COGNITIVE ERGONOMICS OF TELEWORK

A ERGONOMIA COGNITIVA DO TELETRABALHO

LA ERGONOMÍA COGNITIVA DEL TELETRABAJO

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ABSTRACT

The growth of telework, especially in the home office modality, has expanded labor flexibility and facilitated the balance between professional and personal life; however, it has also intensified ergonomic challenges that affect health, well-being, and productivity. In this context, cognitive ergonomics plays a central role, since remote work tends to increase mental demands related to multitasking, continuous use of digital technologies, the need for constant attention, and decision-making in highly demanding intellectual environments. Furthermore, the absence of clear boundaries between working time and personal time contributes to the intensification of mental workload, increasing the risk of cognitive fatigue, chronic stress, and burnout syndrome, with impacts on concentration, working memory, and performance. The literature highlights that the systematic analysis of cognitive risks in telework can be strengthened by specific tools for measuring perceived mental workload, enabling the identification of critical overload points and guiding preventive interventions. Strategies such as adjustments in task distribution and intensity, the establishment of breaks, implementation of institutional support policies, and work reorganization are fundamental to reducing occupational stress and promoting greater efficiency. Thus, the structured application of cognitive ergonomics to telework simultaneously contributes to the preservation of mental health and to the improvement of work quality and productivity.

Keywords: Telework. Cognitive Ergonomics. Mental Workload. Mental Fatigue. Burnout.

RESUMO

O crescimento do teletrabalho, especialmente na modalidade home office, ampliou a flexibilidade laboral e favoreceu a conciliação entre a vida profissional e a pessoal; contudo, também intensificou desafios ergonômicos que afetam a saúde, o bem-estar e a produtividade. Nesse contexto, a ergonomia cognitiva assume papel central, uma vez que o trabalho remoto tende a aumentar as demandas mentais relacionadas à multitarefa, ao uso contínuo de tecnologias digitais, à necessidade de atenção constante e à tomada de decisões em ambientes de elevada exigência intelectual. Além disso, a ausência de fronteiras claras entre o tempo de trabalho e o tempo pessoal contribui para a intensificação da carga mental, elevando o risco de fadiga cognitiva, estresse crônico e síndrome de burnout, com impactos na concentração, na memória de trabalho e no desempenho. A

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literatura destaca que a análise sistemática dos riscos cognitivos no teletrabalho pode ser fortalecida por ferramentas específicas de mensuração da carga mental percebida, permitindo a identificação de pontos críticos de sobrecarga e a orientação de intervenções preventivas. Estratégias como ajustes na distribuição e na intensidade das tarefas, definição de pausas, implementação de políticas institucionais de suporte e reorganização do trabalho mostram-se fundamentais para reduzir o estresse ocupacional e promover maior eficiência. Assim, a aplicação estruturada da ergonomia cognitiva ao teletrabalho contribui simultaneamente para a preservação da saúde mental e para a melhoria da qualidade e da produtividade do trabalho.

Palavras-chave: Teletrabalho. Ergonomia Cognitiva. Carga Mental. Fadiga Mental. Burnout.

RESUMEN

El crecimiento del teletrabajo, especialmente en la modalidad de trabajo en casa, ha ampliado la flexibilidad laboral y ha favorecido la conciliación entre la vida profesional y personal; sin embargo, también ha intensificado los desafíos ergonómicos que afectan la salud, el bienestar y la productividad. En este contexto, la ergonomía cognitiva asume un papel central, ya que el trabajo remoto tiende a aumentar las demandas mentales relacionadas con la multitarea, el uso continuo de tecnologías digitales, la necesidad de atención constante y la toma de decisiones en entornos de alta exigencia intelectual. Además, la ausencia de límites claros entre el tiempo de trabajo y el tiempo personal contribuye a la intensificación de la carga mental, elevando el riesgo de fatiga cognitiva, estrés crónico y síndrome de burnout, con impactos en la concentración, la memoria de trabajo y el desempeño. La literatura destaca que el análisis sistemático de los riesgos cognitivos en el teletrabajo puede fortalecerse mediante herramientas específicas para medir la carga mental percibida, permitiendo la identificación de puntos críticos de sobrecarga y orientando intervenciones preventivas. Estrategias como ajustes en la distribución e intensidad de las tareas, la definición de pausas, la implementación de políticas institucionales de apoyo y la reorganización del trabajo se muestran fundamentales para reducir el estrés ocupacional y promover una mayor eficiencia. Así, la aplicación estructurada de la ergonomía cognitiva al teletrabajo contribuye simultáneamente a la preservación de la salud mental y a la mejora de la calidad y la productividad del trabajo.

