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Review Article

Mental health in mine workers: a literature review

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Abstract: The mining environment is hazardous for worker's health. It can affect the mental health, triggering symptoms and diseases, such as anxiety, job stress, depression, sleep disorders, mental fatigue and other. The aim of this study was to describe and analyze the scientific literature about the mental health in mine workers and to summarize the findings. The method used was scoping review. The principal outcomes were the following: evidence in the last 12 years in the topic was focused in four themes 1) Psychological problems & personal factors (38.2%); 2) Psychosocial problems & health related factor (23.6%); 3) Well-being (21.1%) and 4) Physical problems & organization factors (17.1%). Several affections, symptoms, characteristics or disorders were inquired about mine worker's mental health, such as job strain, unsafety experiences, poor quality of sleep, non-subjective well-being, job unsatisfaction, social-relations conflict, risk of accidents and injuries, musculoskeletal disorders (MSDs), substance abuse, dangerous working conditions and demanding job organization, and so on. For those factors, Mining could expose to serious mental health problems to a part of their workers. It's necessary to deepen the elaboration of international policies and carry out more scientific research and suggestions to make programs on the topic.

Key words: Mining, Occupational health, Workers Health, Occupational risk, Workplace health, Industrial Health

Introduction

The mining work has been identified as one of the most hazardous environment for the work activity that exist around the world[1)]. It's defined as a high load work, featured with risky conditions and organization systems that involve long distances from workers residences, high demand due shift work schedules and job strain related to compliance the business aims. The available literature has detailed that these characteristics can severely affect the worker's safety and health, causing diseases, disabilities and even death.

Regarding these negative consequences, the literature has highlighted that the mine workers could develop different ailments and health complications, both physical and mental, which are linked with physical risks, such as dust exposure[2)], high temperatures[3)], high altitude[4)], noise and vibrations environment[5)], chemical substances and heavy metals[6)], injuries and accidents[7)]; likewise with the psychosocial risks, such as high job demand[8)], psychological distress[9)], shift work schedules[10)], distance and isolation with respect to the family[11)], hostile legal environments, aggressive employers, outsourcing[12)].

Owing to the existence of both kind of risks at mining work (physical and psychosocial), the world research in the theme has characterized some typical occupational diseases, for instance respiratory illnesses, such as silicosis, tu-

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berculosis, asthma[13], pulmonary edema and Acute Mountain Sickness[14]; cardiovascular illnesses, such as heart disease[15], high blood pressure[16]; musculoeskeletal disorders[17]; some types of cancer, such as lung cancer[18] and prostate cancer[19]; mental disorders, for instance, job stress, anxiety and depression[20], sleep disorders and fatigue. These are serious indicators of the perilous environment where they work, which can develop suffering experiences and downgrade the mine worker's health.

The above mentioned, not only reduces the health status of workers, also affects the mining organization. In the study conducted by Nakua *et al.*[21], they found that 265 miners (25.8% of all miners surveyed) reporting injuries during the past year. This resulted in equal to overall incidence rate of 19.67 injuries per 200,000 hours worked and almost 26.9% to 35.8% of the cases presented moderate or severe absence at work, respectively. Additionally, Widanarko *et al.*[22] affirmed that the presence of Low Back Symptoms (LBS) increased the odds of reporting reduced activities (odds ratio, OR: 4.42, 95% CI: 3.18–6.15) and absenteeism (OR: 4.74, 95% CI: 3.32–6.77); estimated around 805 days lost due to LBS in a year reduced the company's productivity by USD 209,300 and USD 200 million in national annual productivity.

According to Street *et al.*[23], job stress was associated with an average of 33.6% work impairment and $45,240.70 (SD = 30,655.26) in productivity costs per employee and workers feeling stressed 'all of the time' four week before reporting the highest productivity costs (M = $75,337.16; SD = $47,379.12). Other mental health problems, like the fatigue and sleep deprivation can decrease the focus and attention to tasks[24] and augment the risks of accidents[25] which rise in long working hours, i.e., irregular shift work[26]. The accidents in mining can be fatal. As an example, in 2018 the Chilean mining registered one of the highest amount of days lost in average for work accidents (36.9 days lost average) and in 2017 showed a growth in fatalities (9.0 workers dead from 100,000 protected), both quantities in respect to the national statistics[27].

Consequently, it's important to know how the worker's health is affected by mining and, hence, correctly manage the associated factors. A good tool on the matter is the summarized literature. In the last decade, some published literature reviewed in the topic centered at lost-time injury[28]; exposure to silica dust and risk of lung cancer[29]; stomach cancer mortality of workers exposed to asbestos[30]; heat and it's impacts to safety and health[31], the adverse effects of work at altitude and acclimatization process[14]; sexual and reproductive health[32]; other types of cancer, allergies and respiratory diseases[33].

However, the literature related to miner's mental health has been more constrained and shallower. It highlights two articles as examples. The first one is the report of Basu *et al.*[34], it emphasizes on the study's findings that half of the participants reported feeling nervous or stressed "sometimes" and cortisol signs of chronic stress and pointed out the association between stress and adverse outcomes like cardiovascular disease, acute myocardial infarction, inflammation, hypertension, inadequate nutrition and alcohol/drugs consumption. The second one is the study of Bauerle *et al.*[35] focused on fatigue at mining and they described the factors associated, such as FIFO system (fly-in-fly-out) impoverish the quality of rest, lack of sleep affects the cognitive outcomes (i.e. reaction time), longer shift work shortens the leisure time, childcare and household activities.

Despite the results, both literature reviews show limitations. The first one briefly addressed on the matter, and the second one only paid attention to fatigue factors. For that reason, the need for a more general literature review arose. In order to summarize the evidence, to help knowing about the mental health related problems at mining work and to bridge the existing gap in literature review on the theme, this study presents the results of scoping review on mental health in mine workers across the world.

Methods

The research question was *What evidences have been produced regarding mental health of mine worker across the world?* The aim of this study was to describe and analyze the published scientific literature about the mental health in mine workers and to summarize the findings. The method used was scoping review as suggested by Arksey & O'Malley[36]. The reason for using that is associated to the three purposes argued by Pham *et al.*[37] because the focus of the present study was 1) to map the body of literature on a topic area (mine worker's mental health); 2) To include a major range of design and methodologies on studies with no interest in the effectiveness of the interventions (see inclusion criteria); and 3) seek to provide a descriptive overview of the material and findings without critically appraising individual studies or show synthesis at the risk of bias (see Results).

Strategies for identifying relevant studies

It was search only studies published in scientific journal indexed in the following electronic databases: WOS (Web

of Science), SCOPUS, SCIELO and BVS (*Biblioteca Virtual de Salud*). These databases contain many articles relative to the aim of this study. Regarding to realism and enough limit of time, the period of years revised were from 2008 to 2019. The quest was undertaken during august 2019.

The keywords used to find the registers were: "Mental health AND miners* mining"; "Mental diseases AND miners* mining"; "Mental disorders AND miners* mining"; "Stress AND miners* mining"; "Depression AND miners* mining"; "Anxiety AND miners* mining"; "Satisfaction AND miners* mining"; "Occupational risk AND miners* mining"; "Occupational diseases AND miners* mining"; "Well-being AND miners* mining"; "Workload AND miners* mining"; "Shift work AND miners* mining"; "Sleep disorders AND miners* mining"; "Suffering AND miners* mining" and "Workplace violence AND miners* miners". The same keywords were used too, but in Spanish. In total, 2,604 articles were found in English, whereas just 35 in Spanish.

Study selection process

The material located was downloaded and saved in RIS format. Then, it was included in *Collaboratron platform* (see https://collaboratron.epistelab.com/), removed the duplicates and so as to 1,266 abstracts of documents were maintained. Two researchers read the abstracts and decided (yes or no) if the article entered to whole review or was excluded. After that, the selected records were shared in a common folder in Mendeley Desktop v. 1.19.4 to ease the reading and notes. A total of 113 articles were finally completely checked.

Inclusion criteria

The articles incorporated fulfilled this inclusion criteria: primary studies or secondary data analysis; available as full read and written in English or Spanish; documents that utilized quantitative or qualitative methods and other design (i.e. case report) and showed these characteristics of quality: research problem correctly described, aims, description of method, well set forth the procedure with clear/concise results and an adequate discussion of them. At last, the documents that presented these features were excluded: narrative or systematic reviews; essays, short communications; books or chapter of books; proposals or assessments of interventions; wrote in other languages and inaccessible for reading and notes.

Results

Forty articles were included by inclusion criteria and relevance with the aim of this review. Fig. 1 summarized the search and selection procedure. Charting the data (see Table 1) was recorded as follows: Authors, year of publication, aim, study location, mining activity, aims, variables assessment, methods/design, instruments, sample. The data about results and conclusions were charting in Table 2.

Regarding to data charting form, 10 articles (25%) were carried out in Australia; nine (22.5%) in China; six (15%) in Chile; four (10%) in South Africa; 2 (5%) in India. In similar quantities (1=2.5%), the rest of documents located in Perú, Ghana, Serbia, Canada, Brazil and Poland. Two studies (5%) included participants from 2+ countries.

About the mining activity, 16 (40%) studies focused on coal mining. Of these, nine (22.5%) considered Chinese coal miners; four (10%) Australian coal miners; Serbian, Brazilian and Indian miners in equal numbers (1=2.5%). On the other hand, three (7.5%) articles centered in copper mining; specifically, two (5%) in Chilean copper miners and one (2.5%) in Indian. Meanwhile, in the same proportions (2=5%), other studies focused on gold (Chilean and Ghanaian miners), metal (Australian and Polish miners), platinum (Australian and South African miners) and two mining activities (silver-gold and copper-nickel miners). One document (2.5%) approached the diamond mining (South African miners) as well as another in the quarry/sandstone mining (Indian miners). A relevant amount (11=27.5%) of documents non-specified mining activity.

In another field, the measured variables in the studies were varied. For that reason, it was grouped in 17 variables. Along with it, these variables were organized in four themes (see Fig. 2) in such way that it summarized the highlighted data. Around the 38.2% of the studies approached the theme *Psychological problems & personal factors*. Inside this category, mental diseases or symptoms (e.g. depression, anxiety, burnout), job stress (e.g. distress, job strain) and sleep quality/fatigue (i.e. sleep disorders and fatigue) were the most evaluated in the documents. Besides, a 23.6% of the studies focused on the theme Psychosocial problems & health related factors. The variables Psychosocial risks (such as job demand, effort/reward imbalance, work-life conflict, etc.); Interpersonal relations (e.g. family and friend relations, workplace relations) and other variables (such as segregation, racism, HIV (Human Immunodeficiency Virus), suicidal attempts, obesity, cancer experiences, disaster experiences, gender discrimination at workplace) were the most analyzed.

