

Analysis Of Mental Fatigue In Productivity

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Abstract

This paper presents an in-depth literature review on the research topic "Mental Fatigue and Productivity Worldwide". The exploration was carried out in the bibliographic database Scopus and a set of 106 research papers were obtained, including articles, book chapters, books, conferences, and abstracts, from the years 1967 to 2023, the main objective was to find information on transient characteristics and research trends within the field of study. Using the Biblioshiny web interface of the Bibliometrix package of the statistical program Rstudio, the file was processed in csv format downloaded from the Scopus metasearch engine, resulting in the following information: Scientific articles are those that are presented in a greater percentage (83%), the year 2021 was the one that had the most contributions with 15 works, one of the journals that had the most impact in the research area was International Journal of Industrial Ergonomics, and one of the authors with the highest H index was Carneiro D. with an indicator of 4 points, together with Novais P. Regarding the analysis presented in the word cloud, the terms "mental fatigue",

"fatigue" and "productivity" are the most relevant in the field of study.

Keywords: mental fatigue, productivity, bibliometrics .

Introduction

Business competitiveness is a phenomenon of constant development at the international level, which product of globalization has caused the entry of more and more actors and competitors seeking to achieve their positioning within the market, where geographical location becomes a secondary factor to take into consideration when making any commercial transaction (Ccanto et al., 2019; Muñoz, Lombeida & Mosquera, 2021).

This reality invites organizations to have the processes and products with the greatest competitive potential, so they can take advantage of the situation, aiming not to get immersed in a loss of their market fraction (Ballesteros, Parra & Aguayo, 2020). This context then creates within organizations a high level of demand towards their workers, who must support the fulfillment of the objectives that allow companies to stay afloat in this increasingly complex environment (López & Sisa, 2020).

This situation, if not addressed in an effective way within the organizations can cause in them various illnesses of a work nature such as exhaustion, Burn-out or mental fatigue (Avecillas Cazho et al., 2021). Mental fatigue is currently positioned as one of the most common ailments of the work context, affecting a good fraction of workers worldwide (Cruz, 2020; Villacís et al., 2021)

This mental fatigue could lead to much stronger suffering in the worker, which may result in effects of greater impact on the health of this (Tran et al., 2020; Xing et al., 2020). Similarly, at the organizational level, this can lead to an increase in absenteeism and turnover rates, At the same time to encourage the appearance of problems in the company associated with the work environment, mobbing, among others (Parra et al., 2020; Cho, & Steege, 2021).

From this, it is that companies today not only set the goal of achieving great productivity indicators within the organization, but also seek to achieve a positive environment for their workers; so that this type of affectations can be prevented and a positive work

environment is achieved that in turn results in the engagement of highly effective personnel in the company (Mendoza-Ocasal et al., 2021; Torrents Arévalo, Vilajosana Crusells, & Cignitas, 2022).

Such is the impact of these indicators of well-being in companies that currently when assessing the level of organizations, indicators such as subjective well-being or worker satisfaction are also reviewed (Espasandín-Bustelo et al., 2021). Diverse academic literature attributes to the relationship between good work environments and productivity indices (Kazimoto, 2016; Muthuveloo, Keat & Teoh, 2022). This becomes much more relevant when recognizing that it is increasingly complex to attract high-level personnel and skills, reason why the generation of positive workspaces allows to promote the attraction and retention of such personnel, resulting in greater productivity and competitive capacity (Kaur et al., 2019; Mendoza-Ocasal et al., 2022).

This context is highly recognized by the academic field which has placed its magnifying glass on the generation of new knowledge that allows identifying the interaction between mental fatigue of workers and productivity, so that they can be used both by the academy itself, as well as by companies and the State who act and formulate strategies based on these scientific facts. With this process identified, it is considered essential to understand the trends in the scientific context related to these variables, as are mental fatigue and productivity. For this reason, the present study is formulated in order to characterize the scientific literature in depth on the research topic Mental fatigue and productivity worldwide.

