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Psychosocial factors related to the increasing automation of work processes: A systematic review

Raul Martinez-Balderrama [a], **Marcela Deyanira Rodríguez-Urrea** [b], **Juan Pablo García-Vázquez** [c], **Ismael Mendoza-Muñoz** [d] **and Gabriela Jacobo-Galicia** [e]

Universidad Autónoma de Baja California, Facultad de Ingeniería, [a] raul.martinez13@uabc.edu.mx, [b] marcerod@uabc.edu.mx, [c] pablo.garcia@uabc.edu.mx, [d] ismael.mendoza@uabc.edu.mx and [e] gabriela.jacobo@uabc.edu.mx.

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Abstract

Purpose: To identify which psychosocial factors can be related to the increasing automation of work processes, determining practical implications relevant to the evaluation of psychosocial risk factors at work within organizations before the imminent transition towards industry 4.0

Design/methodology/approach: A systematic review of the literature was carried out. The review structure was based on the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) approach for the studies selection and the Noblit and Hare's meta-ethnographic approach for data analysis and synthesis.

Findings: Thirty-five studies were selected which passed all the selection stages. Six psychosocial risk factors were detected whose behaviors may be influenced by the increasing automation of work. Evidence suggests that the factors of development possibility, change management, mental load, routine content, and job insecurity may increase their exposure due to job modifications owing to new automation technologies. On the other hand, social relationships at work have the ability to positively influence the successful implementation of new automated processes.

Originality/value: The results obtained represent excellent indications of an overview of psychosocial risk factors that may increase their danger due to the increasing automation of work processes and Industry 4.0.

Keywords: *Psychosocial Risks; Psychosocial Risk Factors at Work; Work Study; Industry 4.0.*

SDG08 Decent Work and Economic Growth.

Introduction

New leading automated technologies, such as cyber physical systems, the Internet of Things (IoT), artificial intelligence, machine learning, cloud computing, among others, will cause important changes in the configuration of the processes of work, a scenario known as Industry 4.0 (Tay, Lee, Hamid, & Ahmad, 2018). For instance, many organizations are working to harness these technologies through automation so they can vastly improve their production processes (Panigrahi, 2021).

These changes will in turn result in job changes within the industry. For example, Frey and Osborne (2017) found that about 47% of total employment in the United States is in the high-risk category of being automated over the next decade or two. David (2017), for his part, argues that approximately 55% of jobs in Japan are at risk of being approached by the automation of tasks in the coming years. On the other hand, Kurt (2019) points out that 59% of jobs are at risk of being affected by automation in Germany. The above results are in line with what the Organization for Economic Cooperation and Development estimated for all its members, including Latin American countries, in that approximately 57% of jobs are at risk due to work automation (Kurt, 2019). In this way, as a product of the constant changes that occur in the work environment due to Industry 4.0, the possibility arises that new psychosocial risk factors at work appear or that factors already present undergo considerable changes (Moreno Jiménez & Báez León, 2010).

However, due to the recent development of new automated technologies, research on psychosocial factors within the context of Industry 4.0 is still limited. So far, it has been possible to locate a review study that investigated the human and ergonomic factors in relation to Industry 4.0 (Kadir, Broberg, & Conceição, 2019). It reports 7 outstanding findings related to cognitive ergonomics: 1) Virtual or 3D models of the supply chain improve perception and create timely interactions between departments to solve problems. 2) Cyber physical systems introduce new forms of human-machine interaction. 3) Computer and problem-solving skills will become a necessity. 4) Augmented reality devices will contribute to the reduction of mental tension. 5) Demographic changes will create new demands for the industries of the future (training and human-machine interaction). 6) The exchange of data between departments improves cognitive ergonomics through ergonomic and performance indicators. 7) The technological forecast can identify the necessary skills from the beginning.

Thus, the research has tended to focus on detecting the positive ergonomic and human aspects-related implications of adopting the technologies emerging in Industry 4.0, rather than on which psychosocial risk factors can affect the employee’s behavior and increase the risks associated with the automation of work.

In this sense, it is considered pertinent to carry out a systematic review to answer the following research question: "What psychosocial factors are related to the increasing automation of work processes, and what are the practical implications for the assessment of psychosocial risks in the workplace before the transition to Industry 4.0?".

Method

The structure of this systematic review used two different approaches. The search strategy and the selection of the studies were based on the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyzes) checklist (Liberati et al., 2009), and for the extraction and synthesis of the data, due to the interdisciplinary nature of the review, the meta-ethnographic approach of Noblit and Hare (1988) was followed. Furthermore, it's important to mention that our systematic review is based exclusively on literature published in specific academic databases and not on external or additional sources.