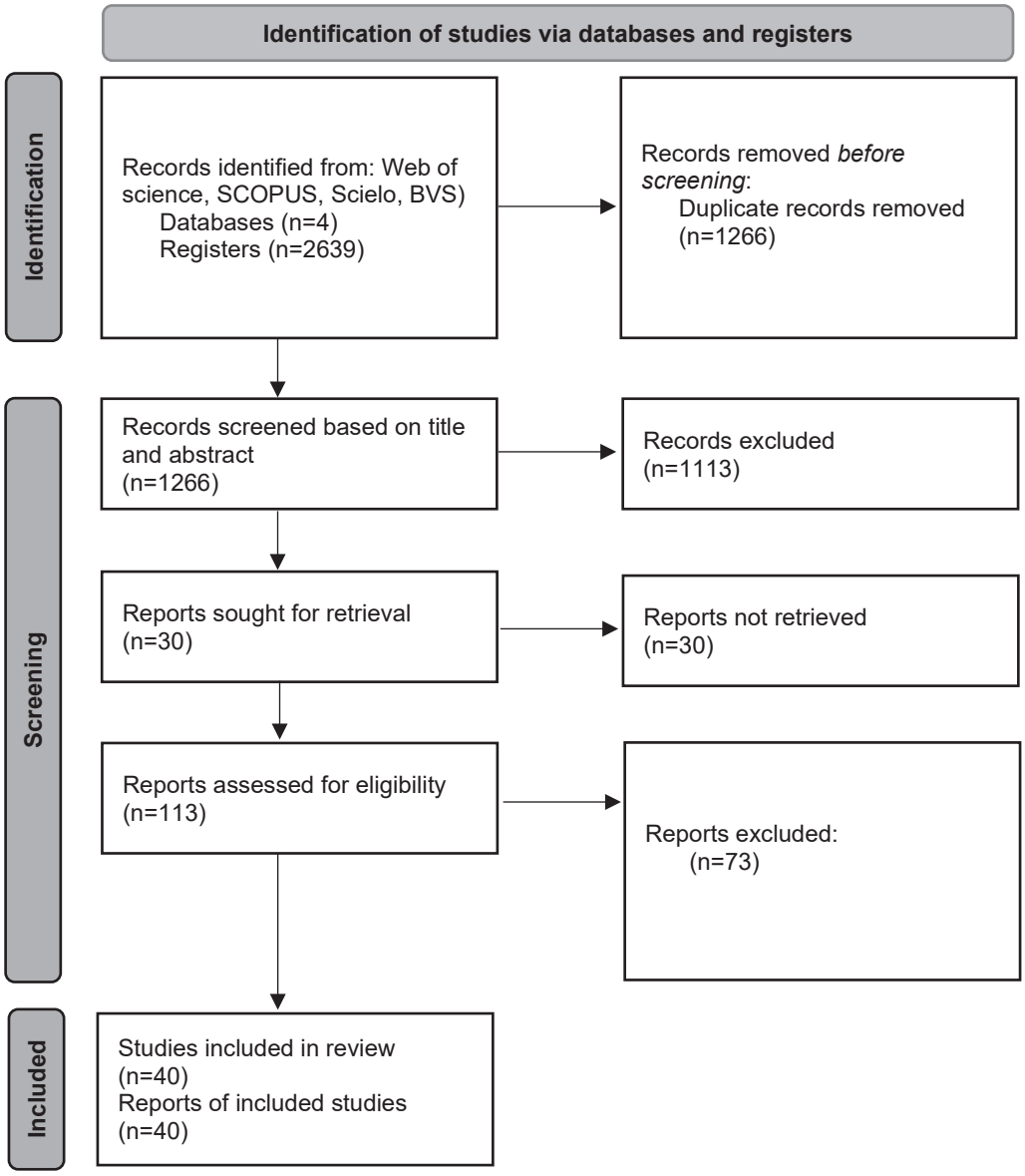

Fig. 1. Summary of search and selection procedure.

Furthermore, a 21.1% of the documents inquired into the theme *Well-being*. The variable Subjective Well-being was the most studied, followed by Job satisfaction and Quality of life. Lastly, a 17.1% of the articles deemed variables according to *Physical problems & organization factors*. They tended mostly to investigate the shift work incidences (i.e., FIFO/DIDO systems and work schedule); organization´s variables (e.g. management, environment, organizational commitment, workplace factors); Injuries and Safety at work (i.e. injuries, safety environment and safe behavior).

On the other hand, most of the studies (35=87.5%) used quantitative designs. From them, the majority used cross-sectional design (70%); followed by longitudinal (12.5%); retrospective case control and quantitative secondary data analysis in the same percentages (2.5%). Then, there were studies that employed descriptive qualitative (7.5%) and exploratory sequential design (5%). In turn, many studies non-specified the sampling strategies (35%); whereas other did. These used convenience sampling (32.5%); stratified sample (cluster-randomly) (17.5%); simple random (10%); matched pair sample and census method in the same frequencies (2.5%). Thus, the range of participants in quantitative design was from 19 to 3,068 individual; whilst in qualitative design was 10-11 individual.

Table 1. Summary of studies information from charting data form

Authors/ year	Aim	Study Location	Mining activity	Variables Assessment	Methods/ design	Instruments	Sample
Yu *et al.*[45] 2008	To describe and evaluate the multidimensional QOL of coal dust workers without pneumoconiosis, and to investigate the impact of socio- demographic, working, and health factors on their QOL	China	Coal	Socio-demographic Quality of Life	Cross-sectional	WHOQOL-BREF (World Health Organization Quality of Life – Brief Questionnaire)	Sampling: non-specified. Participants: 305 (284 males) exposed to coal dust, age ($\bar{x}$)=32 years; 200 non-exposed (all males), age ($\bar{x}$)=34 years
Vera & Contreras[46] 2008	To describe the frequencies and types of sleep disorders found in mine workers who work at north of Chile mining company	Chile	Copper	Sleep Disorders Fatigue	Cross-sectional	Epworth scale. Pulse oximetry	Sampling: non-specified. Participants: 180 (non-specified gender), age ($\bar{x}$)=31.5 years
Paul[44] 2009	To evaluate the risk of occupational injuries to underground coal mine workers, controlling for their social, technical and personal characteristics	India	Coal	Socio-demographic Personality Employment Safety-environment Social support Work-hazards Safe work behavior Work-injury	Retrospective case-control	Own multi-items questionnaire (made with the variables assessment)	Sampling: randomly. Participants: 150 (non-specified gender) control group, age ($\bar{x}$)=37.3 years; 150 (non-specified gender) non-control group, age ($\bar{x}$)=37.3 years.
Ansoleaga & Toro[38] 2010	To determine whether or not there are differences of risk to suffer depress symptoms by exposure level to psychosocial risk at work.	Chile	Copper	Job demand Job control Effort-reward Distress Drugs/OH (Alcohol) consumption Depression	Cross-sectional	EQCOTESST (Quebec Survey on Working, employment and OHS conditions) questionnaire PRIME-MD (Primary Care Evaluation of Mental Disorder)	Sampling: Stratified random. Participants: 303 (288 males), age ($\bar{x}$)=non-specified, only the range: from 19 to 64 years.
Wang *et al.*[47] 2010	To longitudinally compare prevalence, psychopathological profile, and baseline levels of stress hormones between two time points (3- and 6-months post-disaster) in the coalmining disaster survivors diagnosed with and without PTSD. Correlations between stress hormones and psychopathological findings were also performed. The second objective was to determine changes in the volume and integrity of the brain at 6 months post-disaster with the employment of volumetric magnetic resonance imaging (MRI) and diffusion tensor imaging (DTI).	China	Coal	Socio-demographic Disaster experience Interpersonal relationship Sleep Quality Comorbid symptoms Depression Plasma cortisol ACTH	Longitudinal	CAPS (Clinical-Administered PTSD scale from DSM) Own 5-items scale of interpersonal relationship. PSQI (Pittsburgh Sleep Quality Index) SCL-90-R (Derogatis' Symptom Checklist-revised) 17-HAMD (Hamilton Scale) MRI (Mortality Risk Index) DTI Scale	Sampling: non-specified. Participants: 69 (all males), age ($\bar{x}$)=37.6 years.

Table 1. Continued

Authors/ year	Aim	Study Location	Mining activity	Variables Assessment	Methods/ design	Instruments	Sample
Paech *et al.*[48] 2010	To examine the effects of working varying numbers of consecutive shifts with varying numbers and timing of days off on employee's sleep quantity and quality.	Australia	Non-specified	Socio-demographic Sleep/wake Shift work	Longitudinal	GHQ-12 (General Health Questionnaire) Sleep diary and wrist activity monitoring devices	Sampling: non-specified. Participants: 111 (110 males), age ($\bar{x}$)=40.3 years.
Masia & Pienaar[49] 2011	To investigate the relationship between work stress, job insecurity, organizational commitment, job satisfaction and safety compliance in a mine and to determine whether one can use work-related variables and attitudes to predict the safety compliance of employees.	South Africa	Non-specified	Socio-demographic Job stress Organizational commitment Job insecurity Safety compliance Job satisfaction	Cross-sectional	Job insecurity scale Job satisfaction questionnaire Affective organizational commitment questionnaire. Workplace accidents and safety compliance questionnaire 4-items scale for role clarity 5-items scale for role conflict 7-items scale for role overload	Sampling: convenience sample. Participants: 158 (152 males), age ($\bar{x}$)=non-specified
Torkington *et al.*[50] (2011)	To explore how fly-in fly-out (FIFO) and drive-in drive-out (DIDO) mining affects the psychosocial well-being of miners' resident in a rural north Queensland town as well as the sources of support miners identify and use in managing these effects	Australia	Non-specified	FIFO (Fly-in-Fly-out) DIDO (Drive-in-Drive-out) Well-being Emotional/stress problems Relationship Family relations	Descriptive qualitative	Semi-structured Interviews	Sampling: convenience sample. Participants: 11 (9 males), age ($\bar{x}$)=non-specified, only the range: from 20 to 59 years.
Ferguson *et al.*[51] (2011)	To investigate the impact of work- and sleep-related factors on an objective measure of response time in a field setting	Australia	Non-specified	Sleep/wake Work hours Response times Shift work	Longitudinal	Sleep diary Work diary Activity monitor PVT (Psychomotor Vigilance Task)	Sampling: non-specified. Participants: 35 (non-specified gender), age ($\bar{x}$)=38.3 years (4 x 4); age ($\bar{x}$)=46.3 (7 x 4) and age ($\bar{x}$)=43.2 (14 x 7).
Jackson *et al.*[52] (2011)	To test the mediating role of separation in the relation between adverse acculturation conditions and well-being of mine employees in the North-West province; To examine Black and White group differences in the experience of mainstream antecedent adverse conditions, separation, and well-being.	South Africa	Non-specified	Socio-demographic Mainstream segregation demands Perceived discrimination Subtle racism	Cross-sectional	12-items measure to Mainstream segregation demands Perceived discrimination scale Subtle racism scale	Sampling: convenience sample. Participants: 241 (208 males), age ($\bar{x}$)=31.65 years.