Methodology

Bibliometric analysis is a tool for analyzing publication databases in order to identify trends, patterns, and important information related to specific fields of research (Glänzel 2012), taken from Lima, Stefan, Thomas, & Murillo-García (2022). On the other hand, Pérez et al. (2003) differentiate between descriptive and evaluative bibliometrics. Descriptive bibliometrics explains in a general way the information produced, analyzing, in addition, its content; while the evaluative measures the impact that the properties of the publication may have from a scientific and social point of view (Niebles-Nunez, Ramirez & Garcia-Tirado, 2022). This technique has had an increasing use in the last decade (Garcia-Samper et al., 2022); and for this reason, it is used in this work to carry out a descriptive

exploration of the literature on the theme "Mental fatigue and productivity worldwide".

This research is of the descriptive type since it consists of reviewing, identifying, and ordering the information collected through the reading of the published works of different authors in different online databases; and longitudinal since it presents the evolution of scientific production throughout the period studied (Hernández Sampieri, Fernández Collado, & Baptista Lucio, 2010). Taken from (García, Rivera, & Ramírez, 2014).

To achieve the best results in information retrieval, the keywords, and terms to be used were first determined, then search strategies such as the use of logical operators were applied. "AND" and "OR", It was then filtered by the English languages, the search equation that reflects what is described above presents below: (TITLE-ABS-KEY ("mental fatigue") OR TITLE-ABS-KEY ("mental overwork") OR TITLE-ABS-KEY ("brain fatigue") OR TITLE-ABS-KEY ("mental burden") OR TITLE-ABS-KEY ("brain decay") AND TITLE-ABS-KEY (productivity)) AND (LIMIT-TO (LANGUAGE , "English") OR LIMIT-TO (LANGUAGE , "Spanish")). There was a total of 106 research papers retrieved between articles, books, book chapters and abstracts.

The documents found were then downloaded from the Scopus metasearch engine in a file in csv format, which was analyzed with the statistical program Rstudio Cloud, which allowed to generate the tables, graphs, and maps of co-citation networks between authors, documents, and sources. For the creation of the bar charts, the Excel program was used.

Table 1. Descriptives

Description	Results
MAIN INFORMATION ABOUT DATA	
Timespan	1967:2023
Sources (Journals, Books, etc)	88
Documents	106
Annual Growth Rate %	3,25
Document Average Age	11,8
Average citations per doc	26,31
References	3681
DOCUMENT CONTENTS	

Keywords Plus (ID)	1080
Author's Keywords (DE)	305

AUTHORS

Authors	358
Authors of single-authored docs	14

AUTHORS COLLABORATION

Single-authored docs	14
Co-Authors per Doc	3,89
International co-authorships %	17,92

DOCUMENT TYPES

Article	74
book chapter	3
conference paper	25
conference review	1
Review	3

The exploration of the literature carried out in the Scopus metasearch engine on the research topic Mental fatigue and productivity worldwide, It shows that a total of 106 documents were recovered in the period of time from 1967 to 2023, the central information indicates that there are 358 authors who study the subject, some individually and others collectively, the average number of citations per document is approximately 26.31, most of the types of documents found were, Articles 74 and Conference Paper 25.

