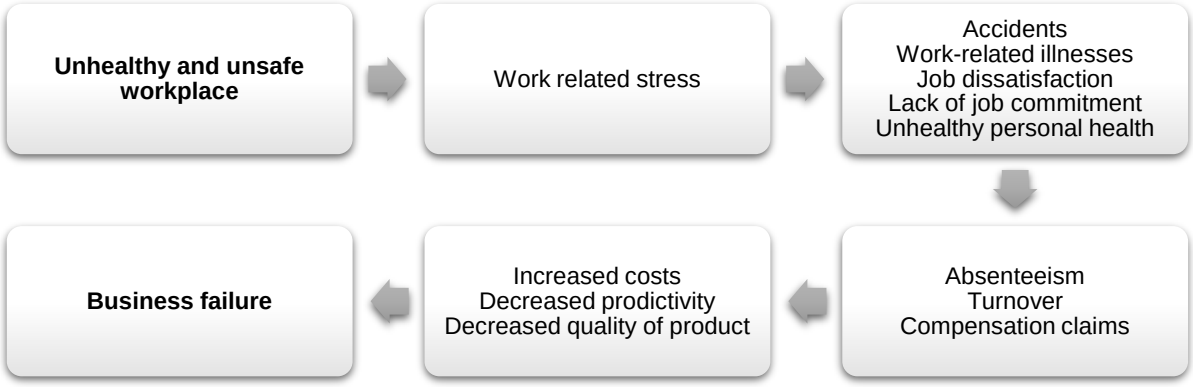
La charge de travail perçue par les TRM est élevée et de nombreuses implications cliniques doivent être considérées, car elle peut entraîner des erreurs, du stress et une diminution de la satisfaction au travail. Tout ceci peut affecter négativement la qualité des soins et la sécurité des patients en radiologie.

Mots clefs : Techniciens en radiologie médicale, radiodiagnostic, bien-être au travail, charge de travail, stress, satisfaction au travail.

1. Introduction

In a world where productivity is at the heart of companies' concerns, workers' well-being has become an essential consideration, regardless of the domain. The International Labor Organization (ILO) recommends organizations to include workers in discussions revolving around restructuration, and other organizational changes, in order to find joint solutions and optimal outcomes. Having greater choice and control over work environment will improve employees' performance and directly affect the company's outcome (International Labor Organization, 2019).

All businesses require workers in order to exist and achieve their goals. Any given company needs to take in consideration workers' well-being to be able to function since an unhealthy and unsafe workplace can have indirect results on businesses' success or failure (Figure 1: Impact of workers well-being on business failure). As shown by the World Health Organization (WHO) in their framework model, an unhealthy and unsafe workplace can lead to work-related stress and thus job dissatisfaction, accidents, injuries and burnout, potentially causing absenteeism and turnover. All these negative outcomes due to the workers' work environment can lead to business failure and thus important costs for a country (Burton, 2010).



Adapted from: Burton, J. (2010). The Business case in a nutshell. WHO Healthy Workplace Framework and model: Background document.

Figure 1: Impact of workers well-being on business success and/or failure

In Switzerland, focusing on psychosocial work environment risks has become, since 2014, a priority for the country. This decision was encourage by studies showing that company costs linked to psychosocial risk factors (such as stress and job dissatisfaction) are estimated, in an economical point of view, up to several billion Swiss francs per year (The Swiss State Secretariat for Economic Affairs (SECO), 2014).

Due to high job demand, understaffing and nature of their work, healthcare professionals have been shown to be among professionals enduring the most stress (Thomas & Valli, 2006 cited by Ashong, Rogers, Botwe & Anin-Sampong, 2016). In a recent publication, the Swiss Federal Statistical Office (FSO) showed that the most significant increase in the number of workers

most often feeling or enduring continual stress due to their jobs, concerned the healthcare sector with a 5% increase in 5 years (18%-23%) (FSO, 2019).

Worldwide, radiographers are no exception to this fact. It is common knowledge that throughout the world the recent evolution of radiologic technologies has changed the face of radiology. As a result, many departments have seen an increase in demand for radiological examinations and thus an increase in workload. To meet these needs, many radiological equipment constructors focus their technological advancements on increasing workflow and productivity. However, increased flow of patients and workload in radiology have been shown to be some of the causes of occupational stress and burnout (Akroyd & al., 2002, cited by Verrier & Harvey, 2010). These psychosocial work environment factors can have a potential negative impact on work well-being and have a direct effect on increasing errors and turnover intentions. As a result, this can lead to poor quality of care and patient safety (Font, Corti & Berger, 2015).

According to the Swiss conference of cantonal health directors (CDS) & Swiss National Health Work Organization's (OdASanté) (2016), a 20% increase of health professionals will be needed by 2025. This need for more healthcare professionals can become a real challenge in the future. Indeed, a recent study showed that 47% of healthcare workers in Switzerland expressed that they did not wish to stay in their current job until retirement. The reasons were directly linked to heavy workloads and poor work well-being through the psychosocial work environment (e.g. job satisfaction) (Unia, 2019). These aspects can lead to an increase in turnover in health professions, and become part of a dangerous and vicious cycle, as health professional turnover will automatically lead to heavier workloads and thus more exhaustion (Probst & Griffiths, 2009).

In Switzerland, and according to Swiss law on work ("Loi sur le travail": LTr), employers are obligated to protect the physical and moral health of their employees. They must take all possible measures that have been proven necessary, that technological advancements allow and that are adapted to the companies' conditions (Art. 2 & Art. 3, Ordonnance 3 relative à la loi sur le travail, 2015 & Art. 6 Loi sur le travail, 2018). For these reasons, it is essential to take into consideration factors of well-being at work in order to initiate actions and changes that will encourage workers' well-being and lifelong careers in radiology.

This thesis will be focusing on diagnostic radiographers' work environment by exploring, in Western Switzerland, radiographers' perceived workload and its association to work well-being factors. The results of this research could allow departments to enhance their awareness concerning the potential negative impacts of increased workload in their radiological departments and take necessary measures to minimize them.

2. Work well-being factors and contributors

2.1. Work well-being

Well-being at work (WAW) is a complex and multifaceted concept that has been the object of a large amount of worldwide research these past decades. It has been shown that WAW is directly linked to workers' health and business productivity and profitability (European Agency for safety and Health at Work (EU-OSHA), 2013). According to the New Economics Foundation (NEF) (2014), evidence has demonstrated that different features of workers' working lives may have varying degrees of influence on well-being, such as increasing individuals' sense of purpose, experiencing positive emotions, motivation and job satisfaction.

As a direct result of the subjective nature of defining WAW, numerous definitions of the concept exist between world organizations and different countries. However, even though a single definition has not been found, in the past 20 years a convergence towards a common determination of WAW contributors has been identified (Schulte P. & Vainio H., 2010 & EU-OSHA, 2013). In order to demonstrate the complexity of the subject and argue the chosen approach of the concept in this study, Table 1 shows a selection of different proven contributors that define employees' work well-being.

Despite the noticeable differences between the terms used to identify the different factors (contributors) influencing WAW, some notions seem to be commonly stated. Indeed, on many occasions, concepts such as the psychosocial work environment and work demand, through job satisfaction and work related stress, have been highlighted as facets influencing WAW (Table 1). The World Health Organization (WHO) has also emphasized the link between a healthy workplace and the concept of psychological work environment in their works. It defines a healthy workplace as:

> one in which workers and managers collaborate to use a continual improvement process to protect and promote the health, safety and well-being of workers and the sustainability of the workplace by considering […]: health, safety and well-being concerns in the psychosocial work environment including organization of work and workplace culture (Rokho K., 2012, p.14).

Based on these findings, this work will essentially focus its research on these previously stated factors of work well-being, namely: psychosocial work environment, job satisfaction and work related stress.

Table 1: Contributors and examples based on literary research defining work well-being

Article	Contributors	Example(s)
International Labor Organization (ILO). (2019). Workplace well-being.	**Physical environment**	Quality and safety
	How workers feel about their work	Job satisfaction
	Work environment	Materials
	Climate at work	Work relations
	Work organization	Management
European Agency for safety at Work (EU-OSHA). (2013). Well-being at work: creating a positive work environment.	**Social well-being**	Strong and loving relationships
	Community well-being	Organizations' investment in their employees' community
	Financial well-being	Financial security
	Physical well-being	Promoted by organizations through providing healthy food
	Career well-being	Employees' professional development
Schulte P. & Vainio H. (2010). Well-being at work – overview and perspective.	**Workplace factors**	Nature of work and job satisfaction
	Environmental factors	Materials
	Socioeconomic status	/
	Host and demographic factors	/
	Health	Absence of illness
	Occupational hazards	Job stressors and risks
New Economics Foundation (NEF). (2014.). Well-being at work: a review of the literature.	**Experience of work**	Experiencing positive and/or negative feelings at work
	Functioning at work	Use of strengths and/or sense of control
	Organizational systems	Fair pay, job security, environmental clarity and management system (feedback and manager behavior)
	Personal Resources	Health and work-life balance
Chartered Institute of Personnel and Development (CIPD). (2016). Moving the employee well-being agenda forward: A collection of thought pieces.	**Working environment**	Ergonomically designed working areas
	Good line management	Effective people management policies
	Work demands	Job design, workload, working hours, job satisfaction and work-life balance
	Autonomy	Control and innovation
	Change management	Communication, involvement and leadership
	Pay and reward	Fair remuneration practices (financial recognition)
World Health Organization (WHO). (2010). Healthy workplaces: a model for action.	**Physical work environment**	Structure, materials and production processes
	Psychosocial work environment	Workplace stressors (factors causing emotional or mental stress)
	Personal health resources in the workplace	Services, information, opportunities and supportive environment
	Enterprise community involvement	Activities a company might engage in to support the social and physical well-being of a community in which it operates

2.2. Psychosocial work environment

According to Hammer & al. (2004), psychosocial experience in the workplace represents the "psychological and social conditions people experience in the workplace" (p.83). These same authors also emphasized the complexity of the topic and the fact that there is no fixed and common definition of this concept. Some may say that it relates to social and personal interactions that may affect workers' behaviors and development through workplace structure, working conditions, experience, and cognitive and emotional processes (Rugulies, 2019). According to the ILO (2015), psychosocial work environment factors include aspects of the job and work environment such as climate or culture, interpersonal relationships at work and the design and content of tasks. It also takes into consideration demands and individuals' attributes such as personality and attitude, which may influence the development of stress at work (Rugulies, 2019). Like work well-being, psychosocial work environment has been an important topic researched by many authors in recent years (e.g. Theorell & Karasek 1996, Hammer & al. 2004, Rugulies, 2019).

In 1979, Karasek, suggested a model assessing stress and stress factors in the work environment. This model takes in consideration two aspects. First, "height of strain" which implies the requirements set within the workplace, such as: work rate, availability, time pressure, effort and difficulty. These requirements represent psychological stressors in the work environment that may have a negative impact on workers' well-being. The second, concerns "decision latitude" and represents the degree of freedom an employee has to control and/or organize his/her work. This aspect takes into consideration both the competence and the decision-making authority that the worker may have (Mulder, 2017).

This model shows that workload itself does not directly lead to high psychological stress. It is the combination of the strain and the decision latitude that the job offers which may have an impact. According to the study, stress can be an outcome provoked by not being able to organize one's work according to one's ideas or desires. As soon as control becomes less available for the employee, the workload will feel higher, which can lead to more stress (Mulder, 2017). These two aspects (control and workload) are thus directly intertwined and linked to the psychosocial work environment though workers' perceived levels of stress (Mulder, 2017). However, according to Hammer & al. (2004), the Karasek demand-control model is considered by many to underestimate and exclude other variables that could influence the psychosocial work environment, such as "individual characteristics, work processes, group or organizational level variables, and social and economic environmental factors" (p.83-84). The authors suggest that interpersonal relations and interactions between employees and management may also influence the psychosocial work environment. In their study, they demonstrated that norms at the organizational level were significantly related to stress reported by workers.

In their report, the SECO (2015) stated that psychosocial work environment risks such as stress have become some of the most important constraints for the workers and their employers. They define psychosocial risks as risks having potential negative impacts on workers' health induced by the work environment, work organization and social conditions such as stress and mobbing. In Switzerland, the most frequent constraints are the pace of work, pressure to meet deadlines and work interruptions. If these constraints are not addressed, they could lead to health problems such as musculoskeletal disorders, cardiovascular diseases and even mental disorders resulting in loss of motivation, job dissatisfaction and decrease in performance. Sudden absences due to illness and a decrease in efficiency will not only cause suffering for the people concerned, but would also represent costs and complications for the company. As a result, the costs generated by economic stress are estimated at several billion Swiss Francs each year (SECO, 2014).

According to Grönroos & Pajukari (2008), psychosocial work environment is associated to the quality of service provided and job performance. As previously shown, psychosocial work environment is a complex concept and is influenced by many different aspects such as work demands, autonomy at work, job satisfaction, goal commitment, clarity of job description and sufficient time and resources.

2.3. Workload

As explained above, workload and demand are some of the main elements of the psychosocial work environment in which a worker evolves, and may influence other factors such as job satisfaction and/or stress. The concept may be defined in many ways. According to Gopher & Donchin (1986), workload is a mental construct that reflects an interaction of mental demands imposed on workers by tasks they must accomplish. It is something that will be experienced by the operator and depends on the effort and capabilities a worker must use in a specific situation or context. It may be defined as the cost experienced by an individual, while achieving a certain level of performance (Hart & Staveland, 1988).

Workload is not only determined by a quantity of work but is influenced by many different factors. Implementation of technology, physically demanding tasks, high expectations and mental constraint all have a direct impact on a person's perceived overall workload levels (DiDomenico & Nussbaum, 2008). Therefore, workload may be approached from two distinct angles: physical and cognitive workload, or mental and psychological workload (Fournier, Montreuil, Brun, Bilodeau & Villa, 2011). In their study, DiDomenci & Nussbaum (2008) argued that when measuring workload, it is essential to not only focus on mental or physical workload but to take both into consideration as they are both part of the overall perceived workload. According to Cain (2007), workload is frequently described by terms such as: mental strain

(mental effort) and emotional strain ("the excess mental effort that comes from anxiety evoking cognitive aspects of the tasks") (p.2). However, according to Gaillard (2010), emotion and workload are not to be associated, as both concepts come from different theoretical backgrounds.

Workload may be determined by a combination of different factors such as: tasks being accomplished, design of systems and equipment, processes and procedures, and situation and environment. Tasks that demand more mental or physical resources will be perceived as high workload. The design of systems and equipment used to accomplish the required tasks will also have an impact on a worker's perceived workload. If a design is poor or demands a lot of time to understand, this will increase perceived workload. It may also be influenced by implementing clear procedures. In any given situation, if a clear procedure checklist is available this will decrease a worker's perceived workload. Finally, the environment (time of day, lighting, emergency situations, noise etc.) in which a specific task must be accomplished will also impact the workload experience (Lyall, 2015).

Prescribed workload corresponds to organizational demands and takes into consideration "the tools to be used to perform the work […]". Actual workload may be defined as "efforts made by individuals to come as close as possible to attaining the prescribed objectives (prescribed workload), […]" (Fournier & al., 2011, p.13). However, perceived workload is what workers may feel about their experienced workload. This is in relation to the prescribed workload, personal resources and work environment. Perceived workload may be interpreted by an individual as being occupationally satisfied or not (Fournier & al., 2011). According to Fournier & al. (2011) and based on the "activity-analysis model" presented by Guérin & al. (2006), there is a big impact of organizational factors on perceived workload. This model suggests that "workload is a dynamic process shaped though an individual's daily activities in interaction with work situations" (Guérin & al., 2006, p.14).

For health professionals, physical workload is highlighted by the physical constraints through factors such as posture, handling and movement. Inappropriately designed equipment, incompatible architecture and continual stationary statures all contribute to the problem of workload (Cazabat, Barthe & Cascino, 2008). Mental workload may be influenced by many factors when working in a hospital environment. In addition to high levels of responsibility, uncertainty, time-related pressures, caregivers are repeatedly confronted to pain and death. All of these elements contribute to increased mental and emotional strain (Cazabat & al., 2008).

Many studies have shown that radiology departments are no exception when it comes to having demanding workloads and that recently these workloads have greatly increased (Rutter

& Lovegrove, 2008; Dunlop, 2015; Ashong & al., 2016; Verrier & Harvey, 2010; Probst & Griffiths, 2009; Singh & al. 2017). This is mainly due to the increasing number of examinations in radiology, the increased pressure to reduce time, the new technological advancements and increased patient expectations (Dunlop, 2015). This increase in demand is also associated with the expansion of radiological technologies (Lehmann, Richli Meystre & Mamboury, 2015). To meet these needs, many constructors currently focus their advancements in radiological technologies on improving workflow in diagnostics. Thus, individual workloads of radiology employees are increasing and are placing staff under more pressure (Rutter & Lovegrove, 2008; Dunlop, 2015).

As a result, many studies have demonstrated that heavy workload can have a number of different negative outcomes. In their study, Grönroos & Pajukari (2008) showed that participants that felt low workload also felt that they were treated more justly, that they had enough time and resources, and that their job description was the clearest. However, workers that had expressed too much or too little work, showed negative associations with psychosocial work environment factors (Grönroos & Pajukari, 2008). Radiographers' work related stress has been shown to be determined by increased demands (including flow of patients) and thus workloads (Lehmann & al., 2015; Probst & Griffiths, 2009; Verrier & Harvey, 2010; Ashong & al., 2016). According to Lyall (2015), experienced workload may vary and move from low to high but with risk of error at both extremes. Performance errors have been shown to be influenced by workload. The author suggests that there exists a workload threshold for error and that it is determined by a combination of several attributes such as: level of expertise, fatigue, distraction and stress. The consequences of increased workload may thus have negative impacts on patient safety and quality of care, since workloads that are perceived as too high or too low will increase the probability of all types of errors (Lyall, 2015).

Furthermore, workload has shown to influence radiographers' intent to stay in the profession (Lehmann & al., 2015) and to have negative impacts on job satisfaction (Grönroos & Pajukari, 2010). According to Kosel & Olivio (2002), most professional health oriented research papers have concluded that "as satisfaction scores increased, employees were more willing to stay with an organization" (p.12). Lifelong retention of radiographers in Switzerland is essential since, according to the OdASanté's 2016 annual report on staffing needs in the health professions, a 20% increase of health professionals will be needed by 2025. If these needs are not met, this will automatically result in an increase in today's workers' workload and thus the negative impacts stated above. A recent study conducted by Unia (largest trade union in Switzerland) (2019), showed that 47% of health workers stated that they did not want to continue in their profession until retirement age. This lack of future prospects within the health sector was explained by heavy workloads and work related health problems.