Information sources and search strategy

The search was carried out from February to May 2020. It was conducted in the following databases: SCOPUS, PubMed, Elsevier and EBSCO. Then, a search string was applied with the following terms: ((automation OR Industry 4.0 OR “smart factory”) AND (psychosocial OR human OR mental) AND (factors OR risks OR effects OR health)). To ensure that all relevant research was identified, the search process was evaluated against a subset of studies previously identified as pertinent. This evaluation was conducted prior to the selection of studies.

Selection of studies

The following eligibility criteria were defined for the selection of the studies that were part of the extraction phase: 1) the articles had to explain automation or a technology thereof, as a source of modification of psychosocial risk factors in the labor or industrial context, 2) they had to analyze the influence of automation on one or more psychosocial risk factors at work, and 3) article type criteria: they had to be original research published in Journals or Conference proceedings, from 2015 onwards, in English only.

The selection of studies was divided into 3 stages: 1) elimination of duplicates, 2) title and abstract filtering, and 3) full-text analysis. This selection process was carried out by a single reviewer and validated by the rest of the co-authors of this article. All potential articles found with the search strategy were exported to Rayyan QCRI software, which was used to locate, choose, and discard the duplicate documents (Ouzzani, Hammady, Fedorowicz, & Elmagarmid, 2016).

In the filtering stage by title and abstract, these sections of the remaining articles were analyzed, taking into account the eligibility criteria. The articles that did not meet the criteria were discarded using the Rayyan software. Each rejected article was tagged with the reason for not being eligible. When the abstract and title did not provide enough information to assess the eligibility of a study, then it was not excluded. Finally, the selected documents were analyzed in full text to confirm that they met the eligibility criteria. They were also identified with a tag that highlighted the fact that they were rejected or passed the full-text filtering.

Data extraction

The data collection and analysis process was supported by the construction of a form in Microsoft Excel that identified the following elements: authors, year of publication, country of origin, objective of the study, design of the study according to its objective, design of the research, spatial context, study participants (if applicable), technologies or aspects of automation addressed, psychosocial factor (s) addressed, orientation of psychosocial factors addressed (positive or risky), type of analysis on the variables of interest, measurement of variables of interest carried out (if applicable), results and description of the relationship between the variables. Table 1 shows how some of the more complex elements are interpreted for data extraction, in order to clarify their purpose.

Table 1. Description of the elements of data extraction

Extraction elements	Description
Study design according to the research objective.	Fundamental: Studies that seek to generate new knowledge or evidence. Applied: Studies that look for developing new instruments, methods, or frameworks.
Study design according to the type of research.	Theoretical: State of the art reviews, theoretical research and conceptual frameworks. Empirical: Case studies, statistical data and experiments.
Spatial context	The spatial contexts in which the study is conducted, (to which industry or work space the study is directed), whether it is only mentioned that it is directed towards one theoretically or that it indicates that the case study was physically conducted.
Aspects of automation addressed	The aspects or technologies that were addressed in the study (IoT virtual reality, machine learning, etc.). Or if you seek to address automation or industry 4.0 as a whole.
Psychosocial factors addressed	The psychosocial factors that can be interpreted as those addressed in the study. The factors in the Cox and Griffiths classifications (Moreno Jiménez & Báez León, 2010) and the Mexican standard NOM-035-STPS-2018 (SEGOB, 2018) were taken into account as a reference, since they introduce and emphasize the most basic and general psychosocial risk factors at work.
Type of analysis performed on the variables of interest	Theoretical: Established hypotheses and theoretical assumptions without experimentation to describe possible associations between the variables of interest. Documentary: Carried out a review of the state of the art to expose possible associations between the variables of interest. Empirical: Developed an experimental or statistical case study to demonstrate possible associations between the variables of interest.

Synthesis of data

Following the meta-ethnographic approach of Noblit and Hare (1988), 3 ordered steps were followed for data synthesis: 1) Relationship between studies. It was determined how the studies are related to each other from the information gathered in the data extraction. 2) Reciprocal translation. Related information between studies was compared and combined into a single matching interpretation of the topic. Each combination was identified as a topic of interest. 3) Line of argument. A new theory or understanding was developed from the reciprocal translations of each identified topic of interest. A more detailed description of each phase of the data synthesis can be seen in Table 2.