Results

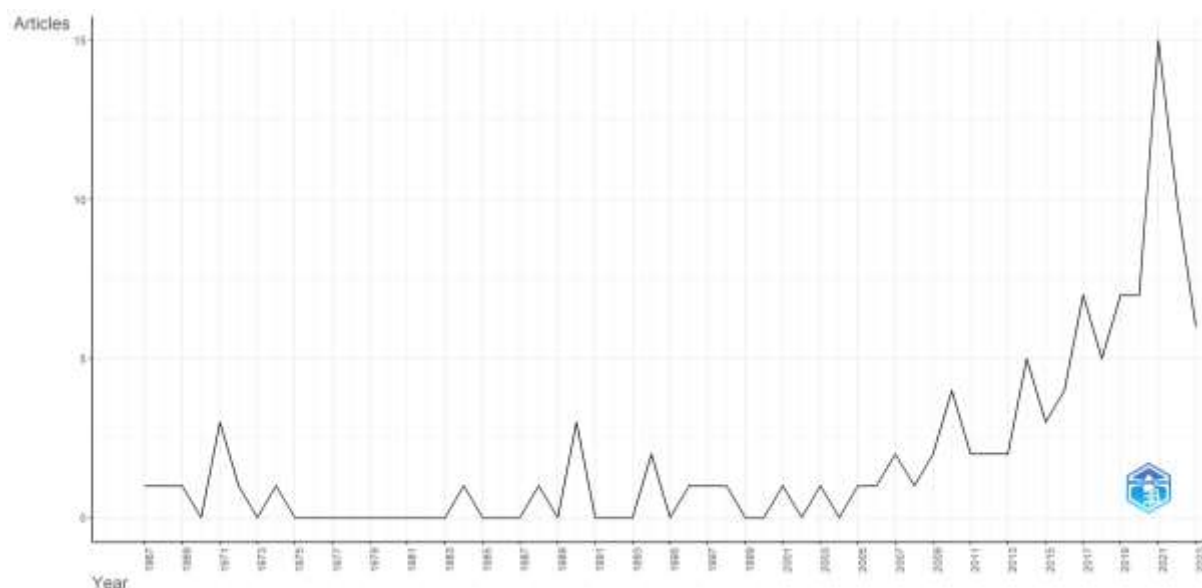


Figure 1. Annual Production Annual.

According to the search period, it can be evidenced that the number of publications in the field of study from 1967 to 2006 did not have a great interest on the part of researchers, maintaining a low trend in its production. In contrast, from the years 2007 to 2023 an increase in productivity can be visualized, highlighting the year 2021 with 15 publications as can be seen in figure 1. Of this, the work in which it is indicated: "Historically, the risks associated with fatigue that builds up during work shifts have been managed through work-time arrangements that specify fixed maximum work shift durations and minimum leisure-time durations. By themselves, such arrangements are not sufficient to curb the performance, safety and health risks caused by misalignment between work schedules and the biological regulation of wakefulness and sleep. Science-based approaches to determining shift length and mitigating associated risks, while addressing operational needs, require the following: (1) a recognition of the factors that contribute to fatigue and the risks related to fatigue; (2) an understanding of evidence-based countermeasures that can reduce fatigue and/or fatigue-related risks; and (3) an informed approach to selecting specific workplace strategies for managing work hours. We propose a set of guiding principles to help stakeholders design a shift duration decision-making process that effectively balances the need to meet operational demands with the need to manage fatigue-related risks." (Gurubhagavatula, et al, 2021).

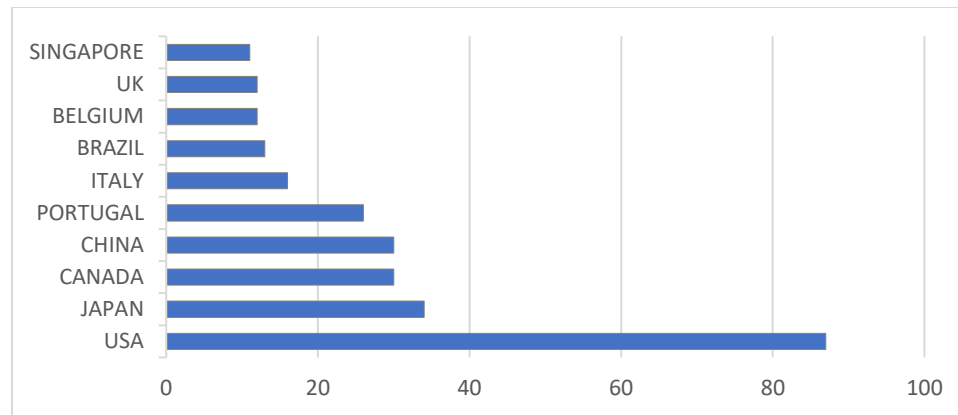


Figure 2. Most relevant countries.

The study topic "Mental fatigue and productivity worldwide" has as main research countries the USA, Japan, Canada, and China, this can be evidenced by graph 2 that shows the top 10 of the most productive regions. Of these, the article that argues that "Chronic pain (CP) lasts more than 3 months, causing prolonged physical and mental burdens to patients. According to the U.S. Centers for Disease Control and Prevention, PC contributes to more than \$500 billion annually in direct medical costs plus associated lost productivity. CP is complex in etiology and can occur anywhere in the body, making it difficult to treat and manage. There is a pressing need for research to better summarize the common health issues faced by consumers living with CP and their experience in accessing painkillers or over-the-counter therapeutic devices. Modern online shopping platforms offer a wide range of opportunities for secondary use of consumer-generated data in PC research. In this study, we conducted an exploratory data mining study that looked at Amazon product reviews related to CP. Descriptive analyses characterized the language of the review, the products reviewed, the representative topics, and the network of comorbidities mentioned in the reviews. The results indicated that most reviews were concise but rich in terms of representing the various health problems faced by people with CP. Despite the noise in online reviews, we see potential in leveraging data to capture certain consumer-reported results or to identify shortcomings of available products." (Fan, Wang, Huang, Liu, & Hooten, 2023).