2.4. Stress

Even though “stress” is a familiar term, its complete psychological aspects are difficult to fully understand. As many other complex concepts, stress may be defined in many ways. According to the SECO (2015 & 2010), in everyday language, the word "stress" can have two meanings: it can describe situations that are too demanding (for example in an agitated and unstable environment), when someone is confronted with a difficult task, or it can refer to a person's own condition when they feel tense and nervous. The notion of stress is used when a person has reached the limits of his/her capacity. Both aspects are taken into consideration in the definition established in health protection, which states that stress may be defined as a psychological state that occurs when the qualitative and quantitative requirements a person has to meet, exceed the means and capacities at his/her disposal to be able to cope with it. This imbalance generates a state of tension and agitation that is experienced by the person as threatening and inevitable. In their report, the authors emphasize that it is clearly a persistent negative state and not a short-term challenge (SECO, 2015).

In the United Kingdom (UK), the Health and Safety Executive (HSE), defines stress as “the adverse reaction people have to excessive pressure or other types of demands placed on them” (HSE, 2017, p.3). However, it is important to point out that a moderate amount of pressure may induce positive outcomes in work motivation but must not be, or be perceived as, excessive (The Society of Radiographers, 2007). This aspect can be known as “positive stress” (Anderson & Arnoult, 1989). Cox, Randall & Griffiths (2002), state that stress may be represented as a balance between demands and resources. A healthy non-stressful work environment may be apparent when demands and resources are equally balanced (cited by The Society of Radiographers, 2007).

Stress is built and induced by a number of complex factors. Stress may be influenced by personal major life events such as divorce, the loss of a loved one, financial difficulties or redundancy. As for work related stress, it is mostly linked to the design, management, environment and organization of the company (The Society of Radiographers, 2007). In their research, the SECO (2010), highlighted a number of factors that contribute to stress (called “stressors”). The most frequently indicated stressors are related to organizational work aspects such as important workloads, time pressure, structural disorganization and an imbalance between effort and reward. Other social factors such as verbal violence, mobbing or discrimination were also reported to be the source of stress in the workplace. Dunlop (2015) adds that long hours and a demanding work environment are some of the factors that can contribute to higher levels of perceived stress and that this stress can be classified as mental, emotional, physical, financial, or environmental. Sources of work related stress (also referred to as “occupational stress”), linked to the content of work, can be categorized as follows: job

content (lack of variety, meaningless work, under use of skills), workload/work pressure (work overload, work under-load, high levels of time pressure), work schedule (shift working, night shifts, unpredictable hours), control (low participation in design making, lack of control on workload) and environment and equipment (availability, lack of space, poor lighting) (The Society of Radiographers, 2007).

According to Thomas & Valli (2006), healthcare professionals have been shown to be among the most stressed professionals. This has been linked for instance to high job demands, compassion fatigue, understaffing, and inadequate resources (cited by Ashong & al., 2016). The UK's National Health Service (NHS) conducted a major study in 2002 that found that four principal factors were the cause of high levels of stress. These stressors were: staffing (mostly due to teams working short of one or two members), high workload, high level of patient demand, verbal abuse and aggression towards staff (cited by The Society of Radiographers, 2007). In Switzerland, Unia (2019) showed that that 70% of the healthcare workers in the country expressed feeling stressed in their work environment and 86% said they often felt tiredness or exhaustion due to their jobs (Unia, 2019).

In radiology, the NHS (2008), demonstrated that 28% of staff have suffered from stress in the 12 months prior to the study due to increased number of patients, raised expectations of the patients/public, loss of clinical autonomy and lack of time for direct patient contact. The participants in the study also described that they felt stressed by the lack of respect for their knowledge and capabilities (cited by Verrier & Harvey, 2010). These factors were confirmed in the study since staff shortage, heavy workload and volume of patients were the most commonly cited stressors (Verrier & Harvey, 2010). Akroyd & al. (2002) also reported in their study that high demands and an increased workload were identified as main contributors to work related stress (cited by Verrier & Harvey, 2010). These results were also confirmed by another study that indicated that the second highest factor associated with occupational stress for radiographers was workload (Eslick & Raj, 2002 & Philips 2019). In addition to this, new and complex technology also can be a stressor for working radiographers. Having to learn to use new devices and software programs can lead to frustrations and stress (Dunlop, 2015).

2.4.1. Burnout

Many studies have emphasized that prolonged occupational stress may lead to exhaustion of physical or emotional strength and/or burnout (e.g. The Society of Radiographers, 2007; Font & al., 2015; Maslach, Schaufeli & Leiter, 2001 & Parker & Kulik, 1995). According to the SECO (2015), when a person of great professional commitment is faced with a high workload and a lack of recovery phases, it leads to overwork. If this overwork persists, it can lead to mental

exhaustion and burnout. Burnout has been shown to be a response to work overload, role conflict and job dissatisfaction (Maslach & al., 2001).

Even though the definition of burnout is one that has raised a number of debates, a consensus between experts was established by determining that it is characterized by three basic aspects: emotional exhaustion, depersonalization and low personal fulfillment (Font & al., 2015; Maslach & al., 2001; Singh & al. 2017, & SECO, 2015). Burnout usually develops insidiously and for a long time without the knowledge of the person concerned. The inability of a person to really recover despite opportunities to do so (in the evening after work, on weekends or on holidays), is a clear sign of burnout (SECO, 2015). It is a psychological state of emotional, physical and mental exhaustion, which also results in a distance from work, and which can be generated by professional activity (e.g. cynicism towards clients or patients). People facing burnout feel that their "batteries" are empty. They feel exhausted and drained (SECO, 2010 ; Dunlop, 2015).

According to Dunlop (2015), medical professionals are motivated and caring individuals who often find themselves experiencing increased stress on the job. The high expectations and high levels of competition, the fact of working with radiation, working irregular schedules, combined with the emotional nature of the work (by encountering patients with life threatening diseases) and the relentless pace, all contribute to higher levels of stress and burnout in health care workers, and more specifically, radiographers.

2.4.2. Consequences of work related stress

The SECO (2015) reported that 34% of active workers in Switzerland have expressed having been stressed in the past 12 months and the results show an increase in perceived levels of stress in the past 10 years. A positive correlation between stress perception, occupational exhaustion and job dissatisfaction was identified. The consequences of such adverse mental constraints may lead to mental or physical health problems: depression, anxiety disorders, musculoskeletal disorders, cardiovascular diseases, diabetes, gastrointestinal diseases and others (SECO, 2015). Kivimäki & Kawachi (2015) demonstrated in their study that work stressors such as a heavy workload and long working hours are associated with moderately elevated risk of incidences of coronary heart disease and strokes.

When stress is left untreated, it may encourage the outcome of conditions such as depression, anxiety, and insomnia. People may also experience cognitive effects such as distractibility, deterioration in short-term and long-term memory, increased error rate, and reduced ability to plan and organize. Cognitive and emotional effects may manifest in behavioral changes, such as diminished enthusiasm at work resulting in increased absenteeism (Dunlop, 2015).

The effect of stress in health care has been subject to many research projects in the past 20 years. Health care professionals are known to work in challenging environments and there are high expectations for their performance. Packed schedules, long shifts, and malfunctions of equipment are part of the radiographers' daily routine and these professional workers must find ways to cope with this. Among others, these factors can contribute to frustration, misunderstanding, tiredness, loss of interest in the practice, boredom and lack of focus, and even error (French, 2004 ; Verrier & Harvey, 2010). The increased risk of potential errors within a radiology department was shown in a study carried out on therapy radiographers (French, 2004). These errors could result in an increase in examination repetition. Some of the potential consequences of having to repeat examinations are: increased patient dose, increased procedure times and costs (Verrier & Harvey, 2010). The more errors occur, the more the workers' stress level may potentially grow (Dunlop, 2015). This demonstrates a continuous negative cycle between stress and errors.

The reduced flexibility in scheduling as well as budget constraints require radiographers to struggle to find time in their off-duty hours to complete continuing education (Dunlop, 2015). Not being able to achieve one's goals and investing in personal professional development has been shown to encourage staff turnover and job dissatisfaction (Lehmann & al., 2015). Furthermore, stress and burnout have been shown to be associated with a reduction in job performance and job satisfaction in general (Font & al., 2015). As burnout is a direct result of prolonged occupational stress, its sources and consequences are similar to those expressed previously in this study.

2.5. Job satisfaction

As previously shown, job satisfaction is a concept linked to the psychosocial work environment and WAW. Many research papers have been conducted on it and many of them state the complexity of defining this multifaceted concept (Aziri, 2011). Firstly, job satisfaction can be defined by a combination of psychological and environmental factors leading to personal expression of job satisfaction. It is also linked to the affective attachment that employees have towards their work. This means that job satisfaction has to do with how people feel about their job (positive or negative feelings) and determines if they like or dislike their work (Aziri, 2011 & Grönroos & Pajukari, 2010). It represents the extent to which an employee's daily production and/or contributions meet their expectations. It is also defined by the workers' sense of achievement and success in their job (Aziri, 2011 & Grönroos & Pajukari 2010). Furthermore, the concept is directly linked to an individual's behavior in his/her job. It is presumed to influence the workers' productivity and personal well-being. It implies being rewarded adequately for any given job, feeling fulfilled and contributing to happiness with one's work.

This concept may be considered as one of the main factors influencing efficiency and effectiveness in the work place (Aziri, 2011).

Job satisfaction may be influenced by many different factors. In Switzerland, Lehmann & al., (2015) showed in their study that Swiss radiographers had positive satisfaction scores no matter the radiological domain, institution type, radiographers' roles or age. They said that the workers' satisfaction was related to the work itself, work relationships, autonomy and relations with the patient. Other factors such as work experience, balanced workload demand, positive professional relations, clarity of roles and positive work environment have been positively associated with job satisfaction (Grönroos & Pajukari, 2010). Additionally, age has also been positively associated with job satisfaction, with how demanding their work felt and with their commitment to the department's goals (Grönroos & Pajukari, 2008). Philips (2019) showed in their international study that radiographers are moderately satisfied with their work and that there is a large gap between radiographers' satisfaction with "quality time with patients" and its importance. Results indicated that this statement was scored as one of the most important aspects of the job; however, it scored the lowest satisfaction scores (Philips, 2019, p.8).

Grönroos & Pajukari (2008) revealed a positive association between suitable workload and the fact that staff felt that they are treated justly. They explained that working in the radiology department is "demanding but it is also autonomous and controllable enough for the employees to find it rewarding" (p.29). A balance is needed between workload and autonomy, which is consistent and follows the Karasek's demand-control model (Mulder, 2017). As previously said, psychosocial work environment factors and their association with job satisfaction have been described in many studies. For example, Probst & Griffiths (2009) showed in their study that radiographers working in radiation therapy expressed negative correlation between perceived levels of stress and job satisfaction. Feeling and having heavy workloads, emotional exhaustion and fear, which are factors that could potentially contribute to stress and burnout, were expressed to be part of the radiographers' work and to be associated to job satisfaction.

According to Probst & Griffiths (2009), job satisfaction can also be associated to employee turnover. The authors showed that if a worker feels dissatisfied with his/her work, this may lead to employee withdraw and thus increase professional turnover intentions. As previously mentioned, this can lead to important coasts for a department and cause problems in staffing needs for the future. However, according to their findings, Lehmann & al. (2015), showed that in Switzerland, radiographers' that were dissatisfied, still showed intent to stay in the profession. They explained this difference by the fact that other studies did not take into consideration long-term retention in the profession.

3. Aim, purpose & research objectives

As previously stated, perceived heavy workloads can be associated to work well-being factors such as job satisfaction and work related stress. The purpose of this study is to enhance the awareness of radiology departments about radiographers' perceived workload and its association to work well-being factors, and initiate actions that will encourage lifelong careers in radiology, since these factors have been linked to job retention and turnover in health departments (Scanlan, Meredith & Poulsen, 2013). The aim of the present study is to explore, in Western Switzerland, radiographers' perceived workload and its association to work well-being factors such as job satisfaction and work related stress. This study is guided by three research questions (study objectives):

1. What is the internal consistency of the instrument measuring perceived workload and work well-being factors in the French speaking Swiss radiology context?
2. What is radiographers' perceived workload in Western Switzerland?
3. Which association is there between radiographers' perceived workload and work well-being factors such as stress and job satisfaction?

Preliminary literature did not show any other studies on the topic in Switzerland and there is no existing validation of this kind of instrument in the present context.

4. Methods

4.1. Study design & setting

This thesis was conducted as part of a Master's degree in health sciences containing a medical radiologic technology-orientated program offered by the University Of Applied Sciences Of Western Switzerland (HES-SO) jointly with the University of Lausanne (UNIL). This cross-sectional designed study was conducted in Western Switzerland.

Switzerland is a small country divided into of 26 cantons. At a crossroads in the Alps of Western Europe, the country boasts four linguistic and cultural regions: German, French, Italian and Romansh. The French speaking part of Switzerland is also called Romandie or, as a result to its geographical situation, Western Switzerland, and consists of six cantons (Geneva, Vaud, Neuchâtel, Jura, Fribourg and Valais). Due to language barriers and geographical proximity, this thesis will focus on this part of the country.

The electronic survey was addressed to the group of head radiographers of Western Switzerland called the "College des Chefs TRM" (CCTRM). The CCTRM has existed for over 30 years and their mission is to take position in political or legislature debates, promote

professional development and preserve and defend radiographers' professional interests. They work closely with the Swiss Association of Radiographers' (ASTRM) of which each associate is a member. The 33 head of departments, members of the CCTRM, come from all backgrounds: university and regional hospitals, clinics, and private institutions, representing 46 different sites throughout all of Western Switzerland (Langlacé & Delhausse, 2019).

4.2. Sampling & data collection procedure

4.2.1. Sampling procedure

For this study, the sampling was executed on two levels. First through purposeful cluster sampling by contact with the CCTRM and then on the second individual level by focusing on radiology departments having radiographers working in diagnostics. Choosing to base this research on radiographers working in diagnostics (radiography/plain x-ray, mammography, CT, MRI and interventional radiology) was based on the fact that according to a Swiss radiographers' labor market analysis, 79.5% of radiographers work partially or only in diagnostics and thus represent a majority of the population of interest (Lehmann & al., 2012).

An email sent on April 23rd 2019 to all the head of departments' part of the CCTRM, asked for the number of radiographers working in their departments, the number of patients per year and, if institutional approvals were needed, to address a questionnaire to their employees. This procedure made it possible to determine total sample size, the size of the different departments, and so, determine if the sample was representative of the target population.

After two weeks, 16 responses out of 33 members of the CCTRM were obtained. On the 9th of May, a reminder was sent to the departments that had not yet answered. Out of the received responses, only four needed to check with their departments for approval. Thus, a PDF version of the questionnaire containing the enclosure letter (Appendix A – Enclosure letters) was sent to the four different heads of departments. All but one obtained the formal authorizations from their institutions to be able to later on transfer the survey to their employees. In total, formal written authorization to send the survey was obtained from 20 members of the CCTRM, representing 23 different institutions throughout Western Switzerland (out of 33 members representing 46 sites). In addition to this sample, three personally addressed institutions agreed to participate in the study, giving a total sample of 26 institutions.

Institutions were from all types and sizes. The number of patients per year varied from approximately 9'000 to almost 200'000 within this sample, giving a vast range of institutions and thus confirming that the chosen sample could be considered as representative. In total, sample size was estimated at 627 radiographers working in diagnostics in Western Switzerland, representing approximately 43.5% of the targeted population.

4.2.1.1. Determining the number of radiographers in Western Switzerland

It is important to mention that this percentage is a rough estimate since in Switzerland, it is very difficult to determine the exact number of working radiographers; there is no existing national database or register, and radiographers are not obliged to be members of the ASTRM. The only official national database is offered by the FSO and data is difficult to extract, as radiographers are classified in a general “medico-technical assistant” group with many other professions. Additionally, due to the different languages and naming conventions in Switzerland, the exact and precise number of radiographers in the country is currently not directly obtainable from this database.

In their article, Lehmann & al. (2012), explained that if we base this estimation on the number of distributed dosimeters, there is a ± 10% margin of error since the institutions do not report from which profession the dosimeters are, nor if one person has several. In 2009, the CDS & the OdASanté, established a report on future needs concerning the number of health workers and determined that 2848 radiographers worked within Swiss hospitals. However, this number did not take into consideration radiographers working in the private sector, which according to Lehmann & al. (2012), represents 14.35% of radiographers. In their study, Lehmann & al. (2012), estimated that there were 3200-3300 radiographers in 2011. In 2016, the CDS & the OdASanté published a new report stating that there are 3968 radiographers in Switzerland in 2014 (working in the private and public sectors). However, their numbers were an estimation based on data from three years earlier and therefor a 20% increase over Lehmann & al (2012) estimates for the same year. In order to determine the current number of radiographers, calculations were based on the numbers given by the CDS & the OdASanté (2016) and the report established by Lehmann & al. (2012), stating a 14.9% increase in radiographers in four years (between 2010 and 2014). By applying this percentage as a baseline, and hypothesizing the same trend over the following four-year period (2014 to 2018), the estimated number of radiographers in Switzerland in 2018 is calculated at approximately 4500.

From these numbers and according to Lehmann & al. (2012), it is possible to determine the number of radiographers working in diagnostics in Western Switzerland. According to their report, 79.5% of radiographers work in diagnostics and 40.2% work in the French-speaking section of the country. However, the authors also mention a bias in their research, as response rates from radiographers in the French and Italian-speaking part of the country were greater than in the German sector. This most certainly led to an overestimation of the number of radiographers in these regions.

If we consider that these proportions have stayed stable since 2012, this allows an approximate estimation of the number of radiographers working in diagnostics in Western Switzerland to be currently calculated at 1440.

4.2.2. Data collection

Data was gathered via an online survey using Limesurvey Version 3.17.3 in 2019.The final survey was composed of 56 items assessing participant's characteristics, levels of perceived workload, stress and job satisfaction. The link to the electronic survey was sent by email to the heads of the 26 institutions having responded positively to participating in this study on June 3rd, with a response deadline on the 23rd of June. Then a first reminder was sent out on June 24th, giving the respondents two weeks to answer (up to the 7th of July). Finally, and in order to increase the response rate, a last reminder was addressed on July 8th with a final deadline on the 21st of July.

On that final date of July 21, 150 participants had completely filled out the online survey, thus giving a response rate of 23.9%. In order to allow participants to fill out the survey at their own pace and to take into consideration the fact that the online questionnaire was filled out at their place of work, participants weren't obliged to completely fill it out. Indeed, the used program allowed people to partially fill the questionnaire, reopen, and complete it a later date. Even though this encouraged participants to respond, it also gave an important number of partially filled out responses (n = 46 out of 196). Since these answers may belong to radiographers having also completely filled the questionnaire and considering the cross-statistical analyses that were conducted, they were not taken into consideration in this study.

4.3. Measurements

4.3.1. Survey

To evaluate perceived workload of radiographers and determine its association to stress and job satisfaction, an online survey built of different standardized questionnaires was used in this study. The survey was composed of 56 questions/statements comprised of four sections: participants' characteristics (10 questions), perceived workload (6 questions), work related stress (35 questions) and job satisfaction (5 questions) using structured closed questions, which will be detailed in the following sub-chapters of this thesis. The end of the survey was dedicated to an open "comments" section, encouraging participants to put forward any problems or comments on the survey (Appendix A – Survey).