Table 2. Phases of data synthesis according to the meta-ethnographic approach

Phases of synthesis	Description
Relationship between studies	Create a list of topics of interest, juxtaposing them and determining how they are related to each other based on the interpretations made when extracting the data.
Reciprocal translation	Compare the topics of interest extracted through the different articles included to be able to combine them in a single coincident interpretation about the topic.
Line of argument	Development of a new theory or understanding through the synthesis and interpretation of the issues identified in the literature.

To record the synthesis of the data, a spreadsheet form in Excel was also developed. First, the identified topics of interest were recorded, which in this case is the association between various psychosocial factors and the increasing automation of work. For this, in the horizontal title of the table (lines) the identified psychosocial risk factors were recorded and in the vertical title of the table (columns), the references were noted, as well as a second column with the automation aspect addressed. The intersections between these two variables consisted of the interpretations of each topic of interest. Each psychosocial factor consisted of a different topic of interest. Table 3 shows the proposal for this first phase of data synthesis, detailing the information that the table should contain.

Table 3. First phase of data synthesis

Reference (Authors and year of publication)	Automation aspect addresed	Psychosocial factors related to the increasing automation of work		
		Psychosocial factor 1	Psychosocial factor 2	Psychosocial factor 3
Authors 1	Aspect 1	Interpretations of the topic of interest 1.1	Interpretations of the topic of interest 2.1	Interpretations of the topic of interest 3.1
Authors 2	Aspect 2	Interpretations of the topic of interest 1.2	Interpretations of the topic of interest 2.2	Interpretations of the topic of interest 3.2
Authors 3	Aspect 3	Interpretations of the topic of interest 1.3	Interpretations of the topic of interest 2.3	Interpretations of the topic of interest 3.3

Once the first stage was completed, the reciprocal translation and the line of argument of each topic of interest were displayed in the next lines of the table in Excel. Table 4 shows the information pertaining to the three phases of data synthesis.

Table 4. Proposal for the follow-up of the three stages of data synthesis

1st Phase: relationship between studies	Individual interpretations of the topic of interest 1	Individual interpretations of the topic of interest 2	Individual interpretations of the topic of interest 3
2nd Phase: Reciprocal translation	General interpretation of the topic of interest 1	General interpretation of the topic of interest 2	General interpretation of the topic of interest 3
3rd Phase: Line of argument	Hypothesis developed from reciprocal translation 1	Hypothesis developed from reciprocal translation 2	Hypothesis developed from reciprocal translation 3

Results

Search and selection of studies

The database search yielded a total of 646 studies. After removing duplicate articles, 588 articles remained. As a result of the title and abstract filtering stage, 135 articles were kept. Subsequently, in the full text filtering stage, 35 articles were selected for data extraction. Figure 1 shows the flow diagram that expresses the selection of the studies.