Table 1. Continued

Authors/ year	Aim	Study Location	Mining activity	Variables Assessment	Methods/ design	Instruments	Sample
				Well-being Ethnic separation demands Work context		3-items measure to Individual separation acculturation orientation 4-items measure perceived co-ethnic separation demands at work. PSI (Psychological Screening Inventory) Work success	
Gallegos[53] (2012)	To identify the most common vital events related to the stress suffered by the workers of a company located in Arequipa.	Peru	Non-specified	Events vitals Job stress	Cross-sectional	Holmes and Rahe's social readjustment evaluation scale	Sampling: non-specified. Participants: 103 (100 males), age ($\bar{x}$)=non-specified, only the range: from 19 to 55 years.
McLean[54] (2012)	To explore psychosocial issues perceived to impact the mental health and well-being of resident (non-fly-in fly-out) mine workers at a local mine in regional Queensland	Australia	Coal	Relationship Lifestyle Work characteristic Mental health attitudes Well-being FIFO	Descriptive qualitative.	Semi-structured interviews	Sampling: convenience sample. 10 (9 males), age ($\bar{x}$)=43.6 years.
Corral[40] *et al*. (2013)	To determine the effects of Hg0 exposure on the nervous system	Chile	Gold	Socio-demographic Smoking and alcohol consumption. Neurological and neuropsychological deterioration	Cross-sectional	Neurological evaluation Neuropsychological evaluation with: BDI-II, direct digit span test and REY complex figure; D2 test, Stroop test and WCST (Wisconsin Test) Blood sampling	Sampling: convenience sample. Participants: 35 (all males) exposed to Hg0, age ($\bar{x}$)=48.3 years; 40 (all males) non-exposed, age ($\bar{x}$)=39.6 years.
Amponsah-Tawiah[55] (2013)	To examine the effects of physical and psychosocial risk factors on workers' safety experience in a sample of Ghanaian miners	Ghana	Gold Non-gold	Socio-demographic Physical hazards Psychosocial hazards Personal safety experience.	Exploratory sequential design	Initial semi-structured interviews Own questionnaire with the variable's assessment (Physical hazards, personal safety experience). COPSOQ (Copenhagen Psychosocial Questionnaire)	Sampling: stratified random. Participants: 307 (all males), age ($\bar{x}$)=37.4 years.

Table 1. Continued

Authors/ year	Aim	Study Location	Mining activity	Variables Assessment	Methods/ design	Instruments	Sample
Garrido & Hunt[39] (2013)	To assess what is the influence of work organization factors based on roles and status on work stress and; To take into account workers' positive and negative opinions about their jobs that could reflect role relationships as sources of stress or well-being	Chile	Non-specified	Socio-demographic Job satisfaction General Health Depression Bullying Work-family interference Workers positive and negative opinions	Cross-sectional	COT (Work-Organization Questionnaire) HADS-A (Hospital Anxiety and Depression Scale) HADS-D	Sampling: non-specified. Participants: 451 (427 males), age ($\bar{x}$)=36 years.
Gow *et al.*[56] (2013)	To analyze the health-related quality of life (HR-QOL) in two groups of diamond miners (HIV - Human Immunodeficiency Virus-negative and positive) in South Africa using three instruments	South Africa	Diamond	Sociodemographic Health-related quality of life (illness, independent living, social relationship, well-being, mobility, self-care, usual activities, pain/discomfort, anxiety/depression, health state)	Cross-sectional	EQ-5D (Quality of Life Test) HUI 3 (Health utilities Index Mark 3) AQOL (Mark 2) (Assessment of Quality of Life)	Sampling: non-specified. Participants: 1,142 (871 males), age ($\bar{x}$)=non-specified.
McPhedran & De Leo[57] (2014)	To describe demographic and psychiatric characteristics, and the occurrence of stressful life events among miners who died by suicide in Queensland. Second, it compared miners and workers in other occupations, who died by suicide, to establish whether those two groups exhibit different characteristics and whether miners were more likely to experience substance misuse, psychiatric illness, and/or stressful life events in the months prior to death.	Australia	Non-specified	Sociodemographic Suicidal intent and past suicide attempts Psychiatric condition Life events Alcohol consumption	Secondary data analysis	Queensland suicide register	Sampling: convenience sample. Participants: 218 (all males). 48 mine workers (all males), age ($\bar{x}$)=39.2 years at time to death.
Carlisle & Parker[58] (2014)	To examine the relationship between perceptions of musculoskeletal pain and psychological distress	Australia	Coal	Sociodemographic Muscoloeskeletal pain Distress Lifestyle behavior Fatigue factors	Cross-sectional	Nordic muscoloeskeletal pain questionnaire. Kessler K6 Own questionnaire about lifestyle and fatigue factors.	Sampling: convenience sample. Participants: 231 (206 males), age ($\bar{x}$)=37.1 years.

Table 1. Continued

Authors/ year	Aim	Study Location	Mining activity	Variables Assessment	Methods/ design	Instruments	Sample
Liu & Chen [41] (2014)	To evaluate the prevalence of depressive symptoms and to explore its associated factors in this population	China	Coal	Sociodemographic Working characteristics Occupational psychosocial factors (Effort-Reward imbalance, overcommitment, perceived physical environment and work-family conflict)	Cross-sectional	CES-D (Center for Epidemiological Studies – Depression) ERI and OC scales (Effort-Reward Imbalance and Overcommitment scales) OSI-R (Occupational Stress Inventory) WFCS (Work-Family Conflict Scale) 3-Items for working characteristics (job rank, monthly income, and weekly working time)	Sampling: cluster sampled. Participants: 1,936 (all men), age ($\bar{x}$)=non-specified, only the range: from ≤ 30 to >50 years.
Loudoun *et al.*[59] (2014)	To evaluate these relationships (shift work, aging, lack control at work and sleep problems) drawing on a sample of Australian mine and energy workers and their partners	Australia	Coal	Sociodemographic Sleep disturbance Worker control Partner satisfaction Circadian type Personality Shift work	Cross-sectional	Morningness-eveningness questionnaire Mini-IPIP scale Own questions about shift characteristics and work-life balance SSI index (Standard Shifwork) HILDA 2011	Sampling: matched pair sampled. Participants: 2,640 (2,534 males), age ($\bar{x}$)=non-specified.
Cui et al. [60] (2015)	To assess the relationships between the risk factors and the incidence of nonfatal occupational injury of coal mine workers of Shanxi Province	China	Coal	Sociodemographic Occupational injury information Psychological state	Cross-sectional	Classification criteria for enterprise workers casualty EPQ-REC (Eysenck Personality Questionnaire) MBI-GS job burnout scale	Sampling: stratified cluster sampled. Participants: 3,618 (3,038 males), age ($\bar{x}$)=41.5 years.
Salas *et al.*[61] (2015)	To assess psychosocial working conditions and psychological distress in Andean underground miners	Bolivia Chile Peru	Silver Gold	Sociodemographic Demand-control Job strain Violence at work Mental health	Cross-sectional	European Working Condition Survey GHQ-12	Sampling: randomly (Perú), convenience sampled (Chile and Bolivia). Participants: 489 (all males), age ($\bar{x}$)=non-specified, only the follow: 138, age <30; 149, age 30–39 and 182, age +40.
Tynan *et al.*[62] (2017)	To investigate patterns of alcohol use within the coal mining industry, and associations with the personal, social, workplace and employment characteristics.	Australia	Coal	Sociodemographic Health history Participant's current health	Cross-sectional	AUDIT (Alcohol Use Disorders Identification Test)	Sampling: quota sampling (stratified sample). Participants: 1,457 (1,225 males), age ($\bar{x}$)=non specified, only these data: 112, age < 24 years; 437, age 25–34 years;

Table 1. Continued

Authors/ year	Aim	Study Location	Mining activity	Variables Assessment	Methods/ design	Instruments	Sample
				Workplace factors and attitudes Alcohol consumption		Own asks about health history, current health and work factors and attitudes. Kessler 10+ (Distress Scale)	434, age 35–44; 320, age 44–54 years; 69, age 55+ years.
Ahmad[63] (2017)	To assess the relationship between stress faced by quarry workers in consonance with their socio-demographic characteristics and their working conditions.	India	Quarry/ sandstone	Sociodemographic Occupational aspects Occupational injuries Job stress	Cross-sectional	Own question questionnaire (occupational injuries and stress) GHQ-12	Sampling: randomly. Participants: 218 quarry workers, age ($\bar{x}$)=41.1 years, 203 (167 males) non-quarry workers, age ($\bar{x}$)=41.3 years.
Manic *et al.*[42] (2017)	To assess the prevalence of burnout and depressive symptoms and to evaluate aspects of proactive coping among underground coal miners in Serbia.	Serbia	Coal	Sociodemographic Injuries Burnout Coping strategies	Cross-sectional	5 asks about injuries CBI (Copenhagen Burnout Inventory) PHQ-9 (Patient Health Questionnaire) PCI (Proactive Coping Inventory)	Sampling: convenience sampled. Participants: 46 (all males), age ($\bar{x}$)=43.8 years.
Deng *et al.*[64] (2017)	To analyze the relationships among musculoskeletal disorders (MSDs), personality traits, psychological distress, and accident proneness of coal miners	China	Coal	Sociodemographic Muscoloeskeletal disorders Personality trait Job distress Accident proneness	Cross-sectional	MDSs Likert scale EPQ (Eysenck Personality Questionnaire) SCL-90 Accident Proneness Questionnaire	Sampling: non-specified. Participants: 992 (all males), age ($\bar{x}$)=non-specified.
Legault *et al.*[24] (2017)	To quantify the extent to which a sample of middle-age male miners experienced sleep related problems.	Canada	Non-specified	Sociodemographic Sleep behavior Subjective sleep Reaction time Executive functions Sleep quality Sleepiness Core body temperature Ambient conditions	Longitudinal	Sleep actigraphy Diary of subjective sleep self-report PVT-B (Vigilance Test) PSQI SSS (Stanford Sleepiness Scale) KSS (Karolinska Sleepiness Scale) ESS (Epworth Sleepiness Scale) Cor-Temp® sensors Veriteq™	Sampling: non-specified. Participants: 19 (all males), age ($\bar{x}$)=41.5 years.