4.3.1.1. Participant characteristics

In order to be able to correctly describe the sample population, data collection was comprised of questions focusing on the participants' characteristics (personal and work related factors). These factors were studied with 10 structured questions (gender, age, civil status, parenting,

education level, type of institution, years of practice, work percentage (full time or part-time), working modality-ies and length of stay in present job).

4.3.1.2. Workload

As previously stated in this study, workload is a complex concept that may be defined in many ways. This is why many different scales to assess it exist within literature, focusing mostly on subjective measures of operator-based workload (Hoonakker, & al., 2011).

4.3.1.2.1. The NASA Task Load Index (TLX)

In this study, perceived workload was assessed using the raw version of the NASA Task Load Index (RTLX). The original version of the scale (NASA-TLX) was developed by Hart & Staveland (1988) to measure workloads in aviation (Hart, 2006). It is currently the most widely accepted subjective measure of overall human workload and is used in many different work environments such as aeronautics, computer systems, transportation and healthcare (cited by Young, Zavelina, & Hooper, 2008; Bagheri, Hossein Abadi, Akbari, Gholami-Fesharaki & Ghasemi, 2017).

The NASA-TLX is a multidimensional scale consisting of six subscales assessing subjective mental demand, physical demand, temporal demand, frustration, effort and performance. In its original version, a weighting procedure is used to develop a score adjusted according to an individual's workload (Hoonakker & al., 2011). Each item is assessed by using a ten step bipolar scale (low to high). The combination of these subscales gives an overall workload score (Bagheri, & al., 2017).

The reliability and validity of the scale has been determined in different studies. Batisse & Bortolussi (1988), showed in their study a test-retest reliability of 0.77. Concerning the validity of the NASA-TLX, Rubio, & al. (2004), demonstrated that for this instrument, the convergent validity is high when compared to two other scales (the Subjective Workload Assessment Technique and the Workload Profile in this case). The study also showed that the concurrent validity of the scale was higher than the two other scales. Finally, the NASA-TLX also showed higher results in comparison to the other instruments in terms of sensitivity (Hoonakker, & al., 2011).

Over the years and through the many different adaptations of the scale, the NASA-TLX has evolved. The most common modification in use has been to shorten the test. This shortened version of the scale is called the Raw TLX (RTLX) and is the version that was used in this study. This scale has gained in popularity because it is less time consuming and simpler to apply. According to Miller (2001), the NASA-RTLX has been shown to be more sensitive or almost equivalent to the original version, in different studies. However, the disadvantage of the NASA-RTLX is the fact that, unlike the original version, the tool does not allow respondents to

weigh the different components and their importance concerning their answers. This aspect is directly linked to the nature of the questions (Andersson, 2017).

4.3.1.3. Occupational stress

4.3.1.3.1. Health and Safety Executive Indicator Tool (HSE IT) for work related stress

To assess work related stress, this study used the HSE IT. The HSE is the UK's regulatory body responsible for health and safety within the work environment and has a standardized approach to addressing work related stress. The HES IT is a standardized questionnaire that provides an indication on how employees rate a company's performance in meeting the management standards (standards created, designed and recommended by the HSE) (Brookes, Limbert, Deacy, O'Reilly, Scott, & Thirlaway, 2013).

The HSE IT for work related stress is composed of 35 statements and questions which relate to 7 dimensions/factors that have been shown to be associated with perceived stress: demands (8 items), control (6 items), managerial support (5 items), peer support (4 items), relationships (4 items), role (5 items) and change (3 items) (Cousins, Mackay, Clarke, Kelly, Kelly & McCaig, 2004). Each item is based on a 5 point Likert scale, 23 questions measure frequency (response from never to always) and 12 questions measure agreement (response from strongly disagree to strongly agree).

The tool has been used in a number of studies worldwide (Brookes, & al., 2013). The scale has been shown to be reliable and valid (Cousins, & al. 2004). Furthermore, in their study, Brookes, & al. (2013), emphasize that the HSE IT is a solid tool and is a reliable measure to explore work related stress within an organization. The tool has been used in different health sectors and more particularly by Verrier & Harvey (2010) in their study in a local radiology department.

According to Verrier & Harvey (2009), the HSE IT might provide a good indication on a company's management of certain work related stressors, however, "[…] it does not give respondents the opportunity to express individual concerns, define stressors specific to radiography or give recommendations for improvement" (Verrier & Harvey, 2009, p. 118).

4.3.1.4. Job satisfaction

As mentioned previously, job satisfaction is a large multifaceted concept and thus many different scales to assess it exist in literature (Bowling, & Hammond, 2008). According to Bérubé, Donia, Gagné, Houlfort, & Koestner (2007), among the existing multiple-item measures of satisfaction, none stand out in popularity. However, the authors mention that a handful of scales are more frequently used within literature (e.g. Overall Job Satisfaction Scale, the Michigan Organizational Assessment Questionnaire and the Job in General Scale).

4.3.1.4.1. Satisfaction with Work Scale/Work Domain Satisfaction scale

In this study, job satisfaction was assessed by using the Satisfaction with Work Scale (SWWS), also called the Work Domain Satisfaction Scale (WDSS). The WDSS in a multi-item global scale of work satisfaction. It is composed of five statements answered by a 7-point Likert scale ranging from "strongly disagree" to "strongly agree" assessing the participants' satisfaction with their job.

The scale focuses on a person's work well-being through their cognitive appraisal of their work situation (Bérubé, & al., 2007). According to Bérubé, & al. (2007), the measure is a good indicator of work related mental health. It is important to note that the SWWS items focus on people's work as opposed to their job in general even though both concepts are closely intertwined. The distinction is noticeable when considering job satisfaction as mostly or only being linked to a person's career satisfaction (career choices, opportunities and development) and not their work related well-being. Thus, "the SWWS measures a domain specific satisfaction which is likely to fluctuate more in accordance with changing contextual factors" (Bérubé, & al., 2007, p.274).

The WDSS was developed, in French, by Blais, & al. (1991), as an adaptation of the Satisfaction with Life Scale (SWLS). The SWLS is a validated and reliable tool used and referenced in many studies (cited by Bérubé, Donia, Gagné, Houlfort, & Lvina, 2016). In their study, Bérubé, & al. (2016) revealed that internal reliability of the WDSS was acceptable (Cornbach α ranging from 0.73 to 0.87). They concluded that their findings indicate that the WDSS provides a good assessment of job satisfaction in French and in English, that it is distinct from its original SWLS and that their paper proves the stability of the scale.

4.3.2. Likert scales

As shown in the previous section of this paper, the survey was comprised mostly of Likert scales. This type of scale is one of the most used scales in quantitative research (Demetriou, Uzun Ozer & Essau, 2015). Likert scales are used because they are simple to construct and easy to read and complete for participants, with easy data analysis (Bertram, 2007).

However, one of the disadvantages of these types of scales is the fact that participants might give an in-between rating to minimize their response by avoiding extreme response categories (central tendency bias) in comparison to a dichotomous type question which would force the participant to choose (Demetriou & al., 2015, & Bertram, 2007). Other biases of using this type of scale are: acquiescence bias (where participants agree with statements as presented in order to please the author), social desirability bias, lack of reproducibility and difficulties to demonstrate validity (Bertram, 2007).

According to Bishop & Herron (2015), the biggest “issue with Likert-type scales and ordinal responses is the appropriate statistical treatment of these data” (p.297). This will be discussed in section 4.5 “Analysis method” of the thesis.

4.3.3. Survey translation

As mentioned previously, this study was conducted in the French speaking part of Switzerland, meaning that the survey had to be sent in French to participants and a translation of the original standardized scales was thus necessary.

4.3.3.1. NASA-RTLX

Concerning the assessment of workload, a validated version, translated from English to French, of the NASA-RTLX was used (Cegarra & Morgado, 2009). The authors tested their translation using first a pre-test with 10 participants and then a study with 28 participants. Their study demonstrated that the French version of the NASA-TLX conserved its sensitivity compared to its original form and that RTLX was still strongly correlated to the NASA-TLX. For these reasons, this version of the scale was used in this study.

4.3.3.2. SWWS/WDSS

As previously mentioned, the tool used to assess job satisfaction was originally created in French. In order to have a full English and French version of the final survey, a validated translated English version of the tool is presented. The authors showed a good internal consistency of both the French and the English versions of the scale with Cronbach’s alpha ranging from 0.73 to 0.87 (Bérubé & al., 2016).

4.3.3.3. HSE IT

The HSE IT tool only exists in its original English form and no validated French version of the document was found. Thus, a thorough translation was conducted in order to obtain a French version of the tool. According to the WHO (2019), the aim of a structured translation process is to assure conceptual equivalence between both versions (original and new translated version). The author emphasizes that “the focus is on cross-cultural and conceptual, rather than on linguistic/literal equivalence” (WHO, 2019). The process comprises several steps: forward translation, expert panel back-translation, pre-testing and feedback, and final version. This paper followed these steps in order to translate the HSE IT from English to French.

First, being bilingual French and English, the author proceeded by doing a forward translation from English to French. This was done by applying and following the WHO’s recommendation, stating that the first translator must be fluent in the target language and should aim the conceptual equivalent and not a literal word-for-word translation (WHO, 2019).

Once the first translation and validation of the French version was established, the Master Thesis candidate's father, Henry de Labouchere, who is also bilingual, processed to do a back-translation of the scale (from the French version back to English), by following the same recommendations as for the previous step (WHO, 2019). Then, the tutor of the Master Thesis, Eija Metsälä, and the author, proceeded to compare both English versions. After comparison, both reviewers found satisfactory content equivalence, thus indicating a good translation.

In order to determine the validity of the translation, a pilot was sent out to 5 radiographers on May 23rd 2019 (see details in section 4.3.4.1.1 Pilot study) and following this, no modifications of the scale were needed or recommended.

4.3.4. Survey validity and reliability

4.3.4.1. Validity

The validity of a survey can be defined as how well an instrument measures what it is supposed to measure or "how well the answer to the question corresponds with the true value for the construct that is being measured" (Leeuw, Hox & Dillman, 2008, p.137). Validity is determined by the relations with other variables (Silva, 1993, cited by Demetriou & al., 2015). In the case of self-reported surveys, validity of the instrument can be determined by correlating scores with similar instruments. There exist four types of validity: construct validity, criterion validity, content validity, and face validity (Demetriou & al., 2015 & Kimberlin & Winterstein, 2008).

Construct validity is guaranteed by examining the relationship of the measure with other known related theoretical measurements proved to be related to the construct (Kimberlin & Winterstein, 2008). According to Demetriou & al. (2015), face validity refers to determining if the items within the survey actually measure the intended content. Criterion validity assesses how well a variable (or the score of a variable) of the new instrument correlates with other existing instruments (Demetriou & al., 2015 & Kimberlin & Winterstein, 2008). Finally, content validity addresses "the extent to which a questionnaire examines all the targeted aspects of a construct" (Demetriou & al., 2015, p.3).

In this thesis, by using existing tested and widely used instruments, validity of the different scales has already been determined and may thus contribute to the validity of the survey (see details section 4.3.1.3-5).

4.3.4.1.1. Pilot study

In order to guaranty validity of the translated version of the survey, a pilot study was sent out to five radiographers on May 23rd 2019. A pilot test is necessary in order to ensure that the questions in the survey are understandable, and also to identify sources of potential errors (Demetriou & al., 2015 & Kimberlin & Winterstein, 2008). The participants had similar

characteristics to those in the aimed population (diagnostic radiographers in Western Switzerland) and came from different backgrounds (gender, institution type, etc…). A couple of weeks prior to distribution, the participants were personally contacted to obtain their agreement to participate in the pilot.

Once they agreed, they received an email (on May 23rd) containing the link to the pilot online survey, with a response deadline on the 31st of May. In that email, candidates were asked to determine the clarity of the questions (understandability), to identify any spelling errors, to determine the time necessary to fill out the survey and to provide suggestions or recommendations for improvement. By May 31st, all respondents had filled out the survey and given personal feedbacks.

Concerning the time taken to fill out the survey, it ranged from 7 to 15 minutes. The participant who took 15 minutes explained that it took longer to fill out the questionnaire, as particular attention was needed to be able to give a complete and adequate feedback. He/she mentioned that it would take less time in normal circumstances. This is why in the final survey participants were informed that it took 10 minutes to fill out.

4.3.4.2. Reliability

According to Demetriou & al. (2015), the reliability of self-report questionnaires must be tested. It determines the consistency of the information obtained from respondents. This means that if a same question is asked several times at different points in time to a subject, with no modification of other variables, the response score should be the same (test-retest reliability) (Demetriou & al., 2015, Kimberlin & Winterstein, 2008, Gonyea, 2005 & Leeuw & al., 2008). This refers to the fact that there is also variability within answers and that a score obtained from a measuring instrument is always composed of the "true" score (perfect measurement accuracy) and "error" in measurement (Kimberlin & Winterstein, 2008). Furthermore, a perfectly reliable scale should assess the exact same score when two respondents' true value on a construct is the same (Leeuw & al., 2008).

Reliability can thus be determined by assessing stability (test-retest processes), internal consistency and/or inter-rater reliability. In this study, the reliability of the scales was assessed by calculating their internal consistency.

Internal consistency "gives an estimate of the equivalence of sets of items from the same test" (Kimberlin & Winterstein, 2008, p.2277). It is assessed by calculating "Cronbach's alpha", which is an average determining the inter-correlation of items as well as the number of items, ranging from 0 to 1 (the closer the result is to 1, the more reliable the scale) (Kimberlin & Winterstein, 2008 & Leeuw & al., 2008). According to Nunnally & Bernstein (1994), a questionnaire can be determined as reliable with a Cronbach's alpha score of 0.7 or higher

(Demetriou & al., 2015). It is important to mention that, according to Leeuw & al., (2008), “a less reliable measure will also be less valid. However, reliable answers are not necessarily valid […]. Validity is the ultimate measure of how good our questions are as measures” (p. 137). Thus, both the validity and reliability of the used scales was taken into consideration in this study.

4.4. Ethics

Research ethics are necessary in order to assure proper research behavior and research integrity. Good research is based on four principles to guide researchers in engaging inherent practical, ethical and intellectual challenges. These principles are: reliability (quality of research), honesty (transparency), respect, and accountability (All European academies, 2017). This study was conducted according to and in complete adequacy with these principals.

4.4.1. Survey approval requests

This study used existing validated tools found during online literary research. In order to be allowed to use them within this study, formal authorizations were needed from the authors. An email asking for formal approval and explaining the context and aim of this study was sent to Mr. B. Gore for the NASA-RTLX, to Mr. M. Blaise for the SWWS/WDSS and to Mr. C. White for the HSE IT, on March 29th 2019. Contact information was found online via official website and/or university websites. Mr. Gore, NASA official and Mr. Blaise, original author, both answered positively the same day. Mr. White, chief executive parliamentary and secretariat office, responded positively on the 8th of April 2019.

As previously mentioned, within the studied sample, only a few heads of departments required a pre-visualization of the survey as a prerequisite for approval from their superior. One institution had to withdraw from the study and no other procedures were necessary.

4.4.2. Consent and information

In Switzerland, many laws assure proper ethical research conduct (e.g. 2014: Loi sur la recherche relative à l’être humain (LRH), 2010: article constitutionnel 118b…). According to the Swiss constitution, Art. 118b (1999), when research is conducted on human beings, participants in the study must give their formal consent and be aware of any risks in participating. The LRH (2011), emphasizes that participants must have a “right to information”, meaning that participants must be allowed to review and/or see any data collected that concerns them.

In order to respect this, the first page of the online survey was an enclosure letter. This letter explained the context, the intent of the study and the time it should take to fill the survey, the guaranteed anonymity of the collected data, and explained to the participants that there were

no risks or compensation associated with participating in this study. Furthermore, the author's personal contact was given, allowing the participants to obtain any information and/or withdraw their participation at any given time. Participants were informed that the results of the study might be published and/or presented in scientific conferences. At the bottom of the page, the participants were required to check a box assuring they had read the previous statements and thus agreed to participate in the study (if the box was not checked they could not proceed to the next page of the online survey) (Appendix A – enclosure letters).

4.4.3. Data protection

The Swiss federal law on data protection (1992) (art. 13, al.2e), stipulates that all research data must be published in a form that does not allow any identification of the participants, thus assuring anonymity. In order to respect this, no data concerning the name, exact workplace or any other characteristics allowing identification of the participants were asked in this study.

In 2016, the European Parliament adopted the new general data protection regulation (GDPR) stipulating that data protection must be assured via innovative methods and technical solutions (European Parliament, 2019). This legislation is also applicable to Switzerland even though the country is not part of the EU (Seiler, 2016). According to the European commission (2019), during the process of data collection, participants must have access to a certain amount of information; the details of which are declared in the GDPR. Therefore, this aspect was taken into account in the provided enclosure letter (Appendix A – enclosure letters).

As previously mentioned, the online software used for this study was Professional Limesurvey Version 3.17.3. In their professional hosting data protection statements, the software editor assures GDPR compatibility. Access to the Limesurvey account was given to the author through the University Of Applied Sciences Of Western Switzerland, Lausanne with a garentee that the associated server is established according to the GDPR norms (LimeSurvey, 2019). In order to guarantee anonymity, answers were encrypted by the software and no information concerning IP addresses was collected. Furthermore, all collected data was secured on a personal computer accessible only by the author and was password protected.

4.5. Analysis method

All statistical analyses were conducted using Statistics/Data Analysis (STATA) program version 15.1. Reliability of the study was determined by calculating Cronbach's alphas for each section of the survey (for perceived workload, stress, and job satisfaction).

4.5.1. Data management and descriptive stats

Participants' characteristics were observed using descriptive statistics: mean, standard deviation (SD), and median for quantitative variables, as well as absolute and relative

frequencies for categorical variables (Appendix B – Table 6: participants' characteristics). Raw data concerning the participants' characteristics variables was recoded in order to establish, categories (e.g. the variable "age" was divided in 5 categories, Appendix B – Table 6: participants' characteristics). Other background variables (such as gender, diploma, institution type…) were recoded and labeled to facilitate statistical analysis.

Data management concerning the variables linked to perceived workload were labeled according to the 6 dimensions of the scale with scores ranging from 0 to 10 and allowing for calculations of mean, SD, median and interquartile range (IQR) for each variable. Finally, a calculated sum was established in order to determine overall mean perceived workload.