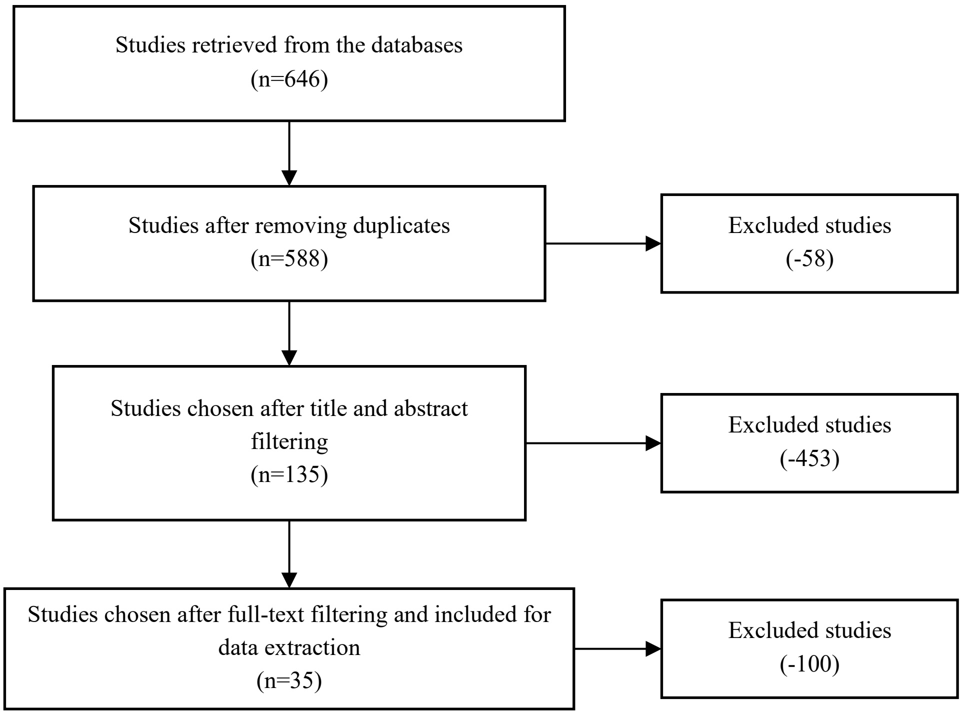

Figure 1. Flow diagram of the studies selection process

Data extraction

Following the elements proposed for data extraction, different results were obtained in relation to the included studies. Regarding the type of article, of the 35 selected articles, 28 were journal articles and 7 were conference articles. Regarding the research objective of the studies, 54% of the studies had a fundamental objective (19/35), that is, they sought to generate new knowledge or evidence. For example, Kaczmarek investigated the effect of different work dynamics on the success of operational workers development (Kaczmarek, 2019). In contrast, 43% of the studies had an applied objective (15/35), that is, they sought to develop new instruments, methods or frameworks. For instance, Perez et al., who sought to design a symbiotic process, where industrial robots could work collaboratively with human operators, and not isolated from them (Pérez et al., 2020). It should be noted that one study raised both objectives. Sanchez et al., who analyze the effects of digitization and robotization processes in the future work for fundamental purposes, but then propose a technological design strategy for digital integration, based on the collaborative use of new technologies and the human factor (Sánchez, 2019). These results can be seen in Figure 2.

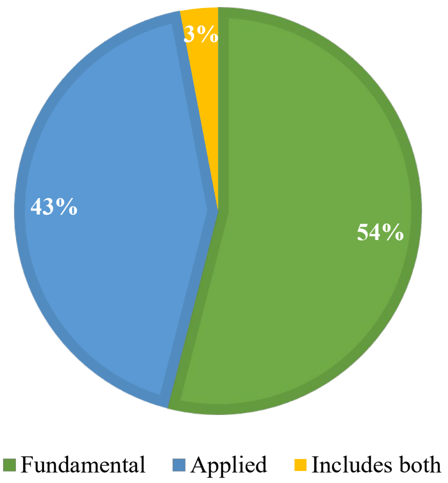

Figure 2. Type of study according to its research objective

Likewise, concerning the methodology used, it was found that 29% of the studies are theoretical (10/35), while 71% of the studies are empirical (25/35). See Figure 3 for these findings.

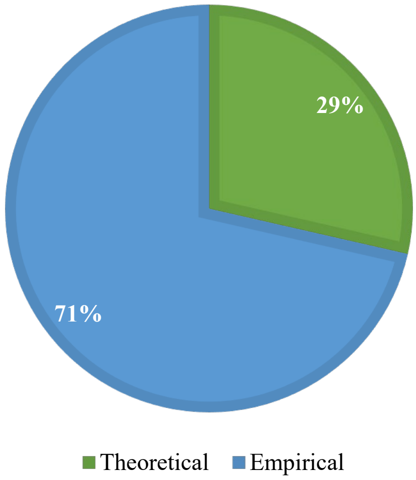

Figura 3. Type of study according to its research method

However, the research objectives of the studies were not necessarily similar to the analysis sought on the variables of interest for this systematic review. For this reason, it has been specifically identified how this analysis has taken place in each study. In this sense, it was found that 8% of the studies developed a theoretical analysis on the variables of interest (3/35). In contrast, 26% of the studies performed an empirical analysis (9/35). Finally, 66% of the studies carried out a documentary analysis on the variables of interest (23/35). Look at this distribution in Figure 4.

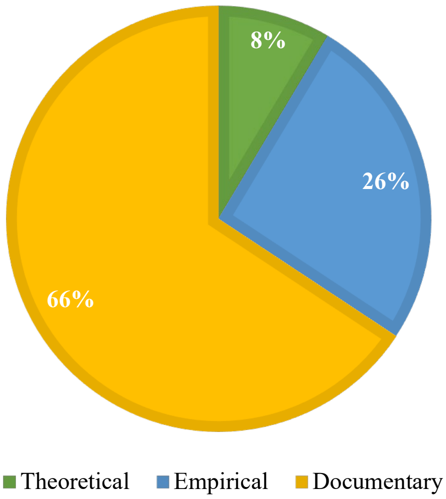

Figure 4. Type of research on the variables of interest

Having established the above, a total of 11 psychosocial factors were detected that could be associated with the increasing automation of work: 1) change management, 2) development of skills and knowledge, 3) work control, 4) routine workload, 5) mental load, 6) job insecurity, 7) social relationships at work, 8) clarity of functions, 9) confidence in technology, 10) situational awareness and 11) leadership. Table 5 shows the selected studies, their type, and their authors, as well as the psychosocial factors that they addressed in their studies.