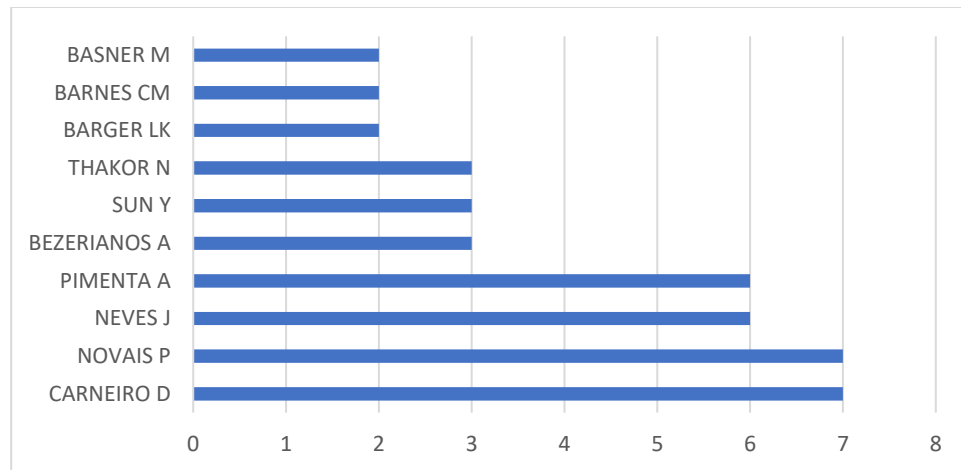


Figure 3. Most relevant authors.

The ten most representative researchers of the study area are presented in figure 3 of these stand out Carneiro D. and Novais P., with 7 works contributed each, their most representative work indicates that “Mental fatigue is a concern for a variety of reasons, including its negative impact on productivity and overall quality of life. An individual's maximum work capacity and performance, whether physical or mental, usually also decreases as the day progresses. The loss of these abilities is associated with the appearance of fatigue, which is particularly visible in long and demanding tasks or repetitive jobs. However, good management of working time and effort invested in each task, as well as the effect of breaks at work can result in better performance and better mental health, delaying the effects of fatigue. This paper proposes a model and a prototype to detect and monitor fatigue, based on behavioral biometrics (Keystroke Dynamics and Mouse Dynamics). Using this approach, the aim is to develop context-aware leisure and work environments that can improve quality of life and individual performance, as well as productivity in organizations” (Pimenta, Carneiro, Neves, & Novais, 2016).

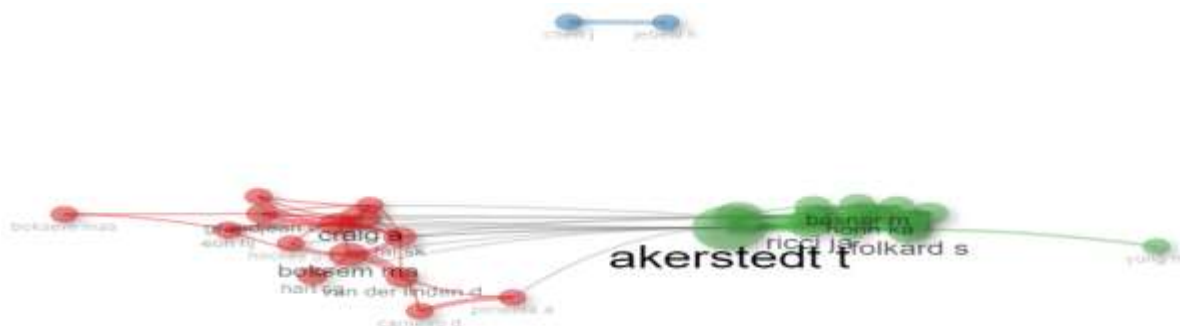


Figure 4. Co-citation of authors.