Data management of results concerning stress (using the HSE IT) started with a coding of the raw data values and a labeling of those values. All 35 variables were individually coded as follows: 0 = "always", 1 = "often", 2 = "sometimes", 3 = "seldom", 4 = "never". This coding was established to facilitate the reading of the results. High scores will show high levels of stress and vice-versa. Furthermore, in presenting results, the wordings of certain items were revised in order to coincide with this procedure (see section 5.4.1. Stress). However, in the original version of the HSE IT, wording of the variables linked to the "demands" and "relationship" standards were expressed in such a way that the measured phenomenon was in the opposite direction (items: 19, 21, 22, 25, 28, 30, 32, 34, 36, 37, 38 and 50 of this study's survey, see Appendix A - surveys). In order to assess stress in the same way between all standards, these items were coded as follows: 0 = "never", 1 = "seldom", 2 = "sometimes", 3 = "often" and 4 = "always" or 0 = "strongly disagree", 1= "disagree", 2 = "neutral", 3 = "agree", 4 = "strongly agree". Once recoding and data management was established, a sum of scores was determined according to the 7 HSE standards: demands (8 items), control (6 items), managerial support (5 items), peer support (4 items), relationships, role (5 items) and change (3 items). From there, the mean score for each standard was calculated.

Variables concerning job satisfaction were recoded as follows: 0 = "strongly disagree", 1 = "disagree", 2 = more or less disagree", 3 = "neutral", 4 = "more or less agree", 5 = "agree", 6 = "strongly agree". Same as for the other Likert scale based data, a total score was calculated in order to determine overall average score of job satisfaction.

When using Likert scale based data one must be careful about appropriate statistical treatment of the data. Within the scientific community, there is a long-running debate on the use of the data as interval or as ordinal. This will have a direct impact on further statistical analysis, since ordinal data uses non-parametric statistics and interval data uses parametric statistics. Non-parametric statistics are considered less statistically powerful than parametric and can involve certain biases within the given results (Bishop & Herron, 2015). However, the authors mention

that when considering an interval scale (for 0 to 10 for example), parametric analysis have often been used (Bishop & Herron, 2015). According to Kuzon & al. (1996), even though the mean of a Likert scale based variable would never be expressed as for example: “Strongly agree and a half”, researchers may have a tendency of expressing the results as “strongly agree.523” (cited by Bishop & Herron, 2015).

According to Carifio & Perla (2007 & 2008), “[…] Pearson correlations and statistical derivatives (multiple regression, factor analysis, multivariate ANOVA, and discriminant analysis) are not very tolerant of uses of ordinal data, whereas F-tests generally are robust with regard to ordinal data” (cited by Bishop & Herron, 2015, p.300). The authors conclude that when using non-interval Likert scales, Pearson correlation or ANOVA should not be considered.

In this study and as previously mentioned, results from Likert scales (HSE and Satisfaction with Work Scale) are expressed by mean, SD and median but not as interval data for further analysis. However, perceived workload was treated as interval data allowing parametric analyses since according to Wu & Leung (2017), if using a range from 0 to 10 (11 points) this allows the data to be considered close to interval scales and used as quantitative data.

4.5.2. Group comparison and association-statistics

4.5.2.1. Perceived workload and participants’ characteristics

In order to determine how and if perceived workload differs according to participants’ characteristics, stratified mean and SD values were determined, followed by different statistical tests according to the nature of the statistics and variables (t-test, ANOVA, Kruskall-Wallis and Wilcoxon ranksum). These comparisons were done for total perceived workload scores and for each of the six dimensions within the NASA-RTLX scale. Normality was determined before each test by analyzing mean, SD, median, skewness and kurtosis values, by assuring with visual analysis of the distribution that it was not bimodal and looking for outliers with graph boxes stratified according to the independent variable.

For dichotomous variables (e.g. gender), once normality was determined, an equal variance test was established. If equal variances were found, a standard t-test was done. However, if no equal variance were found, a t-test with Welch’s approximation was adopted instead. In the case of non-parametric distribution, the Wilcoxon rank-sum test was used to determine any statistical differences.

To determine the perceived workload differences within multi-categorical variables, once normal distribution of the variables was determined, Bartlett’s test for equal variance was done and if no statistical differences were shown, it was followed by ANOVA. If the ANOVA showed

any statistical differences between at least two of the groups, the Pairwise comparisons of marginal linear predictions determined which one. However, if stratified variables did not follow normal distribution, then the non-parametric Kruskal-Wallis test was established. When a statistically significant difference was found, a Wilcoxon rank-sum test was established between each group to determine which group showed statistical differences.

During this procedure, when determining normality, some stratified results had one or two outliers. When n was big enough (>30), this data was considered having normal distribution, allowing parametric analyses. In order to validate this procedure, a result comparison of each test was established between parametric t-tests and non-parametric tests. This comparison did not show any differences.

4.5.2.2. Perceived workload, stress and job satisfaction

In order to determine correlations between perceived workload and stress, non-parametric correlations were established. The use of such statistics is recommended when using Likert scale data (considered ordinal). All correlations were determined by using Kendall's correlation statistic. Correlations were calculated between total workload, total stress and each HSE standard. The same operation was done according to the 6 dimensions within the NASA-RTLX.

Correlations between perceived workload and job satisfaction were also calculated with non-parametric Kendall's rank correlation coefficients and were established for the five items concerning job satisfaction and total job satisfaction scores. Using the same non-parametric test, correlation between occupational stress and job satisfaction was also calculated.

5. Results

This section concerning the results of the study are presented according to the three research study questions of this paper (see section 3). First, by presenting the response rate and participant characteristics (context of the study), then internal consistency of the used instrument, followed by radiographers' perceived workload, and finally by presenting the association between perceived workload and work well-being factors.

5.1. Response rate and participants' characteristics

5.1.1. Response rate

As previously mentioned, the response rate for this study was 23.9% (n = 150). According to Nutly (2008), adequate response rate depends on the purpose and use of the gathered data. One must also take into consideration sample size when assessing response rate adequacy. The same author suggests that within the education domain, a response rate of 15% for a sample of 150 participants would be considered adequate but would mean a 10% sampling

error and a confidence level at 80%. In health research, an online survey response rate of approximately 30% may be considered acceptable. Many authors have demonstrated response rates going up to 80% when using online surveys and reminders (same as what was done in this study) (Leeuw & al., 2008). The study's response rate can thus be considered low. This aspect will be discussed in section 6.4.1.2 "External Validity" of the paper.

5.1.2. Participants' characteristics

General participants' characteristics are shown in Table 6: participants' characteristics (Appendix – B). These results show that at the time of the study, a majority of responders were female (61%). Mean age of the participants was 40.4 ± 10.78 (median of 40). When considering civil status and having children living in the household or not, the largest group was found with radiographers that were married (49%), and had children (55%), ranging from one to three children. The highest proportions of diploma types concerned radiographers having RedCross Diplomas or Bachelors of Science (42% and 43% respectively), and only one respondent had a Master of Science. 21 radiographers mentioned having "other types of diplomas". Most of these (~80% of the 21) were radiographers having obtained a French State Diploma. The largest group proportionally of respondents worked in regional hospitals at the time of the study (48%) and had over 20 years of practice (35%). Most of the respondents worked full time (55%). Finally, 140 out of the 150 participants worked in conventional x-ray, 61 in mammography, 104 in CT, 88 in MRI and 51 in interventional radiography. 16 radiographers mentioned working in "other modalities", with half of these working in ultrasound, four in nuclear medicine and two as managers (the last two, mentioned working in coronagraphy and PACS).

5.2. Research question 1: Internal consistency of the instrument

5.2.1. Reliability

To determine the internal consistency and thus the reliability of the used instrument, Cronbach's alphas of each scale within the survey were calculated. For the NASA-RTLX scale assessing workload consisting of six items (mental demand, physical demand, temporal demand, performance, effort and frustration), the results showed a Cronbach's alpha of 0.64. By deleting the "frustration" item, internal consistency of the scale went up to 0.75. The 35 items of the HSE IT assessing stress showed an internal consistency of 0.83. For the five items assessing job satisfaction with the SWWS/WDSS, Cronbach's alpha was 0.89. According to C. Ortoleva Bucher (personal communication [PowerPoint presentation], May 3rd 2019), there is no exact consensus among researchers concerning the interpretation of these results. However, it is generally admitted that a Cronbach's alpha over 0.7 can be considered satisfactory. Table 2 shows calculated Cronbach's alphas for each scale used in this survey.

Table 2: Cronbach's alphas for each used scale

Scales	Cronbach's alphas
NASA-TLX	0.64
NASA-TLX without « Frustration » item	*0.75*
HSE IT	0.83
SWWS/WDSS	0.89

5.3. Research question 2: Radiographers' perceived workload

5.3.1. Perceived workload

Mean, SD, median and IQR of perceived workload scores according to the six NASA-RTLX dimensions are shown in Table 3.

Table 3: Perceived workload - mean, SD and median scores on a 0 (= low) to 10 (=high) scale

	Mental demand	Physical demand	Temporal demand	Performance	Effort	Frustration	Overall
Mean	7,32	7,21	7,71	7,09	5,51	4,04	6,48
SD	1,76	1,94	1,7	1,66	2,37	2,64	1,23
Median	8	7	8	7	5,5	3	6,5
IQR	3	3	2	2	4	5	1.66

These results show that all dimensions except "Frustration" obtained mean and median scores above 5 on the 0 (= low) to 10 (= high) scale with an overall average mean score of 6.48 ± 1.23 (median: 6.5). The highest mean score was 7.71 and concerned perceived workload associated with "Temporal demand". It is important to note that mental demand, physical demand, and performance all also scored a mean score above 7 in this study. Highest median scores were found with "Temporal demand" and "Mental demand" (median: 8).

A box plot representation of the results, allowing visual comparison of median and IQR values of each workload dimension is shown in Figure 2.

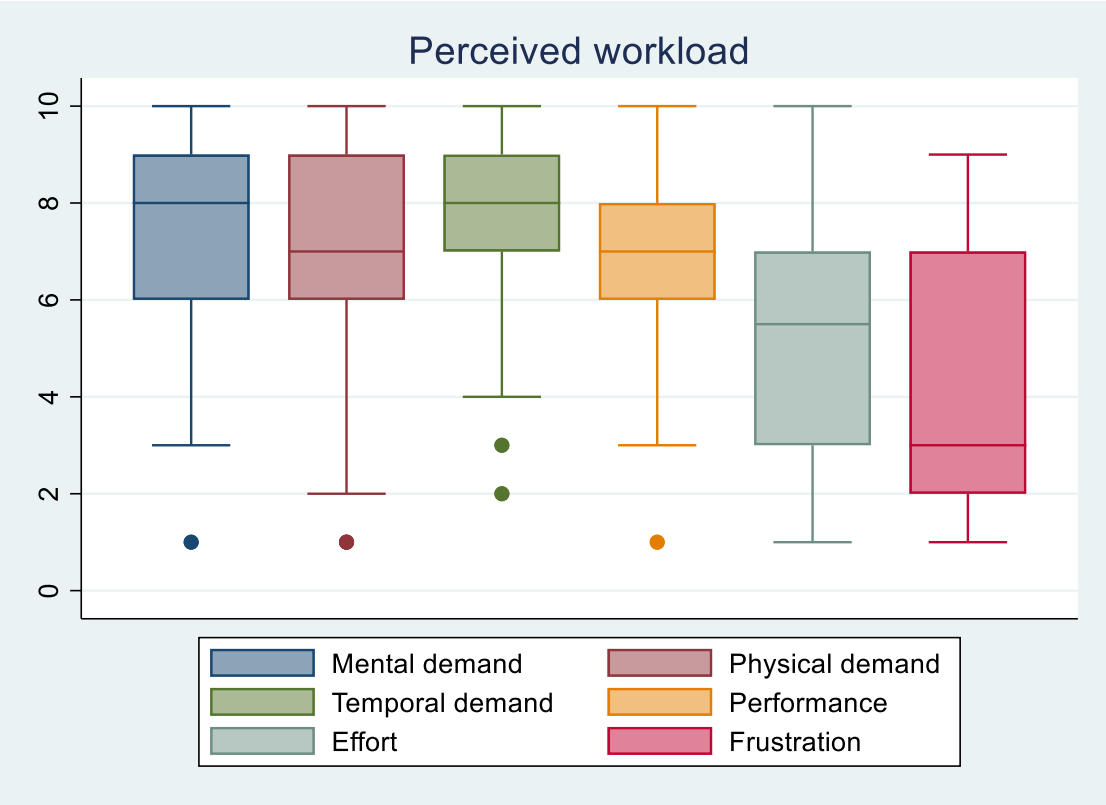


Figure 2: Box plot of perceived workload scores on a 0 (= low) to 10 (= high) scale

5.3.2. Perceived workload according to participants' characteristics

Mean and SD values of participants' perceived workload according to their background characteristics are presented in Table 7 (Appendix B). The following sub-chapter presents differences between groups, mean ± SD values (or median scores according to relevance to the used statistical tests) and confidence interval when significant differences were found.

5.3.2.1. Participants' characteristics

Standard t-test showed no statistical differences of mean perceived workload scores between men and women ($p>0.05$) except for perceived physical demand ($p<0.05$). The data suggests that women perceive higher physical workload demand in their practice (7.67 ± 1.6) in comparison to men (6.49 ± 2.18) ($p<0.05$, CI 95%: 0.52-1.83).

Tests (ANOVA or Kruskall-Wallis, according to normal distribution of the data or not) did not show any statistical differences between perceived workload according to age groups or civil status ($p>0.05$).

Standard t-test using a Welch approximation showed statistically significant mean differences between radiographers that have children compared with those who did not ($p<0.05$, CI 95%: 0.23 to 1.49). The results suggest that radiographers without children score higher levels of perceived physical demand (7.59 ± 1.66) than those with children (6.74 ± 2.14). No other statistical differences of perceived workload were determined.

5.3.2.2. Education and work related factors

As only one respondent mentioned having a Master of Science, for statistical analysis, this item was recoded in order that the unique value would figure in the category called “other”. The ANOVA and Kruskal-Wallis tests did not show any statistical differences of perceived workload according to diploma type ($p>0.05$).

Only perceived workload concerning temporal demand according to institution type showed statistical difference between at least one of the groups with the ANOVA ($p<0.05$). Pairwise comparisons of marginal linear predictions was established and showed a statistical difference between radiographers working in regional hospitals versus those working in university hospitals. Perceived workload scores concerning temporal demand from regional hospitals were shown to be lower (7.07 ± 1.8) than those working in university hospitals (8.27 ± 1.48) ($p<0.05$, CI 95%: -2.01 to -0.39).

The number of years of practice did not show any statistical differences (Kruskal-Wallis test) in total workload scores ($p>0.05$) nor in the performance dimension ($p>0.05$). ANOVA test did not show any statistical differences concerning mental demand, physical demand, temporal demand, effort, or frustration according to years of practice ($p>0.05$).

For statistical relevance, radiographers’ work percentage groups were recoded and regrouped in order to have sufficient data in each sub-group. Some statistical differences between groups were found concerning perceived effort ($p<0.05$). The pairwise comparisons of marginal linear predictions showed that there was a statistical difference between radiographers working at 90% and those working at 60% or under. Radiographers working at 60% or less had lower perceived workload effort scores (4.54 ± 1.96) than those working at 90% (7 ± 2.29) ($p<0.05$, CI 95%: -4.61 to -0.3). The Kruskal-Wallis test concerning perceived frustration showed statistical differences between at least one of the groups ($p<0.05$). The non-parametric Wilcoxon rank-sum tests showed statistical differences for three groups: between radiographers working 60% or lower compared to those working 100%, or 80% ($p<0.05$) and between radiographers working 70% compared to those working 80% ($p<0.05$). These results suggests that radiographers working 60% or less, have a lower score of perceived workload linked to frustration (median score: 2) than those working full time (median score: 5) or at 80% (median score: 4). Radiographers working at 70% also seem to have lower perceived workload linked to frustration (median score: 2) than those working at 80% (median score: 4).

T-test of perceived workload concerning performance according to working or not in plain imaging showed statistically significant mean differences between both groups ($p<0.05$, CI 95%: 0.023 to 2.14). The results suggest that radiographers that do not work in conventional plain x-ray seem to have higher scores of perceived workload linked to performance (8.1 ±

1.29) than those who do (7.01 ± 1.66). Standard t-test showed a statistically significant difference in mean scores concerning radiographers working in mammography or not, according to temporal demand ($p<0.05$, CI 95%: 0.08 to 1.19). The results suggest that radiographers not working in mammography have higher scores (7.97 ± 1.65) than those who do (7.33 ± 1.7). For all other variables, t-test and Wilcoxon rank-sum tests did not show any significant differences ($p>0.05$). Wilcoxon rank-sum tests and t-tests did not show any statistical differences of mean perceived workload according to working in CT or not ($p>0.05$). Statistical significant difference with a standard t-test for radiographers working or not in MRI was only shown between groups concerning perceived effort ($p<0.05$, CI 95%: 0.12 to 1.65). The results suggest that radiographers who do not work in MRI have higher scores concerning effort (6.03 ± 2.45) than those who do (5.15 ± 2.26). None of the t-test or Wilcoxon rank-sum tests showed any statistical differences of perceived workload for each dimension and between both groups concerning radiographers working in interventional radiography ($p>0.05$).

5.4. Research question 3: association between radiographers' perceived workload and work well-being factors

5.4.1. Stress

5.4.1.1. Perceived stress

Mean, SD and median scores of the 7 HSE standards and the 35 items that comprise the HSE IT are shown in Table 8 (Appendix B). As previously mentioned, these scores are associated to a Likert scale ranging from either "Always" (= 0) to "Never" (=4) or "Strongly disagree" (=0) to "Strongly agree" (=4) for all variables except those related to the demands or relationships standards that have an inversed coding due to the nature of the statements. In order to facilitate reading of these results, mean scores concerning the items from the demands or relationship standards will be marked with a "*". Furthermore, wording of certain items of the scale have been revised in the text according to coding modifications (put in *italic* in the text).

The four lowest mean scores demonstrating lower levels of perceived stress concern the following statements: "*I am not subject to bullying at work*" (0.53* ± 0.81), "I am clear what my duties and responsibilities are" (0.72 ± 0.75), "I know how to go about getting my job done" (0.73 ± 0.64) and "I am clear what is expected of me at work" (0.79 ± 0.57). Three out of these four statements are linked to the HSE IT "Role" standard. Highest mean scores representing higher perceived stress were found in the following statements: "I have to work very fast" (2.49* ± 0.85), "*I do not have a say in my own work speed*" (2.47 ± 1.02), "*Staff are never consulted about change at work*" (2.46 ± 1.03) and "*I do not have a choice in deciding what I do at work*" (2.45 ± 1.08). The first statement is from the HSE "Demands" standard, the second and third from the "Control" standard, and the last from the "Change" standard.

The lowest mean score HSE standard was the “Role” standard (0.91 ± 0.49) and the highest concerned the “Change” and “Control” standards (2.04 ± 0.82; 2.03 ± 0.71) (Figure 3). Other mean standard scores ranged from 1.72* ± 0.63 (“Demands”) and 1.15* ± 0.69 (“Relationships”). Overall mean was 1.86 ± 0.28 being slightly under the “neutral” value according to the scale.