Table 1. Continued

Authors/ year	Aim	Study Location	Mining activity	Variables Assessment	Methods/ design	Instruments	Sample
Li *et al.*[65] (2017)	To explore the mechanism of subjective well-being impact on miners' unsafe behaviors, and then put forward some suggestions to coal enterprise managers to improve the level of coal mine safety management	China	Coal	Sociodemographic Subjective well-being Unsafe behavior Positive and negative emotions Life satisfaction	Cross-sectional	Subjective well-being scale Emotion scale Life satisfaction scale Unsafe behavior scale	Sampling: randomly. Participants: 184 (all males), age ($\bar{x}$)=non-specified, only the range: 19, age < 25 years; 114, age 26–35 years; 43, age 36–45; 8, age ≥ 46 years.
Yu *et al.*[66] (2017)	To measure unbalanced mental fatigue and it cause in shift work paradox	China	Coal	Sociodemographic Mental fatigue Reaction time Sleeping duration Sleepless time Coal-mine managers supervision	Longitudinal	10-items psychometric fatigue assessment scale. Ruler test Own questions coal-mine managers.	Sampling: non-specified. Participants: 100 (all males), age ($\bar{x}$)=non-specified, only the range: 31, age 20–29 years; 27, age 30–39 years; 27, age 40–49 years and 26, age 50–59 years.
Firoozi chahak *et al.*[67] (2017)	To determine the level of stress, anxiety, and depression in workers of one copper mine in Kerman Province, Iran	Iran	Copper	Sociodemographic Anxiety Depression Job Stress	Cross-sectional	DASS-21 (Depression, Anxiety and Stress Scale)	Sampling: census method. Participants: 250 (non-specified gender), age ($\bar{x}$)=31.8 years.
Rubin *et al.*[68] (2017)	To understand which gender-based workplace issues are negatively related to women miner's mental health and job satisfaction	Australia (Africa, South America, South east Asia)	Non-specified	Sociodemographic Gender workplace issues Mental health Job satisfaction	Cross-sectional	Own 6 factors workplace gender-based issues DASS-21 Own 4-items job satisfaction	Sampling: convenience sampled. Participants: 263 (all female), age ($\bar{x}$)=37.1 years.
Castellucci & Altamiran[69] (2018)	To determine the shift system that allows for sustainable time management, considering the characteristics of the mining company analyzed	Chile	Non-specified	Sociodemographic Sleep quality/quantity Fatigue Health and well-being Social and domestic situation Coping	Cross-sectional	SSI SWOT analysis	Sampling: non-specified. Participants: 105 (non-specified gender), age ($\bar{x}$)=32.7 years.

Table 1. Continued

Authors/ year	Aim	Study Location	Mining activity	Variables Assessment	Methods/ design	Instruments	Sample
Han *et al.*[70] (2018)	To assess the quality of life (QOL) of coal miners in Xuzhou, China and explore influencing factors to QOL of coal miners.	China	Coal	Sociodemographic Working history BMI Job tenure for dust exposure Quality of life Smoking/drinking	Cross-sectional	Own asks for: BMI, job tenure for dust, Smoking/drinking SF-36 (Health Survey)	Sampling: non-specified. Participants: 354 (all males), 612 underground miners, age ($\bar{x}$)=41.5 years; 354 ground miners, age ($\bar{x}$)=43.7 years.
James *et al.*[71] (2018)	To assess the prevalence of psychological distress in employees in the metalliferous mining industry in Australia, and to examine associated demo- graphic, health, and workplace characteristics	Australia	Metal	Sociodemographic Psychological distress Individual health history Current health history Workplace factors	Cross-sectional	K10 (Anxiety and Depression checklist) Own asks about health history and current; workplace factors. AUDIT	Sampling: convenience sampled. Participants: 1799 (1575 males); age ($\bar{x}$)=non-specified, only the range: 111, age < 24 years; 665, age 25-34 years; 466, age 35-44; 373, age 45-54 years; 171, age 55+ years.
Ramashia *et al.*[72] (2018)	To explore and describe the experiences of mine workers experiencing a cancer diagnosis requiring radiation therapy	Australia	Platinum	Emotional experiences Changes after cancer diagnosis (personal/family) Information access to radiotherapy	Descriptive qualitative	Unstructured interviews	Sampling: convenience sampled. Participants: 11 (8 males), age ($\bar{x}$)=non-specified, only the range: from 32 to 73 years.
Joaquim *et al.*[43] (2018)	To characterize mental health components in 89 underground coal miners in southern Brazil.	Brazil	Coal	Anxiety Depression Physical health Psychological capital Sleep quality	Cross-sectional	PSQI-BR (Brazilian Pittsburgh Sleep Quality Index) Beck Depression Inventory III Beck Anxiety Inventory PCQ-12 (Psychological Capital Questionnaire)	Sampling: convenience sampled. Participants: 89 (non-specified gender), age ($\bar{x}$)=32.9 years.
Li *et al.*[73] (2019)	To investigate the status of occupational stress and its influence on the quality of life of copper-nickel miners, in order to provide a theoretical basis for alleviating occupational stress to improve their quality of life.	China	Copper Nickel	Sociodemographic Job stress Quality of life	Cross-sectional	ERI SF-36	Sampling: stratified cluster. Participants: 1,857 (1,635 males), age ($\bar{x}$)=33 years.

Table 1. Continued

Authors/ year	Aim	Study Location	Mining activity	Variables Assessment	Methods/ design	Instruments	Sample
Pelders & Nelson[74] (2019)	To assess associations between demographic, work, living and socioeconomic conditions, and lifestyle characteristics, and fatigue in the South African Mining Industry	South Africa	Platinum	Sociodemographic Fatigue Sleep Health Fitness for work Lifestyle factors Commuting time	Exploratory sequential design	Focus group KSS Samn-Perelli Fatigue Scale	Sampling: convenience sampled. Participants: 73 (50 males) respond the questionnaire; 24 (15 males) incorporated in the focus group, age ($\bar{x}$)=37 years.
Ma *et al.*[75] (2019)	To examine whether the association between personality traits and quality of life (QOL) was mediated by sleep quality in coal miners and to explore whether the relationship between surface workers and underground workers was different.	China	Coal	Sociodemographic Quality of life Personality traits Sleep quality Obesity Diabetes Smoking/drinking	Cross-sectional	Blood sample Automatic Biochemical analyzer IPAQ (International Physical Activity Questionnaire) EPQ-RSC (Eysenck Personality Questionnaire – short scale for chinese) Six own questions for sleep quality WHOQOL-BREF (World Health Organization Quality of Life Questionnaire)	Sampling: cluster stratified/ randomly. Participants: 3,090 (2,602 males), age ($\bar{x}$)=non-specified, only the range: 888, age < 35 years; 1181, age 35–35 years; 1027, age ≥ 45.
Mościcka-Teske *et al.*[76] (2019)	To present the results of research on the scale of psychosocial risks among miners	Poland	Metal	Sociodemographic Stressful working conditions Accidents Psychosocial risk at work Occupational risk Job satisfaction	Cross-sectional	PRS (Psychosocial Risk Scale) Own scale named A-D scale Own questions about absenteeism, frequency of accidents, health status and ability to work. Own 7 aspects for job satisfactions.	Sampling: non-specified. Participants: 483 (424 males), age ($\bar{x}$)=40.4 years.

Source: Own elaboration (2020)

Table 2. Summary of results and discussion/conclusion of documents reviewed

Authors/Year	Principal findings	Discussion/conclusion
Yu *et al*. (2008)	- Significative different in the general values about the dimensions of WHOQOL-BREF (i.e. physical health, psychological health, social relationship and environment) between coal dust exposure workers and non-exposure to coal dust workers. - QOL physical predictive factors: high educational level, working less than 8 hours and in a safe environment. QOL psychological: types of job, welfare satisfaction, work danger, more hobbies, smoking, one-child family. Workers work at underground, smoking and more one-child family reported worse QOL psychological. QOL social: live in countryside. QOL environment: working underground, working hours, smoking and drinking. - 79.3% of participants had "average", "good" or "very good" feelings about their QOL. 68.5% of workers reported "average", "good" or "very good" feelings about their health status.	- Cohabiting workers had worse QOL than single workers (p.511) - Educational level was associated with the physical and social domains of QOL. Workers with higher educational level tended to enjoy better QOL (p.511) - Working variables, types of job (psychological and environmental), working hours (physical, social, and environmental), welfare satisfaction (psychological, social, and environmental), self-reported social status (environmental), and work danger (physical, psychological, and environmental) were significant factors affecting QOL (p.511) - Underground workers had a worse working environment and worse security, which might explain their worse QOL (p.511) - Smoking (psychological and environmental) and drinking (environmental) were significant factors related to QOL (p.511)
Vera & Contreras (2008)	- 48.3% of workers declared smoking regularly. - 38% of workers declared sedentary. 69.5% presented weight disturbance (overweight or obesity) - Almost the 60% of workers declared to have fatigue symptoms. - 45.2% presented perturbations in oximetry values. 89.2% of workers have some type of sleep disorder (sleep apnea).	- Sleep disorders prevalence was almost 30%. This is extremely high, because the sleep disorders affected around to 10% of the general population. - 71% of workers presented overweight or obesity. The high frequency of sleep disorders finding in this group might be associated not only to the overweight, but with the shift work system. - The obesity could be related to the sleep apnea.
Paul (2009)	- Negative affectivity (p<0.01) and risk taking (p<0.05) were positively related to work injuries. Impulsivity (p>0.10) and depression (p>0.10) were not related to work injuries. Job dissatisfaction (p<0.10) was positively related to work injury. No significant relationships were found for job stress (p>0.10) and safe work behavior (p>0.10). None of the safety environment predictors (p>0.10) were statistically related to work injury. none of the social support variables (p>0.10) were statistically related to work injury (p.286) - Older age group is 2.14 times more likely to be injured than the youngest age group. Highly negatively affected workers are 2.54 times more prone to injury than the less negatively affected workers. Workers who have high job dissatisfaction are 1.71 times more likely to become injured in comparison to their low scoring counterpart (p.287)	- Care should be taken for the aged and experienced workers in terms of their job responsibilities and training requirements (p.288) - Negative behaviors from the mine workers must be eliminated. Long term planning through: 1) developing a sense of caring and respect for one an- other; 2) building helpful and co-operative relationships with co-workers and supervisors/management; 3) developing a range of social skills and help them learn what constitutes acceptable behavior; and 4) special training with psychological treatment that will develop confidence (p.288) - The accident involved workers are more job dissatisfied and, hence, are less job involved and often bored with their jobs (p.288)
Ansoleaga & Toro (2010)	- 40% of workers presented high job demand, 11% low control and 5% of them sensed psychological tension. 33% experienced effort-reward imbalance, 22% low social support, 12% high distress. - 33% of workers declared had consumed at least one of three psychotropic (i.e. anxiolytics, hypnotics or ant depressives). Psychotropic consumption increased 4 times more probability to suffer depressive symptoms. - 23% of workers indicated to have depressive symptoms. The workers with low social support, evidenced more likelihood (79%) to have depressive symptoms. 78% of workers with effort-reward imbalance had 78% likelihood more to present depressive symptoms. Workers with high demands had more 83% of risks to present depressive symptoms. Workers with high stress presented 4.5 times more of probability to have depressive symptoms.	- There are significant differences between workers with low social support in regard to workers with high social support according to depressive symptoms. In the same way, workers with high effort-reward imbalance and workers without it; high psychological demands in comparison with workers without it; with high job stress among those without it and with one or more psychotropic consumption among those without it; have more risks to present depressive symptoms. - The psychotropics consumption have higher prevalence (27%) in the workers sample than general population in Santiago City (1.95%). Almost 14% of the sample consumed anti-depressants compared with 1.69% in general population. - The affection of mental health in mine workers could be hidden, because sometimes it is thought that they do not suffer at work due to their masculinity.