Figure 4 indicates that in terms of cocitation between authors, three clusters were identified, each cluster indicates that its members share the same line of research. The most representative researchers of the red cluster are: Klimesch W., Sun Y., Pimenta A. and Craig A. The most outstanding of the green cluster are: Akerstedt T., Toker P., Ricci J.A., and Folkard S. and finally those who are part of the blue cluster, which only make it up, Chen J. and Jebelli H.

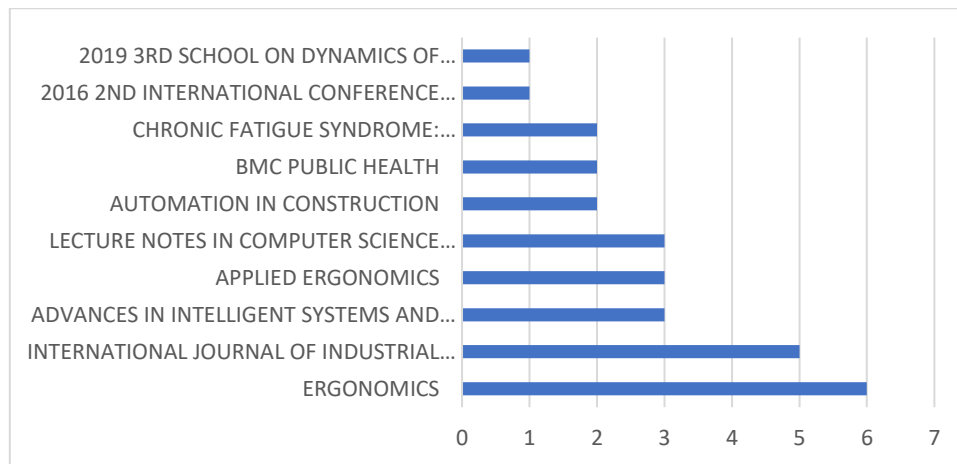


Figure 5. Most relevant journals.

According to the authors, Ottaviani Aalmo, Spinelli, Magagnotti, & Visser (2023) "Many forestry roles have changed from being manual tasks with a high physical workload to being a machine operator task with a high mental workload. Automation can support a decrease in mental fatigue by eliminating tasks that are repetitive and monotonous for operators. Cable chipping presents an ideal opportunity for early adoption of automation technology, specifically the movement of the cart along a defined corridor. A Valentini V-850 cable was used in an Italian harvest environment, to measure the ergonomic benefit of cart control automation. The study showed that automating yard cart movements improved the ergonomic situation of workers directly involved in related primary tasks. However, the caveat is that improving one job task can negatively affect the other job tasks and therefore introducing automation on a job site should be done after considering all system-wide impacts. Pro Summary: automation decreased winch operator's mental workload while improving overall productivity. At the same time, the mental and physiological workload of the

operator in charge of bending the whirlwind increased slightly. Ideally, winch automation should be combined with mechanization to balance intervention and increase both operator well-being and productivity". The research work cited above is one of the most representative of those published in the top 10 of the journals with the most contributions presented in Figure 5. Of these stand out "Ergonomics" and "International Journal of Industrial Ergonomics".