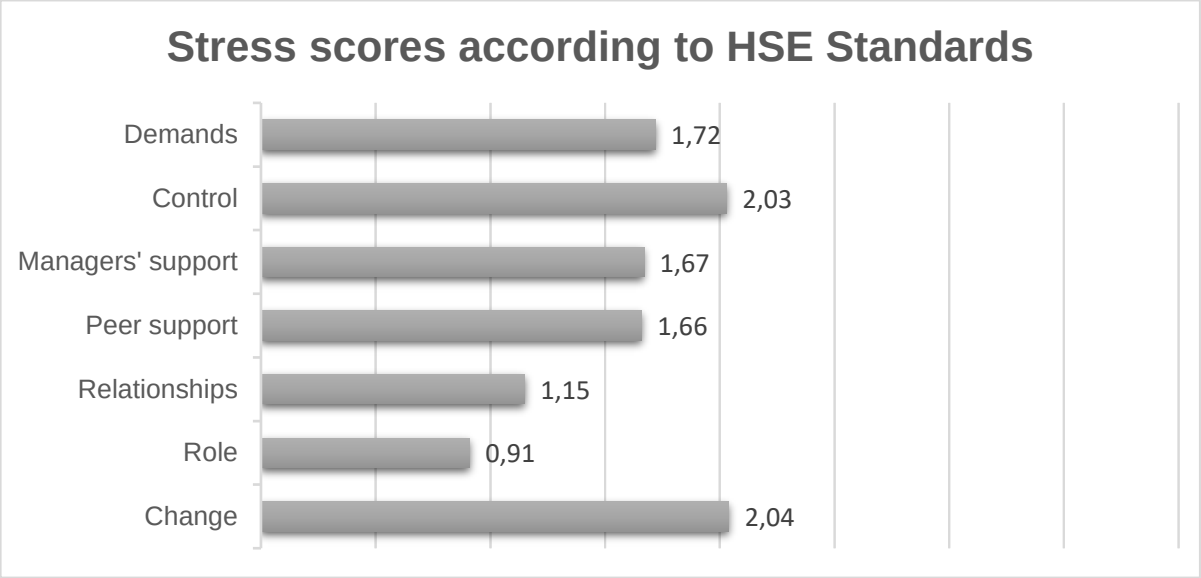


Figure 3: Mean scores according to the Health and Safety Executive (HSE) standards based on a 5-point Likert scale

Additionally, average cumulative frequencies of low scores based on participants’ scores for each question were calculated. These results showed that approximately 19% of radiographers in Western Switzerland scored on average either 3 or 4, indicating moderate to high levels of overall perceived occupational stress.

5.4.1.2. Association between perceived workload and stress

Results (p-value and tau-b) of the correlations between perceived workload and stress based on Kendall’s rank correlation coefficients (τ_B) are shown in Table 9 (Appendix B).

Total workload showed statistically significant correlations with total perceived stress scores and each HSE standard except for the peer support standard. The highest positive correlation was found between total workload scores and the demands standard ($p<0.05$) with a positive correlation of 0.34. The lowest correlation for total workload was found with the managers’ support standard ($p<0.05$, $\tau_B = 0.13$).

Mental workload was only statistically correlated with the demands standard ($p<0.05$), with a positive correlation of 0.12, which is the lowest statistically significant correlation in these results. As for total workload, physical demand was statistically positively correlated with all

standards except peer support. The highest correlation was found with total stress scores ($p<0.05$, $\tau_B = 0.27$) and the lowest with the role standard ($p<0.05$, $\tau_B = 0.13$). Temporal demand also showed statistically significant correlations with total perceived stress scores and each HSE standard except for the peer support standard. Highest correlation concerned the demands standard ($p<0.05$, $\tau_B = 0.5$) and is the highest calculated statistically significant correlation in these results. The lowest correlation concerning temporal demand and stress was found with the role standard ($p<0.05$, $\tau_B = 0.17$). Statistically significant correlation between performance and stress were found in all but the peer support and role standards. Highest positive correlation was with the demands standard ($p<0.05$, $\tau_B = 0.34$) and the lowest with the change standard ($p<0.05$, $\tau_B = 0.13$). Effort was positively correlated to each HSE standard and total stress scores except peer support. The highest value concerned the demands standard with a positive correlation of 0.32 and the lowest value was found with the control standard ($p<0.05$, $\tau_B = 0.18$). Frustration only had a statistically significant correlation with the role HSE standard ($p<0.05$, $\tau_B = 0.14$). In general, these results suggest that when perceived workload is higher, so is perceived stress.

5.4.2. Job satisfaction

5.4.2.1. Overall job satisfaction

As for perceived workload and stress, mean, SD and median values of job satisfaction were calculated and are shown in Table 4. The 7 point Likert scale associated with job satisfaction ranged from “Strongly disagree” (= 0) to “Strongly agree” (= 6) with the neutral value situated at 3. The highest score was found for the following statement: “I am satisfied with the type of work I do” (4 ± 1.37) and the lowest score was “If I could change anything about work, I would change almost nothing” (2.31 ± 1.77). Overall mean for job satisfaction was close to the “neutral” value not showing any particular satisfaction or dissatisfaction of radiographers with their work (3.32 ± 1.29).

Table 4: Job satisfaction - mean, SD and median scores based on a 7-point Likert scale (“Strongly disagree” to “Strongly agree”)

Statements	Mean	SD	Median
1. In general, the type of work I do corresponds closely to what I want in life	3.71	1.50	4
2. The conditions under which I do my work are excellent.	2.93	1.62	3
3. I am satisfied with the type of work I do	4	1.37	4
4. Until now, I have obtained the important things I wanted to get from my work.	3.63	1.46	4
5. If I could change anything about work, I would change almost nothing.	2.31	1.77	2
Overall	**3.32**	**1.29**	**3.4**

5.4.2.2. Association between perceived workload and job satisfaction

Correlation results between perceived workload and job satisfaction using Kendall's rank correlation are shown in Table 10 (Appendix B). Total workload was statistically and negatively correlated to all job satisfaction variables except the first and third statements ($p<0.05$). The highest correlation was found with the second statement concerning excellent work conditions with a negative correlation of -0.28. Meaning that when work conditions are considered excellent, perceived total workload scores seem to be lower (and vice versa).

Mental workload was not statistically correlated to any job satisfaction items ($p>0.05$). Physical demand and performance showed the same results as total workload with the highest negative correlation also being with conditions under which the respondents work ($p<0.05$, τ_B = -0.28 & -0.23). Temporal demand and effort were statistically negatively correlated to each item ($p<0.05$). The highest value for both dimensions were found with total job satisfaction ($p<0.05$, τ_B = -0.28 & -0.27). This shows that when temporal demand and effort are perceived as high, total job satisfaction seems to be lower (and vice versa). No statistically significant correlations were found between frustration and job satisfaction.

5.4.2.3. Association between occupational stress and job satisfaction

Calculated correlations, using Kendall's rank correlation, between occupational stress and job satisfaction are shown in Table 11 (Appendix B). Statistical significant negative correlations were found between all items. The highest negative correlation concerned the managers' support standard and obtaining important things wanted from work ($p<0.05$, τ_B = -0.5), and the lowest was between "if I could change anything, I'd change nothing" and the peer support standard ($p<0.05$, τ_B = -0.2). These results generally suggest that when stress is perceived as high, job satisfaction is low.

5.5. Survey general comments

Out of the 24 comments left at the end of the survey, 7 of them concerned radiographers mentioning frustration within their jobs linked to the productivity and financial aspects of their work and thus putting patient care at a second level.

Other comments concerned either positive motivational comments or clarity of the statements. The later will be discussed in section (6.4.1.1.4. Survey) of the thesis.

6. Discussion

6.1. Perceived workload

This study showed that radiographers' overall mean perceived workload was above average (6.48 on a 0-10 scale). Mental demand, physical demand, temporal demand and performance

all scored above 7/10 in this study, with temporal demand being the highest score. These results confirm existing literature suggesting that radiographers have highly perceived workloads (Rutter & Lovegrove, 2008; Dunlop, 2015). This observation may be directly linked to the nature of work in health and more specifically in radiology. Indeed, and as previously mentioned, healthcare workers and radiographers are known to have many physical constraints in their work, mostly due to posture, handling and moving patients and/or equipment. Additionally, regular encounters with death and sickness can also lead to increased mental and emotional strain (Cazabat & al., 2008). Physical strain and ergonomics in radiology has been assessed in many studies (Sharan, Mohandoss, Ranganathan, Jose & Rajkumar, 2014 ; Kumar, Moro & Narayan, 2004 ; Goyal, Jain & Rachapalli, 2009 ; Pais, Azevedo, Medeiros, Freitas & Stamato, 2012). A systematic review showed that 72%-77% of radiographers present lower back pain linked to lifting patients, bending and movement repetition (Sharan & al., 2004). One of the main negative outcomes stemming from work-related physical problems is an increase in absenteeism, creating a greater workload for the rest of the team (Paris & al., 2012). In order to decrease perceived physical workload and strain, ergonomic principals must be encouraged through adequate training and work organization (Goyal & al., 2009).

These high results of perceived workload are somewhat different to those found in a previous study conducted in Switzerland. In their study Lehmann & al. (2015), showed that >63.5% of radiographers expressed being satisfied or very satisfied with their workload. This difference might be explained by the fact that in their study, workload was evaluated with only one question in a general survey and according to satisfaction, not on levels of perceived workload according to specific dimensions as was done in this study.

It is not surprising that the highest score of perceived workload concerned temporal demand. Diagnostic radiology is a discipline of radiology that is driven by very short examination times. The increased number of examinations and the decrease in time allotments for each individual patient both have an impact on radiographers' perceived temporal workload (Dunlop, 2015). This shortened time with patients is also known to be the source of certain frustrations for these caregivers. In this study, a few general comments left at the end of the survey were related to frustration; this frustration was due to the lack of sufficient time with the patients. This misalignment between radiographers' personal devotion to their patients and the time constraints increases perceived workload in diagnostic radiography and could lead to a reluctance to stay in the profession and an increase in turnover (Lehmann & al., 2015).

Furthermore, these high scores of perceived workload may be influenced by the expansion and use of new technologies. In radiology, technological developments are constant and can

be a strain for those working with them. The necessity to constantly adapt procedures and work methods to new and complicated technologies can be stressful, especially if proper training is not provided (Dunlop, 2015; Lehmann & al., 2015). This aspect could also explain why the results showed that radiographers that do not work in plain imaging showed higher levels of perceived workload linked to performance. The accomplishment of tasks and goals linked to conventional x-ray may be considered as less challenging than other modalities that use more complex technologies.

Another reason for high-perceived overall workload and temporal demand could be linked to staff shortage. As previously mentioned, staff shortages have been shown to be one of the main contributors to perceived stress through workload since understaffing will automatically induce more work (Vernier & Harvey, 2010 ; Ashong & al., 2016 ; The Society of Radiographers, 2007). Understaffing in healthcare in Switzerland has been reported and recommendations for future staffing needs have been estimated (OdASanté, 2016). Departments should take appropriate steps to increase staffing in radiological departments; the objective being a decrease in perceived high workload and a guarantee of quality of care in the future.

The study also showed that radiographers without children scored higher levels of perceived physical demand than those with children. This result might be surprising but may be explained by the fact that radiographers with children may perceive their workplace physical demands as lower than the ones they have at home. However, it is important to mention that the lowest score of perceived workload concerned “Frustration”. This implies that radiographers within this study do not feel insecure, discouraged or irritated about their work. Job security and stability are important aspects to value and encourage in departments, since they may influence workers’ goal commitment and implication within the workplace (Grönroos, Pajukari & Matinheikki-Kokko, 2009).

The results of this study concerning perceived workload have confirmed the fact that according to Rutter & Lovegrove (2008) and Dunlop (2015), perceived workload in radiology is high. As previously noted, the increased number of examinations coupled by understaffing are placing staff under increased pressure. This can result in higher workloads leading to errors, and can have a negative impact on patient safety (Lyall, 2015).

6.2. Stress

The overall mean score value for perceived stress was shown to be equivalent to the “neutral” score on the used scale. This shows that overall, radiographers working in diagnostics radiology in Western Switzerland are neither stressed nor not stressed at work. When considering the HSE standards, the “Role” standard had the lowest score, thus showing the

lowest level of perceived stress. Radiographers seem to be clear on expectations from their hierarchy, procedures to be followed, as well as their duties and responsibilities. This standard is linked to understanding roles and responsibilities, and ensuring that these roles are not conflicting within the organization. These aspects must continue to be valued and encouraged since, according to Vernier & Harvey (2010), being aware about organizational goals and having a clear understanding of individual roles, can ultimately reduce burnout.

The “relationship” standard had the second lowest score. This observation demonstrates that relationships between professionals are perceived as healthy and pleasant. This supportive team environment must be encouraged. However, it is important to mention that some comments provided at the end of the survey suggested that these results might be different if the considered relationships were between radiographers or between radiographers and radiologists. In the case of the later, results might have been higher.

Highest scores were found in the “change” and “control” standards. The control standard indicates to what extent workers’ opinions, ideas, and suggestions are positively received and considered by their respective hierarchies. These results may be linked to the nature of a radiographers work. The lack of autonomy and protocol-guided nature of the accomplished tasks may influence the sense of not having a say on how one works. The highest score within the “control” standard was related to a worker’s ability to influence time schedules and/or patient allotments. This reflects directly to the highly time pressured nature of diagnostic radiology. According to Vernier & Harvey (2010), “lack of control due to patient flow is also associated with workload/staffing issues” (p. 121). The authors suggest that radiographers should be more consulted about their work patterns and departmental organization in order to improve (Vernier & Harvey, 2010). As previously explained, lack of control has been shown to have an important influence on perceived stress through perceived workload (Mulder, 2017). These aspects are therefore linked to the psychosocial work environment and norms at the organizational level may be related to occupational stress (Hammer & al., 2004).

The high score regarding the “change” standard is an indication that departments do not properly execute management and communication of organizational changes. Practical implications of change at work are not necessarily clear. Radiographers are not regularly consulted and therefore miss opportunities to question managers about change. Vernier & Harvey (2010), suggest that in order for this situation to improve, better communication systems and increased consultations with staff must be implemented. When working in a fast evolving work environment like radiology, efficient communication is essential. Furthermore, it is recommended that “radiographers should be provided information, training and support when undergoing organizational change.” (Vernier & Harvey, 2010, p.123).

As previously mentioned, 19% of the participants showed having moderate to high perceived occupational stress. These results are similar to those suggested by the FSO (2019), who showed that 23% of workers in Switzerland feel frequently or continually stressed in the workplace. However, a recent research report published by Philips (2019), showed that between 40-97% of radiographers working in the United States, France, Germany and the UK showed moderate to severe stress. This difference may be explained by the fact that in the study conducted by Philips (2019), they only had a small sample of radiographers per country and may thus not be fully representative of the targeted population. However, the results of this present study show that actions in order to decrease perceived stress must be encouraged by radiological departments, as almost a fifth of radiographers have moderate to high perceived occupational stress in Western Switzerland.

A positive correlation between total workload scores and total perceived stress scores was determined in this study. This observation suggests that when perceived workload is higher so is perceived stress. More specifically, the results in this study show that total stress scores have the highest correlation with perceived workload linked to temporal demand. These results coincide with previous papers in which many authors have demonstrated and shown that workload and time pressure (linked to flow of patients) is one of the main work related stressors (Lehmann & al., 2015; Probst & Griffiths, 2009; Verrier & Harvey, 2010; Ashong & al., 2016 ; SECO, 2010 ; The Society of Radiographers, 2007 ; Eslick & Raj, 2002).

6.3. Job satisfaction

Radiographers in this study scored an average of 3.32 on the SWWS, which is slightly higher than the “neutral” value on the scale. This indicates that they are not particularly satisfied or dissatisfied with their work. These results are similar to those found in a previous study in Switzerland (Lehmann & al., 2015). In their study, Lehmann & al. (2015), had shown that the dimensions linked to job satisfaction which are the highest in radiology concern: technological equipment, radiographer teams and job content. This also coincides with the present results as the highest score was found with the following statement: “I am satisfied with the type of work I do”. This aspect is directly linked to the nature of the profession itself and not to its setting. Recent and well-functioning equipment may contribute to work satisfaction through improved image quality, reduced physical strain and may allow professionals to focus more on patient well-being. According to Mamboury (2011), patient care has been shown to be one of the main reasons why students choose to work in radiology; as previously mentioned, being able to focus on the patient may be able to decrease certain frustrations for these professionals (cited by Lehmann & al., 2015). Philips (2019), who showed that patient-care and helping people are the two main motivations for this profession choice, confirmed this statement.

However, in this study the lowest satisfaction score related to change in the work ("if I could change anything about work, I would change almost nothing"). This aspect could be linked to work organization, recognition from physicians, institutional environment, salary or career perspective as all these elements have been shown to score lower in a previous study in a similar context (Lehmann & al., 2015). Lack of recognition from other health professionals is a well-known fact for radiographers and it may induce apathy towards their work and professional development (Yielder & Davis, 2009). In order to develop a sense of control and job satisfaction, organizations should focus on providing professional development opportunities in line with radiographers' personal desires (if they wish to or not and if so, what area or level). This will encourage professional empowerment and professional engagement, which will lead to better work performance (Grönroos & Pajukari, 2010 & Philips, 2019). Furthermore, poor work organization potentially causing this low job satisfaction score, could be linked to perceived workload.

In this study, total job satisfaction scores were negatively correlated to total workload scores. These results indicate that when workload is perceived as high, job satisfaction decreases. More specifically, the highest correlations were found between the statement linked to working conditions and total perceived workload, physical and temporal demand. These observations coincide with those expressed by Grönroos & Pajukari (2008), who demonstrated the existing link between workload and job satisfaction. Not having enough time and resources could lead to lower job satisfaction and higher perceived temporal demand. These aspects may be influenced by many factors such as work organization, staff shortages and high time pressures.

All these results show that departments must make efforts to decrease perceived workload for their employees as it has potential negative impacts on perceived stress and job satisfaction. As a result and as previously described, if workload and stress are perceived as high, this may potentially cause lower job satisfaction, which can lead to important negative impacts on work well-being, productivity, turnover and patient outcomes, and important economical negative outcomes for departments.

Figure 4 visually demonstrates and summarizes potential negative outcomes as well as the existing complex links between these different notions. Arrows and correlations in red have been demonstrated within this study, the others are based on the literary review that was established for this research.