Table 2. Continued

Authors/Year	Principal findings	Discussion/conclusion
Wang *et al.* (2010)	- The prevalence rates of PTSD were 35.4% (17/48; 95% CI: 21.9–48.9%) at 3 months and 31.3% (15/48; 95% CI: 18.2–44.4%) at 6 months after the disaster. There were significative association among survivors had PSTD with: experienced traumatic events, interpersonal relationship, sleep quality, length of being miner and to be extremely exhausted or sick. - 14.3% have depressive symptom at 3 months of disaster. And 10.4% at 6 months. There were the following symptoms: interpersonal, psychoticism, anxiety and paranoid ideation.	- Among 35% to 31% of the survivors complied the DSM-IV criteria to PTSD diagnostic at 3 and 6 months post-disaster. - Exist significative positive correlations between cortisol level and the severity of several comorbid symptoms at 6 months, including somatic and interpersonal symptoms. Survivors from severe coalmining disasters have considerably high prevalence rates of PTSD and comorbid symptoms (depress, anxiety, hostility)
Paech *et al.* (2010)	- TST for days off was significantly longer ($p<0.001$) than day and nightshifts. TST showed a significant effect across consecutive shifts for all rosters ($p<0.01$) (p.603). No founded statistical differences around rosters systems and subjective sleep quality among shift-work schedule (day, night or days off).	- Miners slept significantly more (around 1 hour) on days off than on workdays in their jobs. Is possible that the sleep debt is accumulated, and the workers don't recovery in after periods. The sleep quality isn't being met.
Masia & Pienaar (2011)	- The model with the variables Job stress, insecurity at work, job satisfaction and organizational commitment were explicative of safety compliance (14.5% to 19.6% of the variance). Only job satisfaction had contribution power to predict the safety compliance. Workers satisfied with their job had 2.24 times more likely to be safety compliant.	- Finding on strong and direct evidence of the relationship between work stress, insecurity and safety compliance (p.7). Job stress and insecurity had inverse relation with safety compliance. Increase in job satisfaction may bring about an increase in safety compliance (p.8)
Torkington *et al.* (2011)	- Missing out on time with children was considered a negative effect of FIFO/DIDO (p.137) - Workers presented concerns about playing less of a role in family life and being an outsider. Also, presented negative impacts on their partner's relationship. They reported sense of upset or lonely; stress of dealing with busy roles, i.e. parenting alone, changing routines, etc. (p.138) - None of the participants reported non-solicited help to solve their issues related to FIFO/DIDO	- Interference of the FIFO lifestyle with social and domestic activities (p.140) - Miners have some insight into the challenges their partners face (p.140) - Preference for seeking support from trusted workmates rather than formal support (p.140)
Ferguson *et al.* (2011)	- The 7x4 roster was associated with lowest RRT (reciprocal response time) scores (indicating highest performance impairment) (P.211). RRT was significantly lower during tests conducted at the end of night shifts (P.211). Mean RRT associated with prior sleep of <6 h was significantly different from the mean RRT associated with prior sleep of 7 and 8 h and >8 h ($p<0.05$) (P.212).	- Sleep history was a significant predictor of response time in the group (p.212) - Most impaired performance was observed at the end of the night shift (p.212 - The differences between rosters in the current study do not appear enough to cause significant changes to sleep.
Jackson *et al.* (2011)	- Blacks reported more subtle racism attitudes at work compared to Whites. Scores on discrimination at work are rather high compared to the scores on the other scales, the most common adverse acculturation condition faced by these mine employees (p.391) - Adverse acculturation conditions, such as mainstream segregation demands, and subtle racism have therefore an indirect and significant influence on physical and psychological ill-health (p.392)	- The adverse mainstream conditions were positively associated with ethnic separation demands and work and individual separation strategy, ill-health and negatively related to subjective feelings of work success (p.392). The work environment featured by more mainstream segregation, discrimination and subtle racism is more likely to contribute to ethnic members encouraging each other to separate. This is accompanying with ill-health symptoms (p.392)
Gallegos (2012)	- Most important events vitals: changes of eating habits, changes in life conditions, changes in sleep habits, changes of economic status and big personal achieve. The vital events were different according to type of role (mechanist, engineer or administrates). - Engineers showed the highest level of job stress. 46% of them, presented an important vital crisis. 22% of administrates presented moderate level of job stress.	- Is possible that the stressors relationship more with the working conditions instead of other variables. Men workers are more sensible to changes in outcomes and personal habits than other vital events. - Engineers have more responsibilities than mechanist and administrators. High demand versus low control.
Mclean (2012)	- Return home after each shift was of enormous value to workers, and this was reflected in their statements (p.128).	- It recognized some mental health problems (such as job stress or depressive symptoms), but of equal form it recognized the mining work promoted well-being.

Table 2. Continued

Authors/Year	Principal findings	Discussion/conclusion
	- Lifestyle related with locality of mine (local staff = community feelings), roster schedule (spend time with family and friends), outcomes (reason for working at mining). - Negative aspects of work identified were the effects of shift work, stressful tasks required and, in some cases, a general feeling of burnout (p.128)	- Some mental health issues appear inherent to the mining profession; family contact, co-workers, management and organizational support can positively impact workplace experiences and well-being (p.130).
Corral *et al.* (2013)	- Neither smoking nor alcohol intake were contributing factors (p.349). - 43% of individuals showed frontal impairment versus 8% in the "unexposed workers" group; 17% of individuals showed tremor versus 5% in the "unexposed workers" group and 11% of individuals showed the triad (frontal impairment, Parkinsonism, and pyramidal syndrome) versus 3% in the "unexposed workers" group (p.351) - Neuropsychological assessment showing that three of the tests applied were influenced by exposure condition (direct digits, perseverative errors of Wisconsin test and Rey´s com- plex figure (memory)) (p.354).	- No significant correlations were observed after applying a bivariate correlation analysis between the levels of blood mercury and neurological and neuropsychological scores (p.355) - Artisanal gold miners showed signs and symptoms of neurological and neuropsychological impairment. Moreover, it was in this group of workers where the highest levels of blood mercury were detected (p.355).
Amponsah-Tawiah *et al.* (2013)	- Poor working conditions in the mines were linked to poor safety experience of the workers. Mining conditions and support and security were also significant predictors (p.80) - Only worse ambient conditions at the mines were significantly associated with the number of times a worker witnessed an accident in which either they or one of their colleagues was injured (p.80). That characteristic of working conditions also to increase the incidence of accidents leading to injury (p.80). - Higher work demands but low control and low support and security also increase the incidence of near misses. Moreover, poor psychosocial working conditions in the mines were linked to poor safety experience (p.80)	- Workers with high workloads, unclear roles and responsibilities over which they have little or no control reported experiencing more near misses (p.82). - The type of mine showed a significant negative relationship with workers' safety experience, with employees in the gold mines reporting witnessing more accidents and experiencing more near misses than their counterparts in the non-gold sector (i.e., manganese and bauxite companies) (p.82). - High job demands and low control over workload were associated with negative safety reported outcomes. Is necessary to achieve a balance between work demands, control and workload (p.82).
Garrido & Hunt (2013)	- Reward and Recognition (RAR), as well as Quality of Relationships with Colleagues (QRC), significantly predicted job satisfaction (JS) (p.49). RAR and QRC significantly predicted general health (GH) of staff. Relationship between GH and JS. - Quality of Relationships with Management (QRM) significantly and negatively predicted anxiety (p.49). - Quality of Relationships with Colleagues (QRC) significantly and negatively predicted bullying on the analysis run on staff (p.50). Workload Issues was a significant and negative predictor of bullying (p.50). - The higher the work-family interference the worst workload predicts (p.51). Poor work conditions and lack of coordination were main topics for job´s problems, family remoteness, treatment style and lack of coordination were the other topics mentioned by subcontracted workers as the main job´s problems (p.51)	- Work organizational factors based on role and status relationships predicted the greatest variance on the outcomes studied, while traditional hazards accounted for a smaller (p.51) - Workload predicts work-family interference as an important role conflict issue contribution (p.51) - On the subcontractor's group, a precarious work environment seems to be the rule, and workers are more stressed in terms of bullying perceptions and anxiety feelings. Precarious work, featured by job instability, has potential negative consequences on the worker´s occupational health (p.51).
Gow *et al*. (2013)	- HIV positive workers score significantly lower on the HUI-3 (M=0.821) as compared to HIV negative people (M=0.914) (t=3.25, p<0.001). In the case of the EQ-5D, HIV positive people (M=0.9186) have a higher quality of life as compared to HIV negative people. Younger people score lower on the AQOL measure (r=20.130, p<0.001) (p.93)	- HIV status was not a strong predictor of HR-QOL in this patient group (p.93) - Little in the way of statistically significant results were found between HIV status and age, employment status, race nationality, job band, or race (p.93). Self-reported health of workers both HIV positive and negative is generally high (p.94)

Table 2. Continued

Authors/Year	Principal findings	Discussion/conclusion
McPhedran & De Leo (2014)	- Miners almost two and a half times as likely to experience relationship problems prior to death by suicide, relative to other workers (p.4) - Miners who died by suicide were marginally (but not significantly) less likely than other workers to be divorced/separated (p.5) - Age at time of death among miner suicides was a mean of 39.2 years (compared with the mean 40.2 years in other workers) (p.4)	- Not find any major differences between miners and other workers who died by suicide in terms of demographics, psychiatric history, problematic alcohol use, and non-relationship-related life events (p.6) - Suggestive evidence that relationship problems prior to death may be more commonly observed in the context of suicide among miners, than among other workers (p.6)
Carlisle & Parker (2014)	- Significant differences in distress levels by job category. The operators were significantly more distressed than supervisors/professionals/administration staff and maintenance workers (p.205). - 28.4% were registered to have mild to moderate distress, and 9.6% had scores indicating high levels of distress. In terms of pain, 19.5% reported no pain, 28.2% reported pain in one or two areas, and 52.3% reported pain in three or more body areas (p.206). Pain was significantly related to distress. In addition to the number of pain regions and younger age both job types were significantly related to worker psychological distress (p.206) - workers whose scores signified high levels of psychological distress indicated that almost 85% were overweight or obese (p.206) - Sleep quality was significantly related to both distress and pain, and participants reported improved sleep quality when rostered off work (p.206)	- There was a significant relationship between pain and distress among coal miners, with more widespread pain associated with greater distress (p.207) - Distress was also more pronounced among the operators/truck drivers, younger workers, and those who were less active during their time off work. It was also associated with absenteeism for workers who reported lower back pain. Pain and distress were also associated with fatigue, which was evidenced by the mediating effect of perceived sleep quality during working periods (p.207) - More widespread pain was associated with decreased sleep quality, and workers were more likely to report being distressed in this situation (p.208) - Exposure to 12-hour rotating shifts accommodating travel and meals leaves limited time for sleep and effective recovery (p.208).
Liu & Chen (2014)	- The prevalence of depressive symptoms among Chinese underground coal miners was 62.8% (p.3). Marital status, education, and monthly income were significantly related to depressive symptoms (p.3–4). Depressive symptoms were significantly higher among respondents with junior high school or under education compared with those with junior college or above education (p.4). Weekly working time, Effort-reward imbalance, Overcommitment, perceived physical environment, and Work-Family conflict had positive correlations with depressive symptoms in the study (p.4)	- The mean level of depressive symptoms was 20.00 (9.99) for the Chinese underground coal miners. Compared with other male occupational groups, this level was higher than 17.13 (8.85) for that of various occupations from Shanghai (p.4) - Prevalence of depressive symptoms was 62.8% measured by a CES-D score of 16 or more in our underground miners, which was higher than that of other male occupational groups including various occupations 47.2% from Shanghai (p.4)
Loudoun *et al.* (2014)	- In the younger subset, shift control was not significant; in the subset comprising workers aged 50 and above, shift control was a significant, negative influence on sleep disturbance (p.1197) - The effect of latitude on sleep disturbance was significant for all workers but there was no significant difference between the impact on younger workers and the impact on older workers (p.1197). For older groups shift control is more important than latitude in reducing sleep disturbance (p.1198)	- Control over shift scheduling is not associated with sleep disturbances for younger workers, for older workers aged 50 or more, low shift control results in more disturbances (p.1198) - Older workers do report more sleep problems than their younger but this is no more influenced by latitude over work tasks than younger workers (p.1198).
Cui *et al.* (2015)	- For all injuries, underground represented about 79.71%, and above ground about 20.29% (p.5) - Significant adjusted odds ratios were work type (light physical labor vs heavy physical labor, workplace (under- found) for gender (female vs male) age (> 55 vs < 25 yr), ground auxiliary vs underground front-line, length of shiftwork experience score showed that introversion had a higher risk of injury than extraversion (p.7)	- Male, heavy physical labor, underground front-line and introversion were associated markedly higher risks of non-fatal occupational injury. Older workers were less likely to injured rather than those under the age of 25 (p.7). - Workers' behaviors, lifestyles and personality traits should also be considered to controlling the hazards associated with front-line physical work (p.11).
Salas *et al.* (2015)	- Job security was considered high by only one-third of the population, with highest levels in Bolivia (47%) and lowest in Chile. 55% of miner faced workplace violence over the previous 12	- Employment conditions were precarious. As expected, psychosocial factors were substantially associated with psychological distress (p.471)