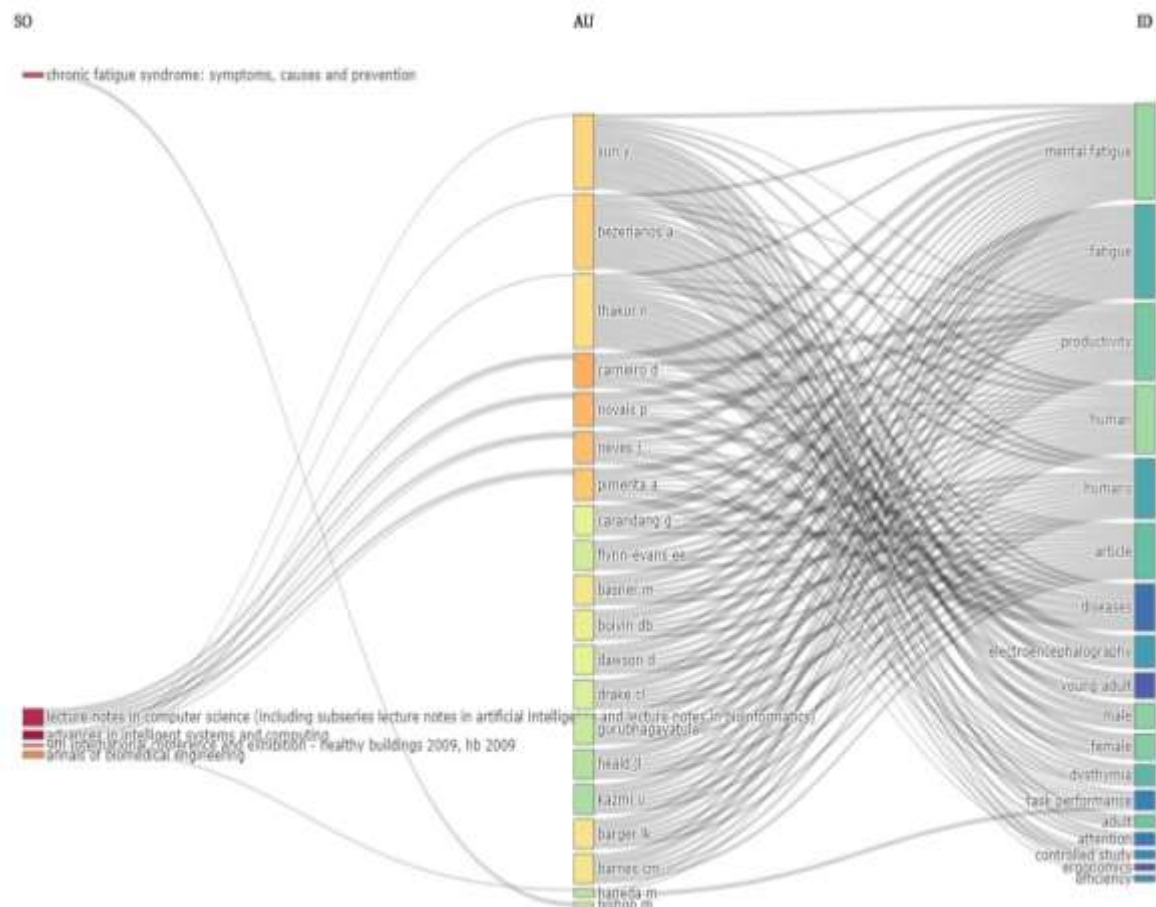


Figure 6. Relationship between sources, authors, and keywords plus fields.

Figure 6 shows the relationship between the journals, the authors and the keywords found in the bibliometric study, in which it can be seen that the main search terms "Mental fatigue" and "Productivity" are related in greater number to the researchers Carneiro D., Novais P., Neves J. and Pimenta A., and that these in turn are related to the journal Lecture notes in computer science. Research work indicate that "In our day-to-day lives, we often experience a feeling of tiredness due to mental or physical workload. Along with that,

there's also a sense of degrading performance, even after completing simple tasks. However, these mental states are often not consciously felt or ignored. This is an attitude that can result in human error, failure and can lead to potential health problems along with a decrease in quality of life. Acute mental fatigue states can be detected by closely monitoring certain indicators, such as productivity, performance, and health indicators. In this article, we propose a model and prototype to detect and monitor acute fatigue, based on non-invasive human-computer interaction (HCI). This approach will allow the development of better work environments, with impact on the quality of life and the work produced" (Pimenta A. et al, 2014). This means that the authors Carneiro D., Novais P., Neves J. and Pimenta A., have as a line of study mental fatigue and productivity and that their works are published in the journal Lecture notes in computer science.

Table 2. Most cited documents.