Table 5. Psychosocial factors addressed in each study

Reference	Psychosocial factors addressed by the study	Type of study according to its research objective	Type of study according to its research method	Type of research on the variables of interest
Siemienuich et al., 2015	Change adaptation, Skills development, Confidence in technology	Fundamental	Theoretical	Documental
Avila, 2015	Skills development, Social relationships at work	Applied	Experimental	Documental
Joe et al., 2015	Social relationships at work, Clarity of functions, Leadership	Fundamental	Theoretical	Documental
Lee et al., 2015	Skills development, Situational awareness	Applied	Experimental	Empirical
Golightly et al., 2016	Skills development, Mental workload	Fundamental	Theoretical	Documental
Peruzzini & Pellicciari, 2017	Change adaptation, Skills development	Applied	Experimental	Documental
Pacaux-Lemoine et al., 2017	Mental workload, Social relationships at work	Applied	Experimental	Documental
Longo et al., 2017	Change adaptation	Applied	Experimental	Documental
Wixted y O'Sullivan, 2017	Mental workload	Fundamental	Experimental	Documental
Patel et al., 2018	Job insecurity	Fundamental	Experimental	Empirical

Kazancoglu et al., 2018	Change adaptation, Skills development, Job routine content, Social relationships at work	Applied	Experimental	Empirical
Gershwin, 2018	Change adaptation, Skills development	Fundamental	Theoretical	Theoretical
Segura et al., 2018	Skills development	Fundamental	Theoretical	Documental
Mattsson et al., 2018	Skills development, Job routine content	Applied	Theoretical	Documental
Hogenboom et al., 2018	Skills development, Mental workload, Situational awareness	Applied	Experimental	Documental
D'Addona et al., 2018	Skills development, Mental workload, Job insecurity, Clarity of functions	Applied	Experimental	Documental
van der Kleij et al., 2018	Situational awareness	Fundamental	Experimental	Documental
Korner et al., 2018	Skills development, Situational awareness	Fundamental	Experimental	Empirical
Perez et al., 2019	Change adaptation, Skills development, Job routine content	Applied	Experimental	Empirical
Kaczmarek, 2019	Change adaptation, Skills development	Fundamental	Theoretical	Documental
Ramzi et al., 2019	Change adaptation, Skills development, Leadership	Applied	Experimental	Theoretical
Longo et al., 2019	Skills development	Applied	Experimental	Empirical
Stachova et al., 2019	Skills development	Fundamental	Experimental	Documental
Lahera Sanchez, 2019	Change adaptation, Skills development, Job insecurity	Fundamental/Applied	Theoretical	Documental
Micheler et al., 2019	Change adaptation, Skills development	Fundamental	Experimental	Empirical

Bogataj et al., 2019	Change adaptation	Applied	Experimental	Documental
Nam, 2019	Job routine content, Job insecurity	Fundamental	Experimental	Documental
Pacaux-Lemoine & Trentesaux, 2019	Skills development, Social relationships at work	Applied	Theoretical	Documental
Kopacek, 2019	Change adaptation, Skills development	Fundamental	Theoretical	Documental
Cimini et al., 2019	Job control, Confidence in technology	Fundamental	Experimental	Documental
Schuffler et al., 2020	Change adaptation, Skills development, Job routine content	Fundamental	Experimental	Theoretical
Sarwono y Bernarto, 2020	Change adaptation, Leadership	Fundamental	Experimental	Empirical
Kadir & Broberg, 2020	Change adaptation, Skills development, Mental workload, Job insecurity, Social relationships at work, Clarity of functions	Fundamental	Experimental	Empirical
Ansari, Hold y Khobreh, 2020	Skills development	Applied	Experimental	Documental
Kim et al., 2020	Confidence in technology	Fundamental	Experimental	Documental

As can be seen in Figure 5, of the 35 articles selected for data extraction, 24 articles addressed the development of skills and knowledge, 15 articles about change management, 6 studies dealt with mental workload, 6 studies addressed social relations at work, 5 studies argued about the routine content of work, 5 articles discussed job insecurity, 4 studies talked about situational awareness, the factors clarity of functions, confidence in technology and leadership were addressed in 3 articles each, and only 1 study mentioned job control as such. Figure 5 shows the frequency with which these psychosocial risk factors were addressed in the selected articles.