Table 2. Continued

Authors/Year	Principal findings	Discussion/conclusion
	months, being the highest in Bolivia. Moreover, they most frequently described their job as being active (42%) and highest level of distress (80%) (p.469) - Distress related to length of work, suffer workplace violence, more demanding work, passive and active jobs.	- Occupational health programs for miners should not only include prevention of occupational accidents and diseases but also should target psychosocial aspects of the work environment (p.473)
Tynan *et al.* (2017)	- (45.7%) of the males and 17.0% of the females scored above the threshold for risky or hazardous alcohol use (p.4). - Bivariate association between self-reported illicit drug use and smoking status, with a significant bivariate association between psychological distress and total AUDIT scores (p.4)	- For males, the number within the at-risk range was almost double gender matched data previously reported on an Australian community sample (24%) (p.6). - Who reported higher alcohol use significantly more likely to report higher psychological distress (p.7).
Ahmad (2017)	- The prevalence of psychological distress was significantly higher among mine workers (66%) than among members of the comparison group (34%) (p.138) - Risk factors for psychological stress among workers were seen among the 'female' sex, those with primary level of education, 'married' workers, those with a marital status of 'divorced/separated' and those suffering from occupational health problems (p.138)	- The analysis shows that female workers are at greater risk of suffering from poor mental health (p.138) - Borrowing of loans and occupational stress were associated, because the debt (p.139) - the health problems faced by the mine workers were three times more likely to be due to stress, and MSDs related with stress level as well (p.139)
Manic *et al.* (2017)	- Coal miners became more depressed with more total years of service and more years of service in the current workplace (p.49) - No significant correlations were found between burnout/age, burnout/total years of service and burnout/years of service in the current workplace, or between depression and burnout (p.49)	- Burnout syndrome in underground coal miners is at a low level and that most participants did not exhibit depressive symptoms (p.49) - Underground coal miners' proactive coping levels are very good (p.49)
Deng *et al.* (2017)	- Coal miners had higher somatization, obsessive-compulsive, depression, anxiety, hostility, phobic anxiety, paranoid ideation, and psychoticism scores than ordinary people (p.444–445) - The type of work having the most serious psychological distress was blasting, followed by blasting assistant, other work types, gas detection, coal mining, electromechanical work, carriage, digging, and water detection (p.446)	- Coal miners had mental health problems, which were serious and worrisome. With increasing working age, the psychological distress of the coal miners also intensified (p.447). - Neuroticism positively correlated with accident proneness. More serious psychological distress had higher accident proneness (p.447)
Legault *et al.* (2017)	- Subjective sleepiness differed significantly across waking times for each of a day off and night shift (p.147) - Longer TST obtained prior to commencing a night shift is correlated with slower reaction times on the PVT-B (Psychomotor vigilance task) (p.148). Working night shift, the miners reported increasing degrees of sleepiness over each of the Test Times (p.147)	- 84% of workers had overweight. Some of the miners may have undiagnosed sleep pathology such as obstructive sleep apnea (p.148) - It is likely that these day shift workers were beginning their shift with some degree of sleep deprivation. not observe any differences in reaction time across shifts or changes during an individual day shift (p.148)
Li *et al*. (2017)	- Positive emotion is significantly negative correlated with unsafe behavior, negative emotion has a significant positive correlation to unsafe behavior and life satisfaction is significantly negative correlated with unsafe behavior (p.7218) negative emotion has the greatest influence on miners' unsafe behavior, followed by life satisfaction, and positive emotion (p.7219)	- Subjective well-being has a significant impact on miners' unsafe behavior, coal mine managers should make the employees' mental health construction a top priority in the process of safety management (p.7220).
Yu *et al*. (2017)	- Night-shift miners' reaction time was on average 0.22 s longer than that of the day-shift miners. The miners working in the night shift have heavier levels of mental fatigue (p.168).	- Miners display heavier mental fatigue symptoms after their night shifts. Night-shift miners expend the same amount of physical energy as day-shift workers,

Table 2. Continued

Authors/Year	Principal findings	Discussion/conclusion
	- Night-shift miners' sleep is more easily disturbed in the daytime, which leads to poorer sleep quality in night-shift miners than that in day-shift miners. When given the choice, 86.89% of miners would prefer to work the day shift (p.169)	they will feel more tired because of the counter biological- clock schedule, which increases mental fatigue (p.170). - To recover from their fatigue, they seek compensation during their work time, day shift with "slack off" (p.171) It was associated with "safety paradox".
Firoozi chahak *et al.* (2017)	- 32.9%, 34.8%, and 35.2% of employees, respectively, suffered from depression, anxiety, and stress at moderate to severe levels (p.52) - Significant differences were observed between the subjects who worked on day shifts and those who had shift work regarding stress, depression, and anxiety (p.54)	- Inappropriate environment, lack of a stable work environment, lack of employment security, unbearable physical environment, and unfamiliarity with ways of dealing with stress are the cause of workers' high scores in stress, anxiety, and depression (P.54). Disturbance of the circadian cycle due to shift work impairs the secretion of enzymes, and this causes stress (p.55).
Rubin *et al.* (2017)	- Women who worked at Australian mine sites reported significantly less organizational and interpersonal sexism and significantly fewer mental health problems (p.6) - There was also a significant positive direct effect of organizational sexism on mental health problems when controlling for sense of belonging (p.7) - There was a significant negative total effect of organizational sexism on job satisfaction (p.8)	- Organizational sexism is similar to the construct of workplace barriers to job progression (p.8) - Older women reported lowers levels of organizational and interpersonal sexism and mental health problems and higher levels of job satisfaction (p.8). - Sense of belonging mediated the associations between organizational sexism and mental health problems and job satisfaction (p.9)
Castellucci & Altamirano (2018)	- 4 × 4 was the most appropriate shift system for workers living in City A, but it presented some drawbacks for the other cases. 6 × 6 shift system met the biopsychosocial factors. Working a night shift that forces them to recover during their free time, which affects their family and social life (p.7)	- the 7 × 7 scheme presented the higher extended blocks of days off, which are attractive for employees. However, it was discarded because it presents the higher number of consecutive night shifts that may affect the duration and quality of sleep (p.8)
Han *et al.* (2018)	- Total scores of QOL and PHC reduced more than 25 points compared with the either norm population in both underground miners and ground workers. longer job tenure for dust exposure and higher education level, miners suffered worse PHC and MHC domain (p.837)	- Underground miners had lower scores of SF-36 in RP dimension than ground workers, and job tenure for dust exposure was the main influencing factor accounting for it. Subjects had lower QOL scores, which were influenced by chronic disease, job tenure for dust exposure, education (p.839)
James *et al.* (2018)	- 44.4% of the sample reported moderate, high or very high levels of psychological distress. high/very high psychological distress declined significantly with age, ranging from 23.4% for those aged less than 25 years, to 8.3% for those aged 55 years. - Higher proportion of participants with a history of depression, anxiety or drug or alcohol problems reported high/very high levels of psychological distress compared to those who reported no history (p.7). High psychological distress was significantly associated with risky/high risk AUDIT (p.7). Shift lengths longer than 12 hours was also associated with greater odds of high distress (p.10)	- Metallurgies workers had high levels of psychological distress at higher levels when compared to a gender and age weighted sample of employed Australians (44.4% compared to 27.2% respectively) (p.11) - Younger participants, those with a history of depression, anxiety and drug or alcohol problems, those who currently drink at risky or high-risk levels, those with fewer social connections and those who reported recent use of illicit drugs were more likely to have higher K10 score (p.11)
Ramashia *et al.* (2018)	- Distress could be caused by the anticipation of pain, death, social isolation, debilitating treatment regimens and diminished quality of life (p.3). - Workers with cancer feeling scared, uncertain and angry about the unwanted changes cancer would bring into their lives (p.4)	- Mine workers are often living away from family and face the cancer journey alone without family support (p.5). - Need to ensure that information giving promotes understanding of the disease and its treatment while caring for the patient holistically (p.5)
Joaquim *et al.* (2018)	- 68.7% of workers indicated to have poor sleep quality. 96.5% did not represent scores compatible with depression. However, mild or moderate anxiety was detected in 7.1% and 5.9%	- We did not observe any correlation among the scores of depressions with time of service or any other variable linked to occupation aspects (p.5)