Palabras clave: Teletrabajo. Ergonomía Cognitiva. Carga Mental. Fatiga Mental. Burnout.

1 INTRODUCTION

Teleworking has consolidated itself as a predominant work modality after the COVID-19 pandemic, significantly transforming the organization of professional activities and the health and well-being conditions of workers. Although this model offers benefits, such as greater flexibility in schedules, reduced commuting, and the possibility of reconciling personal and professional life, it has also highlighted relevant challenges, especially with regard to the ergonomic conditions of domestic workstations and the organizational support offered by institutions (ILO, 2020; WANG *et al.,* 2021). In addition, these conditions are not homogeneously distributed, reflecting socioeconomic and gender inequalities related to access to adequate furniture, equipment, infrastructure, and institutional guidelines (OAKMAN *et al.,* 2020; KOSSEK; LEE, 2011; OECD, 2021).

In this scenario, ergonomics, as a field aimed at adapting work to human characteristics, assumes a strategic role in promoting safe, healthy and productive work environments. In the context of the home office, ergonomic challenges encompass physical, cognitive, and organizational dimensions. While the physical aspects include inadequacies in furniture, posture, lighting, and equipment, associated with increased discomfort and musculoskeletal disorders, the organizational aspects involve work intensification, pressure for results, time management, communication, institutional support, and balance between professional and personal demands (DUL, 2012; CARDOSO; GONTIJO, 2012; GALVÃO et al., 2020; BRITO; SILVA, 2022).

However, according to the authors, it is noteworthy that the cognitive dimension has become particularly critical, since telework often intensifies exposure to multitasking, constant interaction with digital technologies, high demand for attention and complex decision-making under time pressure, increasing mental overload and psychosocial risks.

Highly demanding cognitive work environments can lead to mental fatigue, increased errors, reduced performance, and compromised mental health, especially when associated with the absence of adequate recovery strategies and breaks (WICKENS, 2008; SILVA et al., 2020; GALE; SMITH, 2021). In the long term, this scenario can contribute to the development of Burnout syndrome, characterized by emotional exhaustion, depersonalization, and reduced professional fulfillment, with direct impacts on well-being and productivity (MASLACH; LEITER, 2016). Thus, cognitive ergonomics emerges as an essential field for the planning and redesign of tasks, systems, and forms of work organization, with the aim of reducing mental overload and favoring healthier working conditions.

The assessment of cognitive load in teleworking can be strengthened by specific instruments, such as NASA-TLX (*Task Load Index*), a validated tool that allows measuring the subjective perception of mental effort, workload, and stress, supporting evidence-based ergonomic interventions (HART; STAVELAND, 1988).

In this context, this study conducts a literature review with the objective of mapping and analyzing evidence and interventions in cognitive ergonomics applied to telework, with an emphasis on the prevention of mental fatigue, occupational stress and Burnout, as well as the promotion of mental health and performance in remote work.

2 LITERATURE REVIEW

2.1 TELEWORK: CONCEPTS AND REGULATORY FRAMEWORKS

Telework is characterized by carrying out work activities outside the employer's physical premises, with the maintenance of the organizational bond and professional interactions through information and communication technologies (ICTs). In this sense, the distinctive element of telework in relation to remote work is the centrality of the use of ICTs as a support for communication, coordination and control of activities (GODOY, 2019). Gajendran and Harrison (2007) define telework as an extension of the organization beyond its physical borders, in which workers perform functions far from the central location, remaining connected to the organization through technological tools.