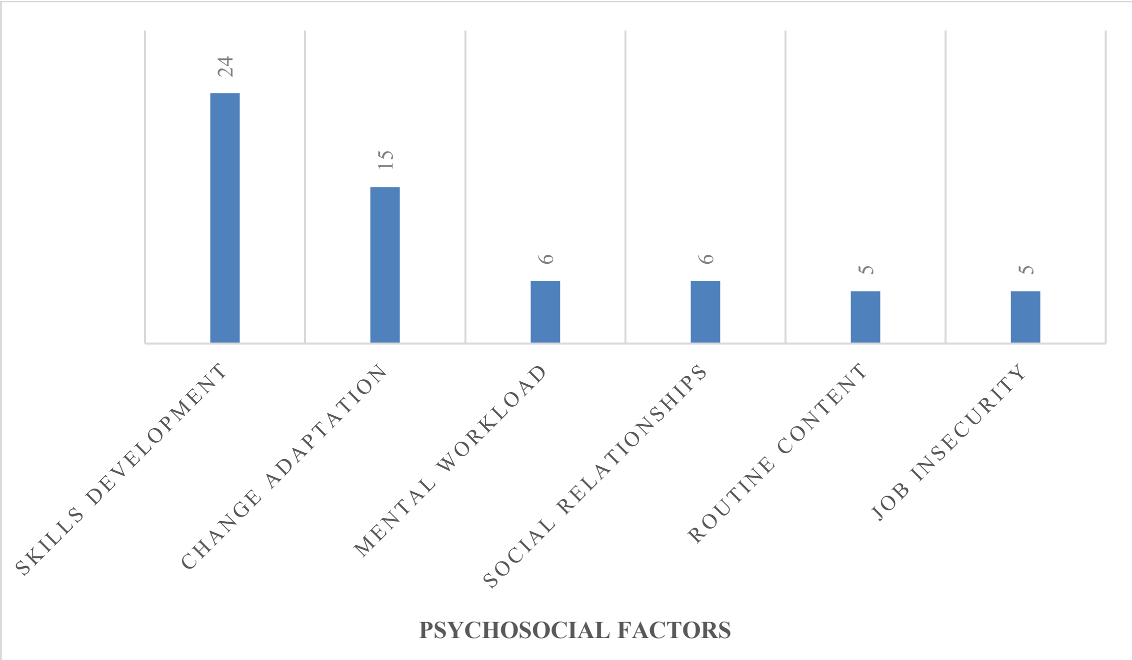

Figure 5. Psychosocial factors most frequently addressed in the literature

Data synthesis

Despite having collected information on 11 psychosocial factors, only those factors that were addressed in at least 5 studies were considered for the synthesis of the data, since factors with less evidence (4 or less) were not considered sufficient to conclude significant hypotheses. In this sense, sufficient evidence was found on 6 psychosocial factors. These factors were: 1) skills development, 2) change adaptation, 3) mental load, 4) social relationships, 5) routine content and 6) job insecurity. Once the list with these 6 elements was exposed, the evidence found from each study was displayed, corresponding to each of the 6 topics of interest. Table 6 shows the synthesized information resulting from one of the studies, in which useful information was identified in 3 of the 6 topics of interest.

Table 6. Fragment of the results of the first phase of data synthesis

Authors and publication year	Automation aspect addressed	Psychosocial factors related to the increasing work automation					
		Development of skills	Change adaptation	Mental load	Social relationships	Routine content	Job insecurity
(Pérez et al., 2019).	Semi-automation of a manufacturing process using robots.	Factors such as fear and uncertainty of operation are accentuated if the operator is a beginner.	Changes in the processes by semi-automation can cause fear and uncertainty of operation.			Operators felt greater ease and confidence to carry out the routine task with the help of the semi-automated operation.	

Subsequently, we proceeded to build the reciprocal translation and the line of argument for each topic of interest. Table 7 presents the results of these phases of the data synthesis. It is necessary to point out that the information extracted on the factors: 1) situational awareness, 2) clarity of functions, 3) confidence in technology, 4) leadership and 5) job control, was not included in the results of the second and third stage of data synthesis, because it was not considered as sufficient evidence to present significant lines of argument.