Table 2. Continued

Authors/Year	Principal findings	Discussion/conclusion
	(p.4). Anxiety correlated negatively with the total score of life quality and their domains, in exception to the environment domain (p.4) - Self-efficiency and hope constructs were positively correlated to all WHOQOL-bref domains and negatively to anxiety (p.5)	- Correlation between sleep and depression or psychological capital variables was not verified, there was an association between satisfaction with the health state and good sleep quality (p.6)
Li *et al*. (2019)	- 42.65% of the miners experience occupational stress. stress was higher for males than females, between the ages of 30–35 years was higher than that observed among other age groups, stress with a junior college education was higher than that of the other groups. - age, level of education, income, and ERI affect quality of life among copper-nickel miners. Older age, lower income, higher education level, and higher ERI are factors related to poorer quality of life (p.6)	- The higher the level of occupational stress, the lower the quality of life of miners, indicating that occupational stress is a risk factor that can diminish their quality of life (p.7) - Most of the work consists of manual labor, and tasks are relatively repetitive and require shift work. However, monotonous work and the labor organization system are the main sources of tension (p.7)
Pelders & Nelson (2019)	- 46.5% reported some degree of sleepiness (p.317). 43.8% of the participants were classified as fatigued. Aged 35 years or younger reported to be fatigued than those older than 35 (p.318) - Higher levels of fatigue were also reported by those that did shift work, those that worked overtime, and permanent employees, although the differences were not statistically significant (p.318) - Sleep disorders, stress, and job dissatisfaction were positively associated with fatigue. Having a medical condition, taking medication, self-reported health conditions, sick leave, and quality of life were not statistically associated with the fatigue variable (p.318)	- Subjective responses and reports of falling asleep unintentionally while at work. The factors that were significantly associated with fatigue were age, race, housing tenure status, healthiness of diet, sleep disorders, stress and job satisfaction (p.318) - None of the work-related variables were significantly associated with fatigue (p.318). - Those who reported having a sleeping disorder experienced higher levels of fatigue, likely due to inadequate restorative sleep (p.318)
Ma *et al*. (2019)	- Neuroticism was negatively correlated to extraversion, personality stability and four domains of QOL, but was positively correlated to psychoticism and sleep quality (p.199). - Personality stability was positively associated with four domains of QOL and extraversion (p.199). - Underground workers extraversion was significantly related to reduce risk of poor sleep quality by adjusting for age, gender, smoking status, alcohol consumption, consumption of tea, education, marital status, experience of work shifting, monthly income, physical activity level, energy intake, sleep duration, obesity, diabetes and MetS (p.199). - Underground workers and surface workers, neuroticism was significantly related to higher risk of poor sleep quality (p.199)	- The passive personality traits with psychoticism, neuroticism or introverted tendencies, were related to a poorer QOL (p.201) - For both surface workers and the underground workers, sleep quality partially mediated the relation between personality and QOL (p.201) - Influence of personality traits and QOL was partially mediated by sleep quality (p.202). - It is necessary for individuals with negative personality profiles to provide psychological counseling in order to improve their sleep quality and QOL (p.204)
Mościcka-Teske *et al*. (2019)	- Miners with lower stress functioned better at work – they assessed their health status and ability to work as higher than miners with higher stress (p.93) - No significant differences in work engagement between miners with low and high levels of stress (p.93). - The highly stressed miners indicated that their main motivation for working in the mine was that they had to work somewhere (p.93) - Job satisfaction among miners is strong, and multileveled-connected with the level of their occupational stress. All 7 dimensions of satisfaction were significantly differentiated by the level of stress (p.93)	- The analysis of the sources of stress showed that weak emotional commitment was most strongly associated with the stressfulness of context factors (soft factors, such as control, organizational culture, inter- personal relationships, role in organization, responsibility, career development, and home-work relations) (p.96) - Employees who perceive that other workers are highly involved are more satisfied with their job (p.96) - The respondents experienced higher levels of stress which lowered their level of job satisfaction (p.96)

Source: own elaboration (2020)

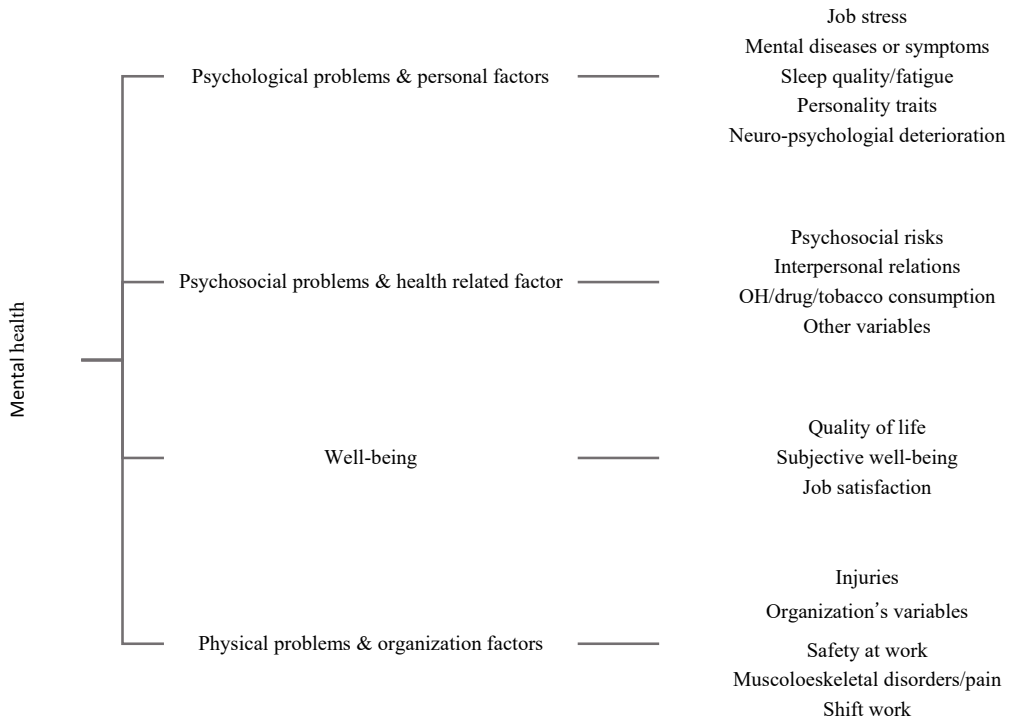

Fig. 2. Themes and variables grouped.
Source: Own elaboration.

In the first case, the average ages declared waved between 31.5 to 55+ years. In the second one, the age range was for 20 to 73 years.

Descriptive analysis about the themes

According to the former four themes (see Fig. 2), the studies that included variables above the *Psychological problems & personal factors* presented findings related to psychological symptoms and diseases, job stress, sleep quality and associated disorders, neuropsychological deterioration and personality traits. For instance, Ansoleaga & Toro[38] researched on the relation between the psychosocial risks and depressive symptoms in copper workers. They used the demand-control model of Karasek & Theorell; the effort-reward model of Siegrist and the Organizational Justice model of Moorman as theorical base into the inquiry problem construction. As well as they applied the EQCOTESST along with two questions from PRIME-MD for depressive symptoms and K6 scale for distress. Similarly, Garrido & Hunt[39] researched on the relations between job stress and other factors (e.g. work organization, depression and anxiety symptoms and well-being). They defined job stress according to Karasek and Siegrist model, but applied their own scale named *Cuestionario de Organización del Trabajo (COT)* to evaluate it. Also, they used HADS scale for assessment anxiety and depressive symptoms.

Other samples of the theme are the studies of Corral *et al.*[40], Liu & Chen[41], Manic *et al.*[42] and Joaquim *et al.*[43] The first one approached on neurological and neuropsychological deterioration due to the mercury exposure. They used the neurological examination and neuropsychological evaluation of depressive symptoms with BDI-II scale, auditive, visual memory, visoconstruction and visuoperception with REY complex figure and executive functions with WCST. The second one evaluated the depressive symptoms within the highly risky and stressful working. They assessed depressive symptoms with CES-D scale, effort-reward imbalance with ERI-OC scale, stressful working with OSI-R and other variables gauged, i.e. work characteristics and work-family. The third one focused on the evaluation of burnout with CBI scale, depressive symptoms with PHQ-9 and the proactive coping with PCI. Finally, the fourth one evaluated depressive and anxiety symptoms with BDI-II and Beck Anxiety Inventory (BAI), psychological capital with PCQ-12 scale and sleep quality with PSQI-BR.

About the sleep quality/disorders and personality traits variables, it stands out the studies of Paul[44] and Legault *et al.*[24] Paul[44] studied the role of negative personality traits, such as negative affectivity, impulsiveness, risk taking and

depression, on the injury risks, safe work behavior and job stress. They used own questionnaire with three-point Likert scales for measuring the variables of personality traits. Legault *et al.*[24] researched on cognitive impairment, sleep disorders, reaction time and executive functions related to heat conditions on shift work schedule. They used the BRIEF-A scale for measuring executive functions, actigraphy and sleep log for sleep behaviors, PVT-B for reaction time, attention and focus and core temperature for heat exposure.

About the *Psychosocial problems & health related factors* theme, the studies researched on psychosocial risks, interpersonal relations, OH/drug/tobacco consumption and other variables. For example, Amponsah *et al.*[55] and Mościcka *et al.*[76] inquired on psychosocial risks. The first one related to the physical and psychosocial risks with the worker's safety experience. Amponsah *et al.*[55] used the International Labour Organization (ILO) concept to define the psychosocial risks along with what is supported by Karasek (job demand, decision latitude and social support) and Siegrist (intrinsic effort, extrinsic effort, and reward). Finally, they used COPSOQ short version along with physical hazards scale that included following variables: mine gas, fires, excessive noise, heat stress, poor visuality and dusty conditions. Then, the study of Mościcka *et al.*[76] compared the level of psychosocial risks among industrial workers (one of these were the miners). They defined psychosocial risks supported by European Agency for Safety and Health at Work (EU-OSHA), and used the PRS scale to assess it.

Moreover, the study of Torkington *et al.*[50] investigated the impacts of FIFO (fly-in fly-out system) on interpersonal relation, specifically, the family life, relationship and partner support. They used the semiestructured interview, in order to ask about wether FIFO systems impacts their lifes and how. In a similar way, McLean[54] researched about the impact in the interpersonal relation, with the difference that they worked with resident participants (non fly-in fly-out). She used the semiestructured interview for asking about the benefits of non FIFO system.

Besides, Tynan *et al.*[62] deepens in the substance use and problems related in coal miners. They used the AUDIT Test to measure the hazardous or harmful drinking and asocciated it with the current health history, illicit drug consumption and workplace factors (such as commute type, years working in mining, employment category, etc.). Corral *et al.*[40] also centered on smoking and alcohol habits as it influences on the neuropsychological scores.

According to other variables measured in the theme, Jackson *et al.*[52] pointed out the role of adverse acculturation on well-being throughout the differences among black and white miner's experiences. They used scales for measuring the mainstream domain (i.e. mainstream segregation demands, perceived discrimination and subtle racism), ethnocultural domain (individual separation acculturation and perceived co-ethnic separation at work), psychological and socio-cultural acculturation outcomes (PSI and Work Success Scales). On another concern, McPhedran & De Leo[57] described the psychiatric characteristics and stressful life events related to the attempts and death by suicide. They used the secondary data analysis of Queensland suicide register to compare the suicide behaviors and death of miners with other occupations.

In another theme, the studies of *Well-being* approached on Quality of life (QOL), Subjective well-being and Job satisfaction. Yu *et al.*[45] defined QOL according to World Health Organization (WHO) and measured it in miners with/without pneumoconiosis. They used the WHO-QOL-BREF for that. Gow *et al.*[56] defined Health-Related QOL supported on Lorenz *et al.* They assessed the comparison of QOL in miners with/without HIV and used the AQOL (Mark 2) for HR-QOL, EQ-5D for health outcomes and HUI 3 for health status and generic health.