Papers	Doi	Citations
JOB V, 2010, PSYCHOL SCI	10.1177/0956797610384745	633
FOLKARD S, 2003, OCCUP MED	10.1093/occmed/kqg047	554
ARYAL A, 2017, AUTOM CONSTR	10.1016/j.autcon.2017.03.003	179
MURATA A, 2005, INT J IND ERGON	10.1016/j.ergon.2004.12.003	106
OKOGBAA OG, 1994, APPL ERGON	10.1016/0003-6870(94)90054-X	88
COLQUHOUN WP, 1968, ERGONOMICS	10.1080/00140136808931006	82
MEIJMAN TF, 1997, INT J IND ERGON	10.1016/S0169-8141(96)00029-7	76
TANABE S-I, 2007, HVAC R RES	10.1080/10789669.2007.10390975	67
KONZ S, 1998, INT J IND ERGON	10.1016/S0169-8141(97)00069-3	67
BEAULIEU-BONNEAU S, 2012, SLEEP MED	10.1016/j.sleep.2012.02.010	57
SMITH NC, 2001, J SPORTS SCI	10.1080/02640410152006090	55
ARTHI V, 2018, J DEV ECON	10.1016/j.jdeveco.2017.10.005	53
CHAROENSUKMONGKOL P, 2016, J HEALTH PSYCHOL	10.1177/1359105315569096	53
CHENG B, 2022, IEEE TRANS COMPUTAT SOC SYST	10.1109/TCSS.2022.3158585	52
SUN Y, 2014, ANN BIOMED ENG	10.1007/s10439-014-1059-8	44
DASARI D, 2017, FRONT NEUROSCI	10.3389/fnins.2017.00297	43
PIMENTA A, 2013, LECT NOTES COMPUT SCI	10.1007/978-3-642-40846-5_23	41
ETTEMA JH, 1971, ERGONOMICS	10.1080/00140137108931232	41
ZHANG C, 2010, POL J MED PHYS ENG	10.2478/v10013-010-0007-7	37
NELSON TM, 1984, ERGONOMICS	10.1080/00140138408963466	28

Table 2 shows the list of the 20 documents with the most citations, of which the work of Job, Dweck, & Walton (2010) is highlighted, indicating that “Much recent research suggests that willpower, the ability to exercise self-control, it is a limited resource that is depleted after effort. We propose that whether or not burnout takes place depends on a person's belief about whether willpower is a limited resource. Study 1 found that individual differences in secular theories about willpower moderated the effects of ego depletion: people who viewed self-control capacity as unlimited did not show decreased self-control after an experience of burnout. Study 2 replicated the effect, manipulating secular theories about willpower. Study 3 addressed questions about the mechanism underlying the effect. Study 4, a longitudinal field study, found that willpower theories predict change in eating behavior, procrastination, and self-regulatory goal striving under circumstances of burnout. Taken together, the findings suggest that reduced self-control after a grueling task or during demanding periods may reflect people's beliefs about the availability of willpower rather than true resource depletion”. This work has 633 citations and is followed by the study of Folkard, S. of the year 2003 published in the journal "Occupational medicine" that has obtained 554 citations.



Purple cluster: it is made up of research such as, Akerstedt T., et al. 2014, Alger S.E., et al. 2019, Alghamdi M.G. 2016, and Arlinghaus A., et al. 2019, to mention the most relevant.

Blue cluster: made up of jobs such as Pimienta A. 2013, and Akerstedt T. 2004.

Green cluster: Integrated by the documents of, Aaron I.A. 2001, Beland Y. 2000, and Bombardier C.H. 1996.

Red cluster: Hart S.G. and Lorist M. 2000, are the two works found in this group.



Figure 8. Author's keyword cloud.

When analyzing Figure 8 of the author's keyword cloud, it can be inferred that the search carried out yielded good results in terms of research papers that deal with the subject of study, because the main terms "Mental fatigue", "Fatigue" and "Productivity" occur more frequently and for that reason stand out more than the words that are around them.

Conclusions.

On the analysis of the literature applied to the study area "Mental fatigue and productivity worldwide", It can be concluded that it is a topic little explored worldwide, although an increase in research production was observed in the last 5 years, being the United States the country with the most contributions in the area with 87 works contributed, followed by Japan with 34, Canada and China with 30 participations.

With respect to the analysis of key words of the authors, it can be concluded that there is a high frequency of key terms related to the subject of study, the most repeated are "Mental fatigue" (24), "Fatigue" (15) and "Productivity" (10).

It is also concluded that the authors Carneiro D., Novais P., Neves J. and Pimenta A. besides being the most relevant in contributions, are the ones that are most related to the key terms and that the journal that publishes the most on the subject is Lecture notes in computer science.

Finally, it can also be concluded that the exploration of the literature carried out in the metasearch engine Scopus, yielded good results, due to being an area of great interest for researchers in recent years

and that I present a clear line of research related to the variables mental fatigue and productivity.

The above revealed allows us to understand the great impact and relevance of issues related to the mental health of the worker with productivity within organizations, where the various managers begin to propose a strategic framework that allows creating safe and healthy work environments that invite the permanence of highly trained personnel and that they can maintain a balance between high productivity and quality of life both inside and outside the work context in a work-free time balance.

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