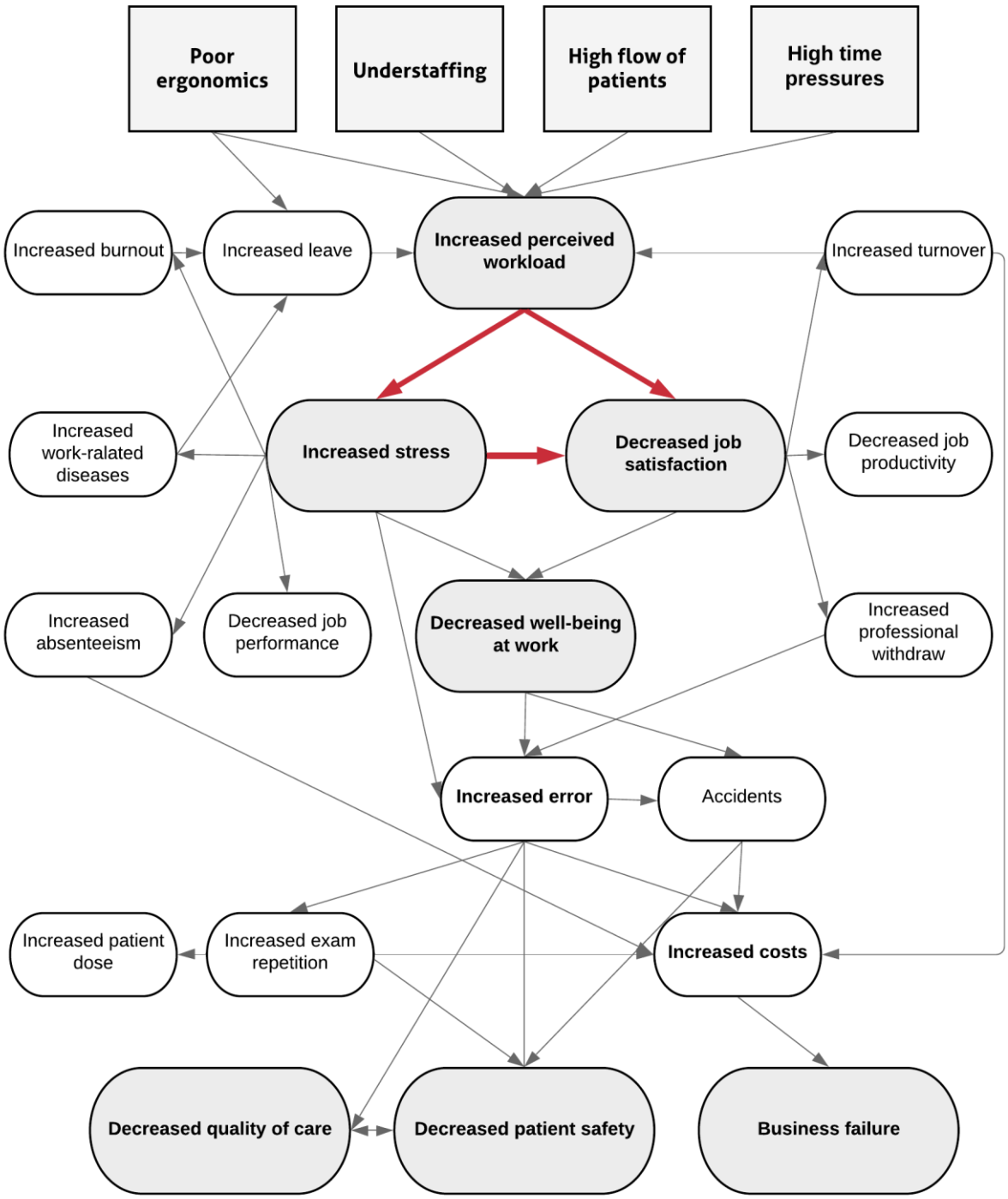


Figure 4: Negative outcomes of increased workload, stress and low job satisfaction.

6.4. Evaluation of the reliability and validity of the study

6.4.1. Validity

The validity of a study may be determined by its internal validity and external validity. Internal validity concerns how the used methods allow the researcher to respond adequately to the research question(s) and thus will be mostly influenced by the research methods. External validity concerns how the selected individuals are sufficiently representative of the population

insuring that the results can be inferred from the population as a whole. This will mostly concern sampling procedure. The different aspects that influence the internal and external validity of this study will be discussed in this section.

6.4.1.1. Internal validity

6.4.1.1.1. Self-reported online surveys

Some of the main advantages of using online surveys are that they are low in cost and fast, and that they can be distributed to a large number of people allowing ultimately for a generalization of findings. Another advantage of using an online survey as opposed to an interview-based survey is the fact that the unwanted interviewer effects are eliminated and that respondents have more privacy to answer the questions when these concern "sensitive" questions (Leeuw & al., 2008 & Demetriou & al., 2015).

According to Kimberlin & Winterstein (2008), when using a measurement scale, it is necessary to report the reliability (by determining internal consistency for example) and validity of the measurements. Self-reported surveys have certain biases such as social desirability biases (where the subject might answer what he/she thinks is socially acceptable), memory bias or subjectivity in interpretation (Kimberlin & Winterstein, 2008 & Demetriou & al., 2015). In their article, Kimberlin & Winterstein (2008), mention that scales using frequencies as a response (e.g. seldom to frequently) can be influenced by this subjectivity. Indeed, an answer such as "sometimes" can mean a different exact number of times depending on who is answering. According to the same authors, the use of self-report can lead to misclassification bias, meaning error in classifying the effect on subjects. Demetriou & al. (2015), suggest that participants may minimize their response when using self-reported questionnaires with Likert scales. The same authors mention that a neutral value "may allow individuals to avoid expressing an opinion even when they have one." (Demetriou & al., 2015, p.2).

It has also been reported that these kind of surveys may also have the disadvantage of not having an interviewer present and thus not being able to answer or explain certain misunderstandings (Leeuw & al., 2008). This is why the enclosure letter (Appendix A – enclosure letters) contained personal contact information allowing respondents to ask any question to the author. Additionally, the "comments" section of the survey also allowed participants to express their feedback and/or comments (these comments are discussed in section 6.4.1.1.4.).

6.4.1.1.2. Statistical analyses with Likert scales

As previously mentioned, Likert scales are widely used within research. However, the interpretation of the data is subject to many debates. In this study, since the scale assessing perceived workload was based on a 11 point interval, the data was considered as non-ordinal,

as recommended by Wu & Leung (2017). This adequate procedure and method increases the validity of the presented results.

6.4.1.1.3. Pilot study

Validity of this study was also increased by employing a pilot study prior to the survey distribution. As mentioned previously, this procedure may allow the researcher to determine understandability of the questions, the time taken to respond and to adapt the questionnaire if necessary.

Feedback obtained from participants in the pilot sending mostly concerned the possible confusion surrounding certain questions of the survey. For example, in the French version of the NASA-RTLX, one of the six items assessing perceived work does not have the same scale name as the others. In the English version, all items are assessed using a 10 point Likert scale from “Low to High”, as in the French version, one of the items is assessed with a scale ranging from “Good to Bad”. This change is due to the translation of the statement, which, in French, does not make sense by using low to high.

Other potential confusions highlighted by the pilot sending were linked to the length and complexity of the questions. This was particularly the case for questions assessing workload, which may have provoked strain or discouragement in participants. A few participants also mentioned that some of the statements/questions could be considered as too vague, and therefore could be subject to various interpretations. For example in the SWWS tool one statement is: “I am satisfied with the type of work I do”. Feedback mentioned that the participant was not sure what was asked in this question: satisfied by the accomplished work or by the type of work that is done? Finally, one participant found that one sentence in the Enclosure letter was not clear but this was not mentioned by any of the other participants and thus no modifications were made. Following the pilot sending, no modifications were made to the questionnaire.

It is important to mention that the complexity of certain questions may have increased the probability of scale error due to misunderstanding and thus may have negatively influence the validity and/or reliability of the study (Gonyea, 2005).

6.4.1.1.4. Survey

The use of existing and validated scales in this study also contributes to its general internal validity. However, these tools also have certain limitations that have been expressed in published articles.

Firstly, as previously mentioned, the scale used to assess workload was the NASA-RTLX, which is a simplified version of the NASA-TLX. Even though studies have shown similar

sensitivity to the original version, the NASA-RTLX does not allow to determine how each component is weighted in regard to its importance. However, its validity has been shown in many different contexts including health (Hoonakker, & al., 2011).

Concerning the HSE IT, as for the previous scale, the validity of the scale has been shown in many studies (Cousins & al., 2004 ; Brookes & al., 2013). In their paper, Brookes & al. (2013), suggest that even though the HSE IT is a good way to assess work related stress, in order to have more detailed information work related stress, researchers should use other scales as well. The use of more than one scale to assess a concept could improve the internal validity of the results. Due to the nature of this study and its objectives, this was not deemed necessary. Brookes & al. (2013), also argue that the HSE IT could be unrepresentative in the case of participants showing very high levels of stress and may ignore “some important issues such as boredom and work overload that also contribute to stress” (p. 471). In this study, as association between perceived workload and stress has been determined, this limit of the scale is not applicable. In general, the tool’s validity within this study is guaranteed.

Since no translated version of the HSE IT was available, a translation was needed. The validity of the translation was guaranteed by the adequately used method (see section 4.4.3).

The SWWS has been shown to be a valid and stable instrument across languages and samples to determine job satisfaction (Bérubé, & al., 2007). However, as for all the used scales in this study, the measurements may be compromised due to the multifaceted nature of the measured concepts. Even though each of these three scales were validated according to different aspects of the measured concepts, there could be more which need to be tested. For example, concerning the SWWS, Bérubé & al. (2007) suggest that the scale does not take into consideration the satisfaction one may have by doing volunteer work even though his/her skills are underutilized and focuses on ones satisfaction with work.

Another aspect to take into consideration when determining the validity of the constructed survey concerns the feedback and comments left by the respondents. Some respondents mentioned in the comment section that answering questions linked to perceived workload and work related stress were difficult to assess due to the nature of their work. They noted that these components could vary greatly depending on the day. For radiographers, the number of examinations can change depending on the day and this can influence perceived workload and/or stress.

Another fact mentioned in the comment section of the survey concerned the complexity of certain questions. A few participants mentioned that questions that having double negatives, that began with “I have a say…” or that were too long, were very difficult to understand. This mainly concerned questions assessing perceived workload and/or work related stress. Two

respondents also mentioned that items within the HSE IT concerning relationships were not precise enough. They mentioned that when talking about relationships between co-workers, these depended on whether they concerned relationships with radiographers or radiologists. They mentioned that relations with radiologists are often more complex or even inexistent compared to those with radiographers. These different statements may suggest biases in some responses. However, based on the very few comments questioning the understandability or clarity of the questions, this does not call into question the validity of the results.

A couple of respondents mentioned that some aspects were not assessed in questions determining their job satisfaction. These aspects concerned salary, working night shifts and lack of recognition of their profession from other healthcare practitioners or the public. According to Lehmann & al. (2015), salary and peer recognition was shown to have relatively poor appreciation from radiographers in Switzerland. Even though these are interesting facts and may encourage further research to be validated, the validity of used instrument has been determined and thus may still give adequate information on domain job satisfaction.

Finally, after a fist read of the results from this questionnaire, one of the items had to be deleted. This was the case for the item assessing the number of years/months that the radiographers had been working in their present job. The reason for doing so was linked to the disparities in the answers. This question was left as an open question and respondents did not all specify if the number they entered concerned years or months. In order not to have any biases in interpretation, this item was completely deleted from the results of this study.

6.4.1.2. External validity

The purposeful cluster sampling procedure used in this study and the focus on radiographers working specifically in diagnostics (through contact with the CCTRM), helped to distribute the survey to a great number of departments within Western Switzerland. This procedure encourages the "representability" of the sample and thus the external validity of the results. "Representability" of this sample was acceptable (43.5% of the target population), but since the targeted population was determined from estimates, it is important to note that the sample percentage of that population may be over or under estimated.

The results concerning participants' characteristics are similar to those found in other research conducted in Switzerland. Lehmann & al. (2015), found gender distribution to be 70% of women and 30% of men in Swiss radiology departments. These results are similar to those found in this research where women represented approximately 60% of respondents and men 40%. Other similar results concerned work percentage, where Lehmann & al. (2015), found a mean working value of 86% and within this sample that mean was at approximately 87%. These findings also correlate with another study sating that 53% of radiographers work full

time (55% in this study) (Lehmann & al., 2012). Finally, participants' characteristics concerning family status (having children or not, and how many) in this research are also similar to those shown in the same study. All of these similar results increase and justify the external validity of the thesis.

According to Kerr, McHugh & McCrory (2009), the validity of findings can be negatively influenced by low response rates and non-response bias. One must thus take into consideration both these aspects when discussing the validity of results. The response rate in this study can be considered low when compared to other international studies in healthcare using online surveys. However, when compared to another Swiss study, the response rate is similar (23.9% VS 25%) (Lehmann & al., 2015). This low response rate may be explained by different factors. Firstly, by asking the head of departments to send the link to their employees, there is no actual way to guarantee that they did so. It is also important to note that a culture of research and its benefits is very new for Swiss radiographers. Indeed, the Bachelor education program only exists since 2002 in Western Switzerland (with first graduate finishing in 2006) and thus many radiographers working at the time being do not have any educational background in research. As a result, they might not be interested in answering at all.

This low response rate may influence non-response bias, which results in potential differences in results between respondents and the rest of the sample. According to Leeuw & al. (2008), if non-response is purely due to chance and completely random, as it is the case of this study, there is no issue. Cook & al. (2000) explain that response rates are not as important as response representativeness when determining the validity of results (cited by Kerr & al., 2009). As previously mentioned the results in this study are representative of the targeted population and demonstrate the external validity of this study.

The objective when determining the validity of a study is to determine if the results are possibly due to chance or if they are truly representative of the target population (Jones, Carley & Harrison, 2003). Power calculations give information on "the probability of not rejecting the null hypothesis when the alternative hypothesis is true. It measures the ability of a test to reject the null hypothesis when it should be rejected" which represents the probability of not making a type II error (Mc-Crum-Gardner, 2010, p.11). In this study, power of all performed tests were calculated and ranged from 0.62 to 0.99. According to Mc-Crum-Gardner (2010), statistical power should be at a minimum of 0.8. Power values that were found to be under this threshold in this study may be explained by the sample size being too small, the magnitude of a clinically significant difference or the type of statistical test that was performed (Jones & al., 2003). However, as most of the tests showed a power above 0.8, this can contribute to the validity of the results in this study.

6.4.2. Reliability

The reliability of the study has been guaranteed by calculating the internal consistency. Results show an internal consistency of 0.64 for perceived workload. As for all subjective scales, the NASA-RTLX has been shown to lack in or have low results of internal consistency (Wilson, 1998, cited by Miller, 2001). This result is lower than expected. In their paper, Hoonakker & al. (2011), found an internal consistency of 0.72 when using the NASA-TLX in healthcare. As already mentioned, there is no true consensus between researchers about acceptable values of Cronbach's alpha. However, it is generally said that a Cronbach's alpha situated between 0.7 and 0.95 can be stated as satisfactory (Tavakol & Dennick, 2011). This suggests that the internal consistency of the NASA-TLX is low in this study.

According to Tavakol & Dennick (2011), a low Cronbach's alpha can be influenced by too few questions, poor inter-relatedness between items or heterogeneous constructs. Indeed, even though Cronbach's alpha gives an idea of whether or not the items of a test are one-dimensional, in the case of multiple factors underlying the items and few questions (as it is the case for perceived workload) the Cronbach's alpha may underestimate true reliability (Tavakol & Dennick, 2011). In order to determine to what the low internal consistency is due, the same authors suggest finding the item having the lowest correlation with the total test score. In the case of this study, the lowest correlation was found between total perceived workload and frustration (r = 0.42) (Tavakol & Dennick, 2011). When retesting the Cronbach's alpha without the "frustration" item, internal consistency went up to 0.75. The item was not deleted from the study, but from these results, it may represent a bias in this study.

The Cronbach's alpha for job satisfaction and stress were similar to those found in other studies using these scales (Bérubé & al., 2016; Cousins & al., 2004). In this study, Cronbach's alphas of 0.83 (stress) and 0.89 (job satisfaction) were found. The internal consistency for stress and job satisfaction can be considered highly acceptable and demonstrates the reliability of the French scales used in this study. Furthermore, reliability is also supported by the detailed methods of this study. Indeed, the thorough and explicit procedure description of how this research was conducted allows other researchers to precisely reproduce the study and thus may contribute to justifying its general reliability.

To conclude, despite certain biases due in particular to the nature of the measurements (e.g. online surveys, use of Likert scales & translation) and the multi-faced concepts that were measured, thanks to precise and accurate methods, this study and its results can be considered reliable and valid.

6.5. Recommendations for practice

Based on the findings in this study, Table 5 suggests clinically relevant recommendations for radiological departments.

Table 5: Recommendation for practice - what to keep and what to improve?

To keep	To improve
Insure job security and stability for radiographers	Encourage ergonomic principals through adequate training and workplace organization
Clearly communicate departments' goals	Adapt examination times and workflow by involving radiographers in the decision-making process
Encourage positive team interactions	Increase the amount of staff
Provide adapted working hours	Consult workers (radiographers) about work patterns and departmental organization
Provide well-functioning and recent equipment	Improve communication of management and organizational changes
Promote and encourage easy contact with managers to talk about work related problems	Initiate and develop clear communication systems between staff and managers (radiographers or radiologists)
	Provide information, training and support during organizational changes
	Encourage professional development focused on opportunities in line with workers desires

7. Conclusion

The thesis showed that diagnostic radiographers' overall perceived workload in Western Switzerland is high. It demonstrated that the highest score for perceived workload concerns temporal demand, which is probably linked to reduced examination times, high time pressures, increased number of examinations, physical and emotional strain, and understaffing.

Assessed work well-being factors (stress and job satisfaction) pointed out that overall, diagnostic radiographers do not feel either stressed or not stressed due to their work. However, almost a fifth of them showed moderate to high levels of perceived occupational stress. Furthermore, low scores on the scale measuring work related stress, thus demonstrating high perceived stress, were found within the "control" and "change" HSE standards. These results suggest that radiographers probably lack in autonomy, are negatively influenced by the protocol-filled nature of their work, cannot influence their work speed and do not consider that communication between management and organizational changes is optimal. As for stress, job satisfaction of the targeted population was shown to be neither high nor low, indicating that radiographers are neither satisfied nor dissatisfied with their work. Once again, the lowest satisfaction score was linked to changes within the workplace, which could be linked to poor recognition, poor work environment or organization, low salaries, or misalignment between career perspectives and opportunities. Both work well-being factors assessed in this study showed statistically significant correlations with perceived workload. The results showed that highly perceived workload is associated to higher levels of work-related stress and lower scores of job satisfaction.

Internal consistency of the three standardized questionnaires used in the survey was acceptable, and the validity and reliability of the study was demonstrated. This indicates that the translated instrument used within the French speaking radiology context was suitable and can be used for follow-up studies.

Based on the results from this thesis, many clinical implications must be considered. As shown, high perceived workload may lead to increased error, have a negative impacts on patient safety, increase stress and decrease job satisfaction. As a result, high-perceived stress may have important negative outcomes such as: increased work-related diseases or increased burnout, which will increase professional leave and absenteeism. These outcomes can lead to a decrease in job satisfaction, lower job performance or interest in practice, and decrease patient safety through increased error, leading to exam repetitions and thus increased dose and costs. Low job satisfaction can itself have negative outcomes such as low productivity, increased turnover and increased professional withdraw, which may also lead to more errors and increased costs. Both high stress and low job satisfaction will have a negative influence

on WAW, which can lead to an important increase in costs and accidents, potentially leading to business failure. All these negative outcomes must be considered, as they will have negative impacts on quality of care and patient safety in radiology. In order to guarantee workers' well-being and minimize these potential negative outcomes, radiology departments must consider increasing staffing, encouraging the use of ergonomic principals, adapting examination times and workflow, improving communication between staff and managers, and encouraging continuing professional development.