In Brazil, the Consolidation of Labor Laws (CLT) establishes, in its article 75-B, that telework corresponds to the provision of services predominantly outside the employer's premises, through the use of ICTs, provided that such condition is not characterized as external work. The legal regulation of telework was also influenced by previous normative frameworks, such as Law No. 12,551/2011, which equated the work performed at the employer's establishment to that performed at the worker's home or at a distance, provided that an employment relationship is configured (BRASIL, 2011).

Subsequently, Law No. 13,467/2017 incorporated telework into the text of the CLT and included provisions related to the guidance of workers to prevent accidents and diseases resulting from work activity. However, it is noteworthy that the legislation does not detail mechanisms for evaluating, monitoring, and controlling the effectiveness of these guidelines, which represents a challenge for the systematic prevention of occupational diseases in the remote context (GODOY, 2019).

The literature points out that the expansion of telework requires adaptations in the organization of work and in the management of working conditions, considering not only structural and technological aspects, but also broad ergonomic implications, involving

physical and cognitive dimensions. Authors such as Barros e Silva (2020) and Eurofound (2020) highlight that, without adequate reorganization of remote work, there is a greater propensity for an increase in occupational illnesses and impairments in performance.

2.2 THE ERGONOMICS OF TELEWORKING

Telework, especially in the home office modality, often occurs in domestic environments that were not planned for work purposes, which favors improvisations in the workplace and inadequacies related to furniture, lighting, and equipment. Such conditions increase the risk of discomfort and musculoskeletal disorders, especially Repetitive Strain Injuries (RSI) and Work-Related Musculoskeletal Disorders (WMSD), which are among the main occupational health problems in Brazil.

Data from the Ministry of Health indicate a significant increase in RSI/WMSD records between 2007 and 2016, with a growth of 184% in the period analyzed (BRASIL, 2019). In addition, information from the Special Secretariat for Social Security and Labor indicates that, in 2019 alone, approximately 39 thousand workers were on leave due to injuries related to this type of illness (FUNDACENTRO, 2020). In addition, the Labor Prosecutor's Office points out that social security expenses with accident expenses have exceeded R$ 100 billion since 2012, with RSI/WMSD being the most frequent injuries among Brazilian workers. This scenario reinforces the need for structured preventive strategies and the implementation of ergonomic practices applied to remote work, in order to reduce physical risks and improve general working conditions.

Although the physical impacts are widely recognized, recent literature shows that the challenges of telework are not restricted to the biomechanical dimension, but must systematically incorporate the analysis of psychosocial and cognitive factors, particularly related to the increase in mental demands, the intensification of work and the continuous use of digital technologies.

2.3 COGNITIVE ERGONOMICS

Cognitive ergonomics is a branch of ergonomics focused on the study of the mental processes involved in the execution of work and in the interaction between the worker, the systems and the work environment. It includes the analysis of attention, perception, working memory, decision-making and mental load, elements directly associated with occupational performance, safety and health (WICKENS, 2008). Mattos (2011) adds that the cognitive focus of ergonomics is directed to tasks that require information processing and mobilization of the worker's mental capacity.

Smith (2006) points out that cognitive factors encompass mental activities that influence work performance and interfere with psychomotor, perceptual and sensory skills, as well as processes such as motivation, learning, memory, communication, problem solving, decision-making and group work dynamics. Thus, cognitive ergonomics focuses simultaneously on the individual, the work system, and the mental demands imposed by the task. Considering that the human capacity to process information is limited, the excess of cognitive demands tends to increase the probability of mental overload, with consequent reduction in performance and greater risk of human failures and errors (MATTOS, 2011).

Historically, research in ergonomics has begun to emphasize systems in which sensory and decision-making aspects predominate, recognizing that the quality of performance depends on the way the worker perceives, processes and uses information in the work environment. Thus, cognitive ergonomics has become essential for the design of more efficient, safe work systems that are compatible with human cognitive capacities (IIDA, 2005).