Table 7. Results of the second and third phases of data synthesis

Phase 1: relationships between studies	Topic 1: Skill development and job automation (Ansari et al., 2020; Ávila, 2015; D'Addona et al., 2018; Gershwin, 2018; Golightly et al., 2016; Hogenboom et al., 2018; Kaczmarek, 2019; Kadir & Broberg, 2020; Kazancoglu & Ozkan-Ozen, 2018; Kopacek, 2019; Körner et al., 2019; Lee et al., 2015; Longo et al., 2019; Mattsson et al., 2018; Micheler et al., 2019; Pacaux-Lemoine & Trentesaux, 2019; Pérez et al., 2019; Peruzzini & Pellicciari, 2017; Ramzi et al., 2019; Sánchez, 2019;	Topic 2: Change adaptation and work automation (Bogataj et al., 2019; Gershwin, 2018; Kaczmarek, 2019; Kadir & Broberg, 2020; Kazancoglu & Ozkan-Ozen, 2018; Kopacek, 2019; Longo et al., 2017; Micheler et al., 2019; Pérez et al., 2019; Peruzzini & Pellicciari, 2017; Ramzi et al., 2019; Sánchez, 2019; Sarwono & Bernarto, 2020; Schüffler et al., 2020; Siemieniuch et al., 2015).	Topic 3: Mental load and work automation (D'Addona et al., 2018; Golightly et al., 2016; Hogenboom et al., 2018; Kadir & Broberg, 2020; Pacaux-Lemoine et al., 2017; Wixted & O' Sullivan, 2017).	Topic 4: Social relationships and work automation (Ávila, 2015; Joe et al., 2015; Kadir & Broberg, 2020; Kazancoglu & Ozkan-Ozen, 2018; Pacaux-Lemoine & Trentesaux, 2019; Pacaux-Lemoine et al., 2017).	Topic 5: Routine job content and work automation (Kazancoglu & Ozkan-Ozen, 2018; Mattsson et al., 2018; Nam, 2019; Pérez et al., 2019; Schüffler et al., 2020).	Topic 6: Job insecurity and work automation (D'Addona et al., 2018; Kadir & Broberg, 2020; Nam, 2019; Patel et al., 2018; Sánchez, 2019).

	Schüffler et al., 2020; Segura et al., 2018; Siemieniuch et al., 2015; Stachová et al., 2019).					
Phase 2: Reciprocal translation	Need for opportunities for workers to acquire new knowledge and skills that allow them to adequately handle the new job demands that automated processes will bring with them.	Workers can be overwhelmed if they are unable to adapt to the various changes that may arise in their work due to the new work processes that automated processes will bring with them.	Drastic changes in mental workload can arise from periods with very low workload and then periods with high and uninterrupted workload, which in turn can cause uncertainty in the worker.	The existence of Good interdisciplinary work and good teamwork can be beneficial for the adaptation and good performance of employees towards new automated processes.	Specifically, while the implementation of new technologies can help the worker to counteract routine workloads, the worker will be forced to adapt his skills to more complex work processes.	The use of new technologies can cause workers to feel job insecurity for fear of being fired and replaced by these new technologies.
Phase 3: Lines of arguments	The possibility of development and training is a psychosocial factor of risk that could affect the workers who are involved in an increasing automation of work.	The change adaptation is a psychosocial factor at risk that could be affected by the increasing automation of work.	The mental workload is a psychosocial factor at risk that could be disturbed by the increasing automation of work, depending on the state of the process.	Social relationships at work will be a psychosocial factor that will influence the successful implementation of the increasing automation of work.	Routine job content is a psychosocial factor of risk that will be affected by increasing job automation.	Job insecurity is a psychosocial factor at risk that will be affected by the increasing automation of work.

Effects related to health

The results obtained also discussed about the negative effects psychosocial risk factors could bring to workers health. In Table 8, a summary of the health effects addressed in the reviewed papers is presented. As can be seen, the five risk factors under study are related to work stress, five factors are linked to anxiety, one to cardio-respiratory capacity, and a last one to musculoskeletal disorder.