This study could be a prelude to many other potential research projects linked to WAW. Further research is needed in order to focus in detail on what influences diagnostic radiographers' high-perceived workloads in Western Switzerland. This could also lead to qualitative studies focusing on professional empowerment by including them in the decision process, by understanding what workers suggest in order to improve perceived workload. Other studies with the same approach and purpose could focus on job satisfaction and/or occupational stress. Another qualitative approach could target the coping mechanisms used by radiographers when faced with high workloads and/or stress. Due to limited time and resources, this study did not assess burnout among radiographers. A quantitative study using standardized instruments assessing burnout could allow departments to have a further understanding of their staff's well-being. Finally, based on the results in this study, if departments follow the suggested recommendations, a follow-up study after implementation could allow a comparison in results and determine their evolution through time.

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Appendix A – Survey

Survey: English version

Participants' characteristics: background factors

1. What is your gender?

Male	
Female	

2. What is your year of birth?

Year	

3. What is your civil status?

Single	
Married	
Divorced	
Widowed	

4. Do you have any children living with you at the time being?

Yes	
No	

a. If yes, how many?

Number	

5. What type of radiological diploma do you have? (more than one answer possible)

Bachelor of science	
Master of science	
Red cross diploma	
other (please specify)	

Participants' characteristics: work related factors

6. What type of institution do you work in?

University hospital	
Regional hospital	
Private clinic	
Private center	
other (please specify)	

7. How many years have you practiced as a radiographer?

< 5	5-10	10-20	>20

8. At what percentage do you work?

< 40%	40%	50%	60%	70%	80%	90%	100%

9. In which modalities do you work (more than one answer possible)?

Conventional X-ray	
Mammography	
CT	
MRI	
Interventional radiography	
Other (please specify)	

10. How many years/months have you been working in your present job?

Years	Months

Workload

11. Mental demand: How much mental and perceptual activity is required (e.g. thinking, deciding, calculating, remembering, looking, searching etc.) in your work? Are your tasks easy or demanding, simple or complex...?

Low									High

12. Physical demand: How much physical activity is required (e.g. pushing, pulling, turning, controlling, activating, etc.) in your work? Are your tasks easy or demanding, slow or brisk...?

Low									High

13. Temporal demand: How much time pressure do you feel due to the rate or pace of your job?

Low									High

14. Performance: How successful do you think you are in accomplishing the goals set by your tasks? How satisfied are you with your performance in accomplishing these goals?

Low									High

15. Effort: How hard do you have to work (mentally and physically) to accomplish your level of performance?

Low									High

16. Frustration: How insecure, discouraged, irritated, stressed and annoyed versus secure, gratified, content, relaxed and complacent do you feel during your work?

Low									High

Stress

17. I am clear what is expected of me at work

never	seldom	sometimes	often	always

18. I can decide when to take a break

never	seldom	sometimes	often	always

19. Different groups at work demand things from me that are hard to combine

never	seldom	sometimes	often	always

20. I know how to go about getting my job done

never	seldom	sometimes	often	always

21. I am subject to personal harassment in the form of unkind words or behavior

never	seldom	sometimes	often	always

22. I have unachievable deadlines

never	seldom	sometimes	often	always

23. If work gets difficult, my colleagues will help me

never	seldom	sometimes	often	always

24. I am given supportive feedback on the work I do

never	seldom	sometimes	often	always

25. I have to work very intensively

never	seldom	sometimes	often	always

26. I have a say in my own work speed

never	seldom	sometimes	often	always

27. I am clear what my duties and responsibilities are

never	seldom	sometimes	often	always

28. I have to neglect some tasks because I have too much to do

never	seldom	sometimes	often	always

29. I am clear about the goals and objectives for my department

never	seldom	sometimes	often	always

30. There is friction or anger between colleagues

never	seldom	sometimes	often	always

31. I have a choice in deciding how I do my work

never	seldom	sometimes	often	always

32. I am unable to take sufficient breaks

never	seldom	sometimes	often	always

33. I understand how my work fits into the overall aim of the organization

never	seldom	sometimes	often	always

34. I am pressured to work long hours

never	seldom	sometimes	often	always

35. I have a choice in deciding what I do at work

never	seldom	sometimes	often	always

36. I have to work very fast

never	seldom	sometimes	often	always

37. I am subject to bullying at work

never	seldom	sometimes	often	always

38. I have unrealistic time pressures

never	seldom	sometimes	often	always

39. I can rely on my line manager to help me out with a work problem

never	seldom	sometimes	often	always

40. I get help and support I need from colleagues

strongly disagree	disagree	neutral	agree	strongly agree

41. I have some say over the way I work

strongly disagree	disagree	neutral	agree	strongly agree

42. I have sufficient opportunities to question managers about change at work

strongly disagree	disagree	neutral	agree	strongly agree

43. I receive the respect at work I deserve from my colleagues

strongly disagree	disagree	neutral	agree	strongly agree

44. Staff are always consulted about change at work

strongly disagree	disagree	neutral	agree	strongly agree

45. I can talk to my line manager about something that has upset or annoyed me about work

strongly disagree	disagree	neutral	agree	strongly agree

46. My working time can be flexible

strongly disagree	disagree	neutral	agree	strongly agree

47. My colleagues are willing to listen to my work-related problems

strongly disagree	disagree	neutral	agree	strongly agree

48. When changes are made at work, I am clear how they will work out in practice

strongly disagree	disagree	neutral	agree	strongly agree

49. I am supported through emotionally demanding work

strongly disagree	disagree	neutral	agree	strongly agree

50. Relationships at work are strained

strongly disagree	disagree	neutral	agree	strongly agree

51. My line manager encourages me at work

strongly disagree	disagree	neutral	agree	strongly agree

Job satisfaction

52. In general, the type of work I do corresponds closely to what I want in life.

Strongly disagree	disagree	more or less disagree	neutral	more or less agree	agree	strongly agree

53. The conditions under which I do my work are excellent.

Strongly disagree	disagree	more or less disagree	neutral	more or less agree	agree	strongly agree

54. I am satisfied with the type of work I do

Strongly disagree	disagree	more or less disagree	neutral	more or less agree	agree	strongly agree

55. Until now, I have obtained the important things I wanted to get from my work.

Strongly disagree	disagree	more or less disagree	neutral	more or less agree	agree	strongly agree

56. If I could change anything about work, I would change almost nothing.

Strongly disagree	disagree	more or less disagree	neutral	more or less agree	agree	strongly agree

57. Comment(s)

Write here (optional)

Thank you for taking the time to complete this survey!

Stephanie de Labouchere.

Survey: French version

Caractéristiques des participants : facteurs contextuels

1. Quel est votre genre?

Masculin	
Féminin	

2. Quelle est votre année de naissance?

Année	

3. Quel est votre état civil?

Célibataire	
Marié(e)	
Divorcé(e)	
Veuf(-ve)	

4. Avez-vous des enfants qui vivent avec vous en ce moment?

Oui	
Non	

a. Si oui, combien?

Nombre	

5. Quel type de diplôme en radiologie possédez-vous ? (Plusieurs réponses possibles)

Bachelor of science	
Master of science	
Diplôme Croix-Rouge	
Autre (veuillez préciser)	

Caractéristiques des participants : facteurs liés au travail

6. Dans quel type d'institution travaillez-vous ? (Plusieurs réponses possibles)

Hôpital universitaire	
Hôpital régional	
Clinique privée	
Centre privé	
Autre (veuillez préciser)	

7. Depuis combien d'années pratiquez-vous en tant que TRM ?

< 5	5-10	10-20	>20

8. A quel pourcentage travaillez-vous ?

< 40%	40%	50%	60%	70%	80%	90%	100%

9. Dans quelle(s) modalité(s) du radiodiagnostic travaillez-vous ? (Plusieurs réponses possibles)

Radiologie conventionnelle	
Mammographie	
CT	
IRM	
Radiologie interventionnelle	
Autre (veuillez préciser)	

10. Depuis combien d'années/mois travaillez-vous dans votre emploi actuel ?

Année	Mois

Charge de travail

11. Exigence Mentale : Quelle est l'importance de l'activité mentale et intellectuelle requise (ex. réflexion, décision, calcul, mémorisation, observation, recherche) pour effectuer vos tâches ? Ces tâches vous paraissent-elles simples, nécessitant peu d'attention (faible) ou complexe, nécessitant beaucoup d'attention (élevé) ?

Faible									Elevé

12. Exigence physique : Quelle est l'importance de l'activité physique requise (ex. pousser, porter, tourner, marcher, activer, etc.) pour effectuer vos tâches? Ces tâches vous paraissent-elles faciles, peu fatigantes, calmes (faible) ou pénibles, fatigantes, actives (élevée) ?

Faible									Elevée

13. Exigence temporelle : Quelle est l'importance de la pression temporelle causée par la rapidité nécessitée pour l'accomplissement de vos tâches ? Est-ce un rythme lent et tranquille (faible) ou rapide et précipité (élevée) ?

Faible									Elevée

14. Performance: Quelle réussite pensez-vous avoir dans l'accomplissement de vos tâches? Comment pensez-vous avoir atteint les objectifs déterminés par vos tâches?

Bonne									Mauvaise

15. Effort: Quel degré d'effort devez-vous fournir pour exécuter les tâches demandées, (mentalement et physiquement) ?

Faible									Elevé

16. Frustration: Pendant l'exécution du travail vous sentez-vous satisfait, relaxé, sûr-e de vous (niveau de frustration faible), ou plutôt découragé-e, irrité-e, stressé-e, sans assurance (niveau de frustration élevé) ?

Faible									Elevé

Stress

17. Je suis au clair sur ce que l'on attend de moi au travail.

Jamais	Presque jamais	Quelques fois	Souvent	Toujours

18. Je peux décider quand faire une pause.

Jamais	Presque jamais	Quelques fois	Souvent	Toujours

19. Différents groupes au travail exigent de moi des choses qui sont difficiles à combiner.

Jamais	Presque jamais	Quelques fois	Souvent	Toujours

20. Je sais comment m'y prendre pour faire mon travail.

Jamais	Presque jamais	Quelques fois	Souvent	Toujours

21. Je suis victime d'harcèlement personnel sous la forme de paroles ou de comportements désobligeants.

Jamais	Presque jamais	Quelques fois	Souvent	Toujours

22. J'ai des délais irréalisables.

Jamais	Presque jamais	Quelques fois	Souvent	Toujours

23. Si le travail devient difficile, mes collègues m'aideront.

Jamais	Presque jamais	Quelques fois	Souvent	Toujours

24. Je reçois un feedback constructif sur le travail que je fais.

Jamais	Presque jamais	Quelques fois	Souvent	Toujours

25. Je dois travailler très intensivement.

Jamais	Presque jamais	Quelques fois	Souvent	Toujours

26. J'ai un mot à dire sur ma propre vitesse de travail.

Jamais	Presque jamais	Quelques fois	Souvent	Toujours

27. Je suis au clair sur mes devoirs et responsabilités.

Jamais	Presque jamais	Quelques fois	Souvent	Toujours

28. Je dois négliger certaines tâches parce que j'ai trop à faire.

Jamais	Presque jamais	Quelques fois	Souvent	Toujours

29. Je suis au clair sur les buts et objectifs de mon département/service.

Jamais	Presque jamais	Quelques fois	Souvent	Toujours

30. Il y a des frictions ou de la colère entre les collègues.

Jamais	Presque jamais	Quelques fois	Souvent	Toujours

31. J'ai le choix de décider comment je fais mon travail.

Jamais	Presque jamais	Quelques fois	Souvent	Toujours

32. Je n'arrive pas à prendre suffisamment de pauses.

Jamais	Presque jamais	Quelques fois	Souvent	Toujours

33. Je comprends comment mon travail s'inscrit dans l'objectif global de l'organisation.

Jamais	Presque jamais	Quelques fois	Souvent	Toujours

34. J'ai de la pression pour travailler de longues heures.

Jamais	Presque jamais	Quelques fois	Souvent	Toujours

35. J'ai le choix de décider ce que je fais au travail.

Jamais	Presque jamais	Quelques fois	Souvent	Toujours

36. Je dois travailler très vite.

Jamais	Presque jamais	Quelques fois	Souvent	Toujours

37. Je suis victime d'intimidation au travail.

Jamais	Presque jamais	Quelques fois	Souvent	Toujours

38. J’ai des contraintes de temps irréalistes.

Jamais	Presque jamais	Quelques fois	Souvent	Toujours

39. Je peux compter sur mon supérieur hiérarchique pour m’aider à résoudre un problème lié au travail.

Jamais	Presque jamais	Quelques fois	Souvent	Toujours

40. J’obtiens l’aide et le soutien dont j’ai besoin de la part de mes collègues.

Fortement en désaccord	Pas d’accord	Neutre	D’accord	Entièrement d’accord

41. J’ai un mot à dire sur la manière dont je travaille.

Fortement en désaccord	pas d’accord	neutre	d’accord	Entièrement d’accord

42. J’ai suffisamment d’occasions d’interroger les responsables sur les changements liés au travail.

Fortement en désaccord	Pas d’accord	Neutre	D’accord	Entièrement d’accord

43. Je reçois le respect que je mérite de la part de mes collègues au travail.

Fortement en désaccord	Pas d’accord	Neutre	D’accord	Entièrement d’accord

44. Le personnel est toujours consulté au sujet des changements liés au travail.

Fortement en désaccord	Pas d’accord	Neutre	D’accord	Entièrement d’accord

45. Je peux parler à mon supérieur hiérarchique de quelque chose qui m'a contrarié ou ennuyé au sujet du travail.

Fortement en désaccord	pas d'accord	neutre	d'accord	Entièrement d'accord

46. Mon temps de travail peut être flexible.

Fortement en désaccord	pas d'accord	neutre	d'accord	Entièrement d'accord

47. Mes collègues sont à l'écoute de mes problèmes liés au travail.

Fortement en désaccord	pas d'accord	neutre	d'accord	Entièrement d'accord

48. Lorsque des changements sont apportés au travail, je sais clairement comment ils vont se dérouler en pratique.

Fortement en désaccord	pas d'accord	neutre	d'accord	Entièrement d'accord

49. Je suis soutenu lors de situation de travail émotionnellement exigeantes.

Fortement en désaccord	pas d'accord	neutre	d'accord	Entièrement d'accord

50. Les relations au travail sont tendues.

Fortement en désaccord	pas d'accord	neutre	d'accord	Entièrement d'accord

51. Mon supérieur hiérarchique m'encourage au travail

Fortement en désaccord	pas d'accord	neutre	d'accord	Entièrement d'accord

Satisfaction au travail

52. En général, le type de travail que je fais correspond de près à ce que je veux dans la vie.

Pas du tout d'accord	Pas d'accord	Plutôt pas d'accord	Indifférent	Plutôt d'accord	D'accord	Tout à fait d'accord

53. Les conditions dans lesquelles je fais mon travail sont excellentes.

Pas du tout d'accord	Pas d'accord	Plutôt pas d'accord	Indifférent	Plutôt d'accord	D'accord	Tout à fait d'accord

54. Je suis satisfait(e) du type de travail que je fais.

Pas du tout d'accord	Pas d'accord	Plutôt pas d'accord	Indifférent	Plutôt d'accord	D'accord	Tout à fait d'accord

55. Jusqu'à maintenant j'ai obtenu les choses importantes que je voulais retirer de mon travail.

Pas du tout d'accord	Pas d'accord	Plutôt pas d'accord	Indifférent	Plutôt d'accord	D'accord	Tout à fait d'accord

56. Si je pouvais changer quoi que ce soit concernant le travail, je n'y changerais presque rien.

Pas du tout d'accord	Pas d'accord	Plutôt pas d'accord	Indifférent	Plutôt d'accord	D'accord	Tout à fait d'accord

Remarques/commentaires

57. Avez-vous des commentaires ou remarques sur ce questionnaire ?

écrire ici (optionnelle)

Merci d'avoir pris le temps de répondre à ce questionnaire!

Stephanie de Labouchere.

Enclosure letter: English version

Dear Participant,

My name is Stephanie de Labouchere and I am a graduate student in health sciences in the radiological technology orientation, at the University of Applied Sciences and Arts of Western Switzerland. For my master thesis, I am exploring radiographers' perceived workload and its association to work well-being factors such as job satisfaction and work related stress. This project is tutored and directed by Eija Metsälä (PhD, Principal Lecture at Metropolia University of Applied Sciences Helsinki) and José Jorge (Associated Professor at the University of Applied Sciences and Arts of Western Switzerland, Lausanne). As a diagnostic radiographer working in Western Switzerland, I am inventing you to participate in this research study by completing the following survey.

The following questionnaire will only require approximately 10 minutes to complete. There is no compensation for responding nor is there any known risks. All of your responses will be recorded confidentially and anonymously. The data collected will be stored in my personal computer, protected by personal password and will only be presented and reported as a collective combined total. The results of this study will be reported in my thesis and may be presented in scientific conferences or published in scientific journals. Participation in this study is strictly voluntary and you may withdraw your participation at any time.

If you choose to participate, please answer the following questions as honestly as possible. The information collected may benefit our profession by providing useful information regarding radiographers work well-being and allow departments to enhance their awareness concerning the potential negative impacts of increased workload.

If you have any questions regarding the survey or this research project in general, please feel free to contact me via my email at stephanie.delabouchere@hesav.ch.

By selecting the "I agree to these terms" checkbox bellow and by completing the following survey, you ensure that you have taken note of this information and you are indicating your consent to participate in this study.

Thank you in advance for your assistance and participation in this project.

Sincerely,

Stephanie de Labouchere

Enclosure letter: French version

Chère participante, cher participant,

Je m'appelle Stephanie de Labouchere et je suis actuellement étudiante en Master en Sciences de la santé, orientation technique en radiologie médicale à la Haute Ecole Spécialisée de Suisse Occidentale (HES-SO). Dans le cadre de mon travail de master, j'explore la charge de travail perçue des Techniciens en Radiologie Médicale (TRM) en radiodiagnostic et son association avec les facteurs de bien-être au travail tels que la satisfaction au travail et le stress occupationnel. Ce projet est encadré et dirigé par Eija Metsälä (PhD, Professeure à la Metropolia University of Applied Sciences, Helsinki) et José Jorge (Professeur Associé à la HES-SO, HESAV, Lausanne). En tant que TRM travaillant en radiodiagnostic, je vous invite à participer à cette étude en répondant au questionnaire qui suit.