Meanwhile, Subjective Well-being was studied by Li *et al.*[65]. They used the concept of Tay & Diener to comprise the subjective well-being (i.e. life evaluation, positive feelings and negative feelings) and to make their own scale from it. Then, they related the subjective well-being with the unsafe behavior. Han *et al.*[70] used the QOL definition by Skevington *et al.* and Liu *et al.* and researched on the comparison in QOL values between underground/ground miners. For that, they employed the SF-36 scale.

Lastly, Job satisfaction was studied by Masia & Pienaar[49]. They related the job satisfaction with the safety compliance. Also, they used the definition of job satisfaction from Hellgren, Sjöberg and Sverke. According to this, job satisfaction is a positive emotional state based in organizational and dispositional factors. For that reason, they employed the Job Satisfaction questionnaire of Hellgren, Sjöberg and Sverke in their research.

Finally, regarding the *Physical problems and organization factor's* theme, the variables included were the following: injuries, muscoloeskeletal disorders/pain, organization's variables (e.g. organizational commitment, working characteristics, environmental conditions, management, etc.) and shift work (i.e. FIFO/DIDO, commuting time, etc.). For instance, Cui *et al.*[60] associated the individual-related factors (such as living habits, obesity, sleep distur-

bances, etc.), job-related factors (i.e. work conditions, hours of work, length of shift work, etc.) and injurie risks. Deng *et al.*[64] studied on the relationship between musculoskeletal disorders (MSDs) and personality traits, distress, and accidents proneness. They used the MSDs questionnaire, Eysenck Personality questionnaire (EPQ) and SCL-90 to assess the psychological distress. Yu *et al.*[66] related mental fatigue and cognitive bias with the safety paradox (i.e., emergent by shift work systems). They approached the phenomenon on the managers and the consequences in the management performance. The mental fatigue reduced the frequency and standard of inspection, it became dangerous for the miners due to the lack of supervision of their safety compliance. James *et al.*[71] related job stress with workplace factors (such as, employment status, current role, number of years in mining, FIFO/DIDO system, etc.) They used the K10 for measuring the distress and own questionnaire about the workplace variables (mainly occupational and workplace characteristics). Pelders & Nelson[74] assessed the commuting time related to fatigue. Despite mentioning that commuting time and fatigue could be related, the study did not find that relation.

Discussion

The purpose of this study was to describe and analyze the published scientific literature about the mental health in mine workers and to summarize the findings. For that reason, it reviewed 12 years of several literature about research on mental health in mine workers across the world. In the period analyzed, most of the articles reviewed were associated to report results about coal miners (40%), followed by copper miners (7.5%). A considerable number of reports (27.5%) didn't specified the type of mining activity.

On the other hand, the results suggesting that the scope of research centered in four themes: 1) Psychological problems & personal factors; 2) Psychosocial problems & health related factors; 3) Well-being 4) Physical problems & organization factors.

The first theme was the most highlighted. Some studies approached on symptoms and psychological-related problems. For instance, job stress, depressive symptoms, anxiety, sleep disorders were announced in the results reviewed. These findings could be related that mining is a part of the industrial sector. In this, the literature has indicated that workers can develop depressive disorders (see Tran *et al.*[77]), moderate-high job stress (see Hoboubi *et al.*[78]), significative level of anxiety (see Rao & Ramesh[79]), sleep disorders or problems related (i.e. insomnia, sleepiness, fatigue, overweight, obesity, breathing-related problem) (see Uehli *et al.*[80]).

In these studies, some findings suggested (e.g. Carlisle & Paker[58]; Loudoun *et al.*[59]; Ahmad[63]; Li *et al.*[73]) that young mine workers, marital status, monthly income or educational level is related to psychological problems. That is concordant with the study of Pavičić *et al.*[81] where they support that young workers industrial sector had more anxiety and depression compared with other. Also, the results are concordant with the following: the study of Mojtabai *et al.*[82], concluded that marital status has been related to mental health disorders, specifically divorce status; with the study of Syrén *et al.*[83] that discussed significant association between incomes and reversed depression, personality traits (i.e. extraversion and neuroticism) and psychological well-being; and the study of Niemeyer *et al.*[84], which indicated that depressive symptoms increased in groups with low educational level and lesser psychological resources. Finally, on neuropsychological deterioration by chemical exposure, the results of Corral *et al.*[40] were associated with the study of van den Bosch & Meyer[85] who mentioned that mercury exposure disturbed neurotransmission and could cause depression and increase the suicide risk.

Concerning the second theme, the articles focused on psychosocial risk at work, interpersonal relations, consumption of substances and other health-related variables. Some studies related the psychosocial risks at work with mental health problems (e.g. Ansoleaga & Toro[38]; Amponsah *et al.*[55]; Salas *et al.*[61]; Li *et al.*[73]). These enounced that high job demand/low control and security, high effort/low reward, higher work-family interference, violence at work and low social support were related to poor mental health and quality of life. This evidence is concordant with a systematic review reported by Fernandes & Pereira[86] on psychosocial risk at work. They commented high stress, high job demands, work-family conflicts, lack of role clarity, quantitative overloads deteriorated the psychological well-being (caused mood disorders, substance abuse and health-related problems, such as diabetes, headaches, etc.). As well, the evidence summarized that interpersonal problems (see Torkington *et al.*[50], Liu & Chen[41]) were related to that indicated by Street *et al.*[23] according to the low relationship between miners and with their families could be a source of stress.

Moreover, the results about consumption of substances (i.e. tobacco, alcohol and drugs) could be explained with the remark by Street & Lancey[87] and Bassiony *et al.*[88] in their study. They said that industrial workers usage of sub-

stances is common, being most prevalent in older males with smoking habits. The mining is featured by a largest presence of male workers and they are exposed to higher workload and inclement conditions (e.g. underground mining) (see Ahmad, Rahmad & Alagarajan.[89]). At the end, other variables, such as suicide risk (see Mcphedran & De Leo[57]) and cancer experiences (see Ramashia *et al.*[72]) showed the feelings and changes in mine workers to trigger suicide attempts and death, as well as the social isolation, fear, uncertainty in who is living with cancer.

Regarding to the third theme, the documents (e.g. Yu *et al.*[45]; Masia & Pienaarz[49]; McLean[54]; Gow *et al.* 2013; Li *et al.*[65]; Han *et al.*[70]) pointed out the relevance of Quality of life (QOL), Subjective Well-being and Job satisfaction in mine workers. Some literature reviews in these topics (see Bora, Saumendra & Murthy[90]; Carolan, Harris & Cavanagh *et al.*[91]; Naz & Sharma,[92]; Loon *et al.*[93]) concluded that the three variables are important to ensure the productivity. For instance, QOL contributes on positive organizational outcomes, retained skilled workers, work effectiveness, protect the mental health at work, etc. Additionally, job satisfaction increases the feeling of optimism and is an indicator of overall job wellness. Also, Well-being is useful to achieve sense of meaning and purpose and experience adequate social interactions (Bartels, Peterson & Reina[94]). All these outcomes are very important in mining because it's a very competitive sector and depends on their scale of production. The productivity is directly correlated to the mine workers[95] and is feasible to be one of reasons that the studies have approached on the three variables previously mentioned.

Finally, about the fourth theme, the articles reviewed (e.g. Wang *et al.*[47]; Paech, *et al.*[48]; Ferguson, *et al.*[51]; Carlisle & Parker[58]; Deng *et al.*[64]; Yu *et al.*[66]; James *et al.*[71]; Pelders & Nelson[74]) inquired on the relationship of mental health risk at work, physical problems and work organization problems (such as fatigue, injuries, safety environment, musculoskeletal pain/disorders (MSDs), management and organization of working day in shift work). About this, the scientific literature said the lack or deprivation of sleep caused physical fatigue (see Caldwell *et al.*[96]) increased the risk of injuries and accidents (see Garbarino *et al.*[97]). Besides, the MSDs impact in mental health outcomes (see Etuknwa, Daniels & Eib[98]), and work in longer periods and shift work are related to serious effects on sleep, time of reactions, safety behavior and mental health status (see Zhao *et al.*[99]; Brown *et al.*[100]). According to what is highlighted in the theme, is possibly argued that in the last time the literature has increased their attention in relation to physical and mental health to assess/manage the risk at work, investigated on safety culture, performance and other factors. In this point, it is also important to comment that mining is involved in an important transformation called "mining 4.0" (see Lööw *et al.*[101]). The incorporation of new technology and robotized processes entails those workers coordinate the use of their mental/physical resources to perform their tasks, and for that reason, may have been important in the reviewed studies that explored on both dimension of workers health.

Conclusion

Mining can expose to a significative part of their workers to serious mental health problems and risk at work. According to the literature reviewed, four themes emerging as relevant to manage that. Thus, psychological problems and personal factors, psychosocial problems and health-related factors, well-being and physical problems and organization factors were highlighted for controlling, improving, and promoting the mental health status and ensuring psychological wellness at mine workers. The evidence suggested that hazardous environment (e.g. risky conditions), work organization (e.g. shift work schedules), interpersonal relations (e.g. work-family conflicts), psychosocial risk at work (e.g. high job demand, job stress), well-being (e.g. quality of life, job satisfaction), substance abuse, personality traits, psychological capital, somatic and physical affection (e.g. MSDs, pain) and other variables summarized in Table 1 and Table 2 must be incorporate in the enterprises démarche, in such a way to ensure the care and promotion of mine workers' mental health.

Limitations

This review was made only with literature published in the databases descripted prior. Also, the focus was descriptive and analytic, non-explicative. Maybe a new review of the theme will help in this way. Moreover, the most of studies were conducted by quantitative methods. This could indicate some lack of studies that deepening in subjective experiences of mental health at mining work, which can preclude to know the personal's appreciations about the relation between their mental health and work performance or workplace. Finally, the most of samples in studies were males. For that, it's necessary improve the female's inclusion in the future studies, because it's fact that their incorporation to the heading significant and in the future, it will be equitable with respect to males. This could contribute to promote specific policies to care mental health at work according to gender of mine workers, avoiding the gender

bias.

Recommendations

It's necessary to make national and international policies to approach mental health in mining, and supervising their compliment, both nationally and internationally. In this sense, the policies could contain orientation to manage the risk of mental disorders and other related-affection, design instruments to vigilance and promote the mental health of mine workers and to keep a national statistics of mental health problems and related-problems. This is possible, because some countries (e.g. Chile, Perú, Australia, etc.) already have a system to guide, monitor and account for accidents in mining. These have been useful to reduce the risk of accidents. In the same way, the system could contribute to reduce the risks of chronic mental health problems along with specifics programs to promote the mental health among miners.

Finally, other variables could be included in new research on mine workers, such as suffering at work. When suffering is pathogenic, it triggers severe consequences on mental health (see Gama *et al.*[102]). This variable wasn't observed in the documents reviewed and can be relevant to contribute with evidence of it to help clarifying the problem in the sector.

Conflict of Interest

None conflict interest related with this study.

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