Table 8. Health effects related to the studied psychosocial risk factors

Psychosocial risk factor	Health effects
Skill development	**Work Stress:** Avila (2015), Peruzzini & Pellicciari (2017), Mattsson et al. (2018), Hogenboom et al. (2018), D'Addona et al. (2018), Korner et al. (2018), Perez et al. (2019), Kadir & Broberg (2020), Ansari, Hold y Khobreh (2020)
	Anxiety: Korner et al. (2018), Lahera Sanchez (2019), Kadir & Broberg (2020)
Change adaptation	**Work Stress:** Peruzzini & Pellicciari (2017), Perez et al. (2019), Kadir & Broberg (2020)
	Anxiety: Lahera Sanchez (2019), Kadir & Broberg (2020)
	Cardio-respiratory capacity: Peruzzini & Pellicciari (2017),
Mental workload	**Work Stress:** Pacaux-Lemoine et al. (2017), Hogenboom et al. (2018), D'Addona et al. (2018), Kadir & Broberg (2020)
	Anxiety: Kadir & Broberg (2020)
	Musculoskeletal disorder: Wixted y O'Sullivan (2017)
Social relationships	**Work Stress:** Avila (2015), Pacaux-Lemoine et al. (2017), Kadir & Broberg (2020)
	Anxiety: Joe et al. (2015), Kadir & Broberg (2020)
Routine job content	**Work Stress:** Mattsson et al. (2018), Perez et al. (2019)
Job insecurity	**Work Stress:** D'Addona et al. (2018), Kadir & Broberg (2020)
	Anxiety: Patel et al. (2018), Lahera Sanchez (2019), Kadir & Broberg (2020)
	Depression: Patel et al. (2018)

Discussion

According to the results obtained, it is argued that six psychosocial factors can be associated with the increasing automation of work and Industry 4.0. These are: 1) skills and knowledge development, 2) change adaptation or management, 3) mental load of work, 4) social relationships, 5) routine content of work and 6) job insecurity.

Regarding the interpreted associations between the six psychosocial factors and increasing automation, the evidence suggests that the factors development of skills, change adaptation, mental load, routine content, and job insecurity may present an ascending behavior of psychosocial risk concerning modifications at work due to automation. In other words, the psychosocial risk generated by exposure to these factors may be increased due to the increasing automation of work. On the other hand, regarding the labor relations factor, the evidence reviewed suggests that having good social relations at work can positively influence the successful implementation of new automated work processes.

The results of this review coincide with the findings of Kadir et al. (2019), who affirm that by implementing the various technologies of Industry 4.0 and the development of process automation, the worker will be forced to go through a process of adaptation and management of the changes produced for being exposed to increasing automation, and that, later, the need will arise for the worker to be open to the possibility of training and obtaining new skills and knowledge to deal with technological change.

Likewise, the evidence collected on the factors related to situational awareness, clarity of functions, trust in technology, leadership, and control of work was limited to establish meaningful lines of argument, since only four or fewer studies addressed these factors. However, this does not necessarily mean that these factors are not related to the increasing automation of work, it was simply considered that the evidence was not sufficient to develop strong lines of argument. Thus, it would be interesting to develop evidence in the future regarding the factors that contributed little information to this review study, to discuss with greater significance the possible relationship of these factors with the increasing automation of work. In this same sense, developing empirical evidence on the psychosocial risk factors that are affected by the automation of work will serve to reinforce or contradict the hypothesis that was determined in this systematic review.

Limitations

There were several limitations to this systematic review. The first is the interdisciplinary nature of the selected studies. This limits the heterogeneity of the studies included in the review. The outcome observations were highly variable among the studies. In this sense, it wasn't possible to perform a meta-analysis in this systematic review, like they typically do in other scientific disciplines.

Also, is important to reiterate that the data extraction and synthesis among the studies was carried out using the Noblit & Hare (1988) approach for qualitative studies, which is based on the interpretation of the authors.

Practical implications

It is considered that the results obtained represent excellent indications of an overview of the psychosocial risk factors that may be associated with the increasing automation of processes and the new technologies of Industry 4.0, as well as the nature of these associations. Also, it is recognized that this psychosocial risk factors produce negative effects in the worker's health such as work stress, anxiety, depression and physical problems like cardiovascular and musculoskeletal diseases. That said, it is recommended that organizations in transition from being automated collect the understandings resulting from this systematic review, paying special attention to these psychosocial risk factors within their psychosocial risk management activities, to be prepared for any negative consequences that these factors can provoke in the well-being and satisfaction of workers, and thus avoid setbacks caused by these reasons, in the successful implementation of the automation of work processes and Industry 4.0.

Conclusion

In summary, the results of this systematic review showed that the psychosocial risk factors at work that may be most affected by the growing automation of processes are: 1) skill development, 2) change adaptation or management, 3) mental workload, 4) social relationships at work, 5) routine job content and 6) job insecurity. These findings emphasize to stakeholders to focus on these specific psychosocial factors of risk in their health and security risk management systems specially when their organizations are in transition of new and automated processes.

Conflict of interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Author Contributions

RMB and MDRU Conceptualization; RMB and JPGV Formal analysis; RMB, GJG and IMM Research; RMB, MDRU and JPGV Methodology; MDRU and JPGV Supervision; RMB, MDRU and JPGV Writing - original draft; RMB, GJG and IMM Writing - review & editing.

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