Ce questionnaire ne prendra qu'environ 10 minutes à remplir. Il n'y a aucune compensation ni risque de participation. Toutes vos réponses seront enregistrées de façon confidentielle et anonyme. Les données recueillies seront stockées dans mon ordinateur personnel, sécurisé par un mot de passe personnel et ne seront présentées et rapportées que sous la forme d'un total combiné collectif. Les résultats de cette étude seront exposés dans ma thèse et pourraient être présentés lors de conférences scientifiques ou publiés dans des revues scientifiques. La participation à cette étude est strictement volontaire et vous pouvez retirer votre participation à tout moment.

Si vous choisissez de participer, veuillez répondre aux questions suivantes aussi honnêtement que possible. Les informations recueillies dans ce travail pourraient profiter à notre profession en fournissant des renseignements utiles sur le bien-être au travail des TRM et permettre aux départements de prendre conscience des potentielles répercussions négatives d'une charge de travail accrue.

Si vous avez des questions concernant le questionnaire ou ce projet de recherche en générale, n'hésitez pas à me contacter par courriel à stephanie.delabouchere@hesav.ch

En cochant la case « j'accepte ces conditions » ci-dessous et en remplissant ce questionnaire, vous assurez d'avoir pris connaissance de ces renseignements et indiquez votre consentement à participer à cette étude.

Je vous remercie d'avance pour votre aide et participation dans ce projet.

Avec mes meilleures salutations,

Stephanie de Labouchere.

Appendix B – Results

Participants' characteristics

Table 6: Participants' characteristics

		Frequencies	Percentage (%)
Gender (n=150)			
	Female	91	60.67
	Male	59	39.33
Age (categories) (n=150)			
	< 30 years old	31	20.67
	30-39 years old	42	28.00
	40-49 years old	44	29.33
	50-59 years old	27	18.00
	60+ years old	6	4.00
Civil status (n=150)			
	Single	63	42.00
	Divorced	14	9.33
	Married	73	48.67
Children (n=150)			
	Yes	82	54.67
	No	68	45.33
Number of children (n = 72)			
	1	21	29.17
	2	45	62.50
	3	4	8.33
Diploma (n=150)			
	RedCross Diploma	63	42.00
	Bachelor of Science	65	43.33
	Master of Science	1	0.67
	Other	21	14.00
Institution type (n=150)			
	University Hospital	51	34
	Regional Hospital	72	48
	Private Clinic	15	10
	Private institution	10	6.67
	Other	2	1.33
Number of years of practice (categories) (n=150)			
	< 5 years	25	16.67
	5-10 years	31	20.67
	10-20 years	42	28
	> 20 years	52	34.67
Working percentage (n=150)			
	100	83	55.33
	90	14	9.33
	80	15	10
	70	14	9.33
	60	18	12
	50	5	3.33
	40	1	0.67
Working modalities **Plain x-ray (n=150)**			
	Yes	140	93.33
	No	10	6.67
Mammography (n=150)	Yes	61	40.67
	No	89	59.33
CT (n=150)	Yes	104	69.33
	No	46	30.67
MRI (n=150)			
	Yes	88	58.67
	No	62	41.33
Interventional radiology (n=150)			
	Yes	51	34
	No	99	66

Perceived workload according to participants' characteristics

Table 7: Perceived workload according to participants' characteristics - mean & SD.

		Total workload	Mental demand	Physical demand	Temporal demand	Performance	Effort	Frustration
Gender	Female	6.54 ± 1.18	7.46 ± 1.59	7.67 ± 1.6*	7.88 ± 1.67	7.22 ± 1.56	5.38 ± 2.25	3.63 ± 2.32
	Male	6.38 ± 1.31	7.1 ± 1.99	6.49 ± 2.18*	7.44 ± 1.72	6.88 ± 1.79	5.71 ± 2.55	4.68 ± 2.96
Age	< 30 years old	6.23 ± 1.12	7.06 ± 1.53	7.13 ± 1.71	7.61 ± 1.54	6.77 ± 1.59	5.16 ± 2.28	3.61 ± 1.94
	30-39 years old	6.48 ± 1.25	7.38 ± 1.89	7.09 ± 2.15	7.69 ± 1.8	7.07 ± 1.77	5.55 ± 2.34	4.09 ± 2.66
	40-49 years old	6.52 ± 1.43	7.41 ± 1.89	7.27 ± 2.23	7.68 ± 1.97	7.18 ± 1.86	5.48 ± 2.66	4.07 ± 2.9
	50-59 years old	6.73 ± 1.03	7.44 ± 1.6	7.22 ± 1.34	7.89 ± 1.45	7.44 ± 1.22	5.89 ± 2.12	4. 48 ± 2.92
	60+ years old	6.39 ± 0.97	7 ± 2.09	7.83 ± 1.6	7.67 ± 0.52	6.5 ± 1.38	5.67 ± 2.34	3.67 ± 2.8
Civil status	Single	6.58 ± 1.17	7.35 ± 1.7	7.56 ± 1.8	7.75 ± 1.69	7.29 ± 1.51	5.57 ± 2.42	3.95 ± 2.41
	Divorced	7.04 ± 1.05	7.71 ± 2.33	7.07 ± 2.37	8.36 ± 1.28	7.14 ± 2.28	6.64 ± 2.71	5.28 ± 2.95
	Married	6.39 ± 1.29	7.22 ± 1.71	6.93 ± 1.94	7.55 ± 1.76	6.9 ± 1.65	5.25 ± 2.22	3.88 ± 2.73
Children	Yes	6.3 ± 1.26	7.13 ± 1.74	6.74 ± 2.14*	7.56 ± 1.86	6.85 ± 175	5.46 ± 2.37	4.04 ± 2.77
	No	6.63 ± 1.19	7.48 ± 1.78	7.59 ± 1.66*	7.83 ± 1.55	7.28 ± 1.57	5.56 ± 2.39	4.04 ± 2.54
Diploma	RedCross Diploma	6.43 ± 1.39	7.37 ± 1.78	6.94 ± 2.11	7.75 ± 1.87	7.09 ± 1.73	5.54 ± 2.47	3.87 ± 2.71
	Bachelor of Science	6.55 ± 1.17	7.23 ± 1.81	7.4 ± 1.94	7.88 ± 1.49	7.23 ± 1.64	5.54 ± 2.45	4.05 ± 2.55
	Other	6.41 ± 0.92	7.45 ± 1.63	7.41 ± 1.26	7.09 ± 1.69	6.64 ± 1.5	5.36 ± 1.89	4.5 ± 2.72
Institution type	University Hospital	6.69 ± 1.19	7.41 ± 2.01	7.45 ± 2.23	8.27 ± 1.48*	7.43 ± 1.76	5.73 ± 2.23	3.63 ± 2.64
	Regional Hospital	6.3 ± 1.28	7.25 ± 1.69	7.22 ± 1.76	7.07 ± 1.8*	6.76 ± 1.57	5.13 ± 2.45	4.35 ± 2.68
	Private Clinic	6.88 ± 1.06	7.47 ± 1.46	6.6 ± 1.59	8.27 ± 1.03	7.33 ± 1.4	6.93 ± 2.02	4.67 ± 2.85
	Private institution	6.12 ± 1.33	7.1 ± 1.66	6.8 ± 2.2	8.4 ± 1.26	7.2 ± 2.04	5 ± 2.54	2.2 ± 0.79
	Other	6.42 ± 0.6	7.5 ± 0.7	7 ± 0	8.5 ± 0.7	7.5 ± 0.7	6 ± 1.41	2 ± 1.41

		Total workload	Mental demand	Physical demand	Temporal demand	Performance	Effort	Frustration
Number of years of pratice	< 5 years	6.43 ± 1	7.16 ± 1.55	7.2 ± 1.85	7.96 ± 1.4	7.2 ± 1.29	5.36 ± 2.06	3.68 ± 2.06
	5-10 years	6.45 ± 1.34	7.23 ± 2.12	7.32 ± 2.06	7.55 ± 2.01	6.97 ± 2.15	5.55 ± 2.48	4.06 ± 2.61
	10-20 years	6.26 ± 1.27	7.24 ± 1.68	6.71 ± 2.16	7.38 ± 1.79	6.69 ± 1.62	5.29 ± 2.53	4.26 ± 2.84
	> 20 years	6.7 ± 1.23	7.52 ± 1.72	7.54 ± 1.67	7.94 ± 1.53	7.42 ± 1.47	5.75 ± 2.36	4.02 ± 2.78
Working percentage	100	6.56 ± 1.21	7.53 ± 1.71	7.1 ± 1.99	7.67 ± 1.55	7.13 ± 1.68	5.1 ± 2.38	4.43 ± 2.76*
	90	6.98 ± 1.41	7.29 ± 2.16	7.79 ± 2.12	8.36 ± 1.6	7.64 ± 1.82	7 ± 2.29*	3.79 ± 2.94
	80	6.22 ± 1.09	7.13 ± 1.68	7.6 ± 1.72	7.33 ± 1.88	7.2 ± 1.42	5.4 ± 2.61	5.07 ± 2.63*
	70	6.27 ± 1.39	7.36 ± 1.82	7.07 ± 1.77	7.79 ± 2.36	6.79 ± 1.72	5.86 ± 2.28	2.79 ± 1.48*
	= or < 60%	5.92 ± 1.07	6.71 ± 1.68	7.08 ± 1.93	7.58 ± 1.72	6.71 ± 1.6	4.54 ± 1.96*	2.91 ± 2*
Working in plain x-ray	No	6.95 ± 1.25	8.1 ± 2.42	6.6 ± 2.59	8.4 ± 1.26	8.1 ± 1.29*	6.2 ± 1.87	4.3 ± 2.71
	Yes	6.45 ± 1.23	7.26 ± 1.7	7.25 ± 1.89	7.66 ± 1.72	7.01 ± 1.66*	5.46 ± 2.4	4.02 ± 2.64
Working in Mammography	No	6.59 ± 1.2	7.24 ± 1.8	7.30 ± 2.04	7.97 ± 1.65*	7.21 ± 1.63	5.6 ± 2.4	4.21 ± 2.68
	Yes	6.32 ± 1.27	7.44 ± 1.72	7.07 ± 1.79	7.33 ± 1.7*	6.9 ± 1.69	5.38 ± 2.35	3.8 ± 2.58
Working in CT	No	6.37 ± 1.2	7.2 ± 2.03	6.93 ± 2.28	7.7 ± 1.92	7.04 ± 1.74	5.35 ± 2.16	3.98 ± 2.65
	Yes	6.53 ± 1.25	7.38 ± 1.64	7.33 ± 1.76	7.71 ± 1.6	7.11 ± 1.63	5.59 ± 2.46	4.07 ± 2.64
Working in MRI	No	6.62 ± 1.25	7.11 ± 1.87	7.48 ± 1.96	7.94 ± 1.71	7.26 ± 1.63	6.03 ± 2.45*	3.9 ± 5.58
	Yes	6.38 ± 1.22	7.47 ± 1.68	7.01 ± 1.91	7.55 ± 1.68	6.97 ± 1.68	5.15 ± 2.26*	4.14 ± 2.69
Working in Interventional radiology	No	6.41 ± 1.21	7.28 ± 1.76	7.25 ± 2.02	7.67 ± 1.76	7.05 ± 1.64	5.38 ± 2.29	3.8 ± 2.56
	Yes	6.62 ± 1.27	7.39 ± 1.78	7.12 ± 1.77	7.78 ± 1.59	7.16 ± 1.71	5.76 ± 2.52	4.51 ± 2.74

*Values having statistically significant means differences ($p<0.05$) with another value within the same group are marked with a **

Perceived stress

Table 8: Perceived stress - mean, SD & median scores according to the HSE standards

HSE Standard	Statement Number (1-35)	Statements	Mean	SD	Median
Demands*			**1.72**	**0.63**	**1.69**
	3	Different groups at work demand things from me that are hard to combine	1.79	0.77	2
	6	I have unachievable deadlines	1.38	0.87	1
	9	I have to work very intensively	1.58	0.73	2
	12	I have to neglect some tasks because I have too much to do	1.63	0.94	2
	16	I am unable to take sufficient breaks	1.81	0.99	2
	18	I am pressured to work long hours	1.63	1.08	2
	20	I have to work very fast	2.49	0.85	2.5
	22	I have unrealistic time pressures	1.44	0.96	1
Control			**2.03**	**0.71**	**2**
	2	I can decide when to take a break	1.77	0.96	2
	10	I have a say in my own work speed	2.47	1.02	3
	15	I have a choice in deciding how I do my work	1.75	1.04	2
	19	I have a choice in deciding what I do at work	2.45	1.08	3
	25	I have some say over the way I work	1.67	1.00	2
	30	My working time can be flexible	2.05	1.17	2
Managers' Support			**1.67**	**0.89**	**1.6**
	8	I am given supportive feedback on the work I do	2.31	1.09	2
	23	I can rely on my line manager to help me out with a work problem	1.45	1.21	1
	29	I can talk to my line manager about something that has upset or annoyed me about work	1.07	0.98	1
	33	I am supported through emotionally demanding work	1.90	1.07	2
	35	My line manager encourages me at work	1.64	1.15	1.5

Peer Support		**1.66**	**0.47**	**1,6**
	7 If work gets difficult, my colleagues will help me	1.03	0.83	1
	24 I get help and support I need from colleagues	0.89	0.73	1
	27 I receive the respect at work I deserve from my colleagues	1.17	0.78	1
	31 My colleagues are willing to listen to my work-related problems	1.19	0.73	1
Relationships*		**1.15**	**0,69**	**1**
	5 I am subject to personal harassment in the form of unkind words or behavior	0.82	0.88	1
	14 There is friction or anger between colleagues	1.56	0.91	1
	21 I am subject to bullying at work	0.53	0.81	0
	34 Relationships at work are strained	1.68	1.03	2
Role		**0.91**	**0.49**	**1**
	1 I am clear what is expected of me at work	0.79	0.57	1
	4 I know how to go about getting my job done	0.73	0.64	1
	11 I am clear what my duties and responsibilities are	0.72	0.75	1
	13 I am clear about the goals and objectives for my department	1.14	0.91	1
	17 I understand how my work fits into the overall aim of the organization	1.15	0.86	1
Change		**2.04**	**0.82**	**2**
	26 I have sufficient opportunities to question managers about change at work	1.71	1.05	2
	28 Staff are always consulted about change at work	2.46	1.03	3
	32 When changes are made at work, I am clear how they will work out in practice	1.97	0.97	2
Overall		**1.86**	**0.28**	**1.87**

*Standards marked with a * have inversed coding due to the wording nature of the statements*

Associations between perceived workload and stress

Table 9: Associations between perceived workload and stress - p-values and tau-b (when relevant)

	Total stress	Demands	Control	Managers' support	Peer support	Relationships	Role	Change
Total workload	0.000 0.264	0.000 0.3357	0.0003 0.2072	0.03 0.1255	*0.3265*	0.0005 0.2033	0.0067 0.1607	0.0084 0.1557
Mental demand	*0.6742*	0.0486 0.1199	*0.6576*	*0.4199*	*0.4424*	*1*	*0.5647*	*0.4203*
Physical demand	0.000 0.2718	0.0003 0.2194	0.000 0.2639	0.0011 0.1982	*0.1803*	0.0005 0.2140	0.0393 0.1284	0.0005 0.2157
Temporal demand	0.000 0.3286	0.000 0.5031	0.0002 0.2260	0.0040 0.1768	*0.2006*	0.0007 0.2112	0.0067 0.1707	0.012 0.2037
Performance	0.000 0.2555	0.000 0.3445	0.0005 0.2117	0.0783	*0.146*	0.0012 0.2018	*0.089*	0.033 0.1333
Effort	0.000 0.2886	0.000 0.3212	0.0022 0.1828	0.0007 0.2024	*0.1384*	0.000 0.2523	0.0003 0.2191	0.0021 0.1878
Frustration	*0.3857*	*0.3939*	*0.5237*	*0.8278*	*0.8921*	*0.371*	0.0247 0.1402	*0.9136*

Associations between perceived workload and job satisfaction

Table 10: Associations between perceived workload and job satisfaction - p-values and tau-b (when relevant)

Job satisfaction	Total workload	Mental demand	Physical demand	Temporal demand	Performance	Effort	Frustration
1. In general, the type of work I do corresponds closely to what I want in life	*0.1673*	*0.3473*	*0.3026*	0.0069 -0.1761	*0.1721*	0.0001 -0.2409	*0.5755*
2. The conditions under which I do my work are excellent.	0.000 -0.2818	*0.3619*	0.000 -0.2809	0.000 -0.3567	0.0005 -0.2255	0.000 -0.2705	*0.2036*
3. I am satisfied with the type of work I do	*0.1761*	*0.1415*	*0.0615*	0.0193 -0.1540	*0.1210*	0.0069 -0.1731	*0.7430*
4. Until now, I have obtained the important things I wanted to get from my work.	0.0087 -0.1604	*0.4491*	0.0006 -0.2194	0.0003 -0.2340	0.0074 -0.1730	0.000 -0.2663	*0.8933*
5. If I could change anything about work, I would change almost nothing.	0.0008 -0.2025	*0.7904*	0.0008 -0.2131	0.0002 -0.2353	0.0016 -0.2013	0.0009 -0.2076	*0.3699*
Total job satisfaction	0.007 -0.1944	*0.7142*	0.0005 -0.2099	0.000 -0.2776	0.0018 -0.1892	0.000 -0.2743	*0.4537*

Associations between stress and job satisfaction

Table 11: Associations between stress and job satisfaction - p-values and tau-b

Job satisfaction	Total stress	Demands	Control	Managers' support	Peer support	Relationships	Role	Change
1. In general, the type of work I do corresponds closely to what I want in life.	0.000 -0.2618	0.000 -0.2603	0.000 -0.2634	0.000 -0.3381	0.0012 -0.2063	0.0004 -0.2255	0.000 -0.2725	0.000 -0.3281
2. The conditions under which I do my work are excellent.	0.000 -0.2762	0.000 -0.4486	0.000 -0.3998	0.000 -0.4381	0.0002 -0.2341	0.000 -0.3704	0.000 -0.3263	0.000 -0.4394
3. I am satisfied with the type of work I do.	0.000 -0.3650	0.000 -0.2743	0.000 -0.3408	0.000 -0.4040	0.000 -0.3362	0.000 -0.3063	0.000 -0.3500	0.000 -0.3457
4. Until now, I have obtained the important things I wanted to get from my work.	0.000 -0.3702	0.000 -0.3082	0.000 -0.3434	0.000 -0.4978	0.000 -0.3355	0.000 -0.3876	0.000 -0.2900	0.000 -0.4615
5. If I could change anything about work, I would change almost nothing.	0.000 -0.2582	0.000 -0.3631	0.000 -0.3009	0.000 -0.4245	0.000 -0.1968	0.000 -0.3556	0.000 -0.3282	0.000 -0.3868
Total job satisfaction	0.000 -0.3403	0.000 -0.3645	0.000 -0.3799	0.000 -0.4716	0.000 -0.2748	0.000 -0.3650	0.000 -0.3443	0.000 -0.4437