In the context of telecommuting, these fundamentals become particularly relevant, as remote work tends to intensify the use of ICTs, increase interruptions and simultaneous demands (multitasking), and reduce clear boundaries between personal and professional life. These elements increase the mental load and can trigger cognitive fatigue, stress, and reduced performance efficiency. Recent studies indicate that the application of cognitive ergonomics principles in high-demand environments contributes to stress reduction, performance improvement, and increased occupational safety (GALE; SMITH, 2021; SILVA *et al.,* 2020). Thus, interventions aimed at reorganizing tasks, managing mental demands, and the appropriate design of remote work systems are relevant strategies to prevent mental overload and promote health and productivity in telework.

2.4 COGNITIVE ASPECTS OF TELEWORKING

Cognitive ergonomics examines the relationship between the worker's mental capacities and the demands imposed by the tasks, covering processes such as attention, memory, perception, decision-making and mental load (CARDOSO; GONTIJO, 2012).

According to the authors, in the context of telework, these demands tend to intensify due to the absence of well-defined boundaries between professional and personal life, the continuous use of digital technologies, and the need for self-management of time and activities.

According to Galvão et al. (2020), mental overload is among the main risks associated with remote work, and can trigger cognitive fatigue, stress and *Burnout* when there are no

adequate measures for the organization of work. This condition is corroborated by Maslach and Leiter (2017), when they point out that the combination of high cognitive demand and low perception of control is a determining factor for professional burnout.

In addition, Moreno et al. (2011) emphasize that cognitive ergonomics interventions — such as scheduled breaks, time management strategies, control of excess information and delimitation of boundaries between home and work — are essential for the preservation of psychological well-being in the home office.

Thus, cognitive ergonomics applied to telework should be understood as a strategic component of occupational health promotion, contributing to the organization of remote work favoring not only productivity, but also reducing the risks of mental illness.

2.5 COGNITIVE ERGONOMIC RISKS

Cognitive ergonomic risks refer to working conditions capable of overloading the worker's mental processes, affecting functions such as attention, memory, perception, decision-making and problem solving (SMITH; MARRAS; KARWOWSKY, 2006). These requirements become especially relevant in activities that demand intense information processing, simultaneous decisions and continuous attention, circumstances that increase the occurrence of human errors, incidents and drop in performance (MATTOS, 2011).

Cognitive ergonomics seeks to understand and evaluate the interaction between the individual and the work system, identifying elements that favor mental fatigue, stress, and cognitive exhaustion. Among the factors most frequently associated with this type of risk are: high mental demand, time pressure, multitasking, informational complexity, unclear instructions and low predictability of activities (IIDA, 2005). Prolonged stay in contexts with such characteristics can trigger negative health impacts, such as occupational stress, burnout syndrome, sleep disorders, and impairments in cognitive function, in addition to compromising productivity and safety at work (SILVA et al., 2020).

2.6 STRESS

According to Iida (2005), stress is among the main problems associated with contemporary work, often related to rigid performance requirements, interpersonal conflicts, competitiveness and high workloads. From this perspective, changes in the emotional state can occur when there is an imbalance between the demands imposed by work and the resources available to face them, favoring the emergence of stress (MATTOS, 2011). Due to its relevance, the theme has been widely incorporated into organizational management practices, and programs aimed at the identification and systematic reduction of stressors

have shown significant results, with an estimated return of up to five times the investment made (IIDA, 2005).

On the physiological level, the initial response to stress involves the action of the pituitary gland, which stimulates organs and glands such as the thyroid, pancreas, liver, and adrenals. These, in turn, release adrenaline in large quantities into the bloodstream, accelerating cardiac activity. The hormones released cause cardiovascular changes that increase blood flow, at the same time that there is constriction of the peripheral circulation, with the purpose of optimizing blood distribution, raising blood pressure (IIDA, 2005).

Repeated and continuous exposure to this response pattern can favor the development of hypertension, increased cardiovascular risk, gastric ulcers, and respiratory infections. Stress also has repercussions on the central nervous system, and can trigger emotional disorders. Symptoms such as anxiety and depression are commonly observed in individuals subjected to highly stressful environments, and in some cases, the use of alcohol, tobacco, or other substances may occur as an attempt at relief (IIDA, 2005).

Also according to Iida (2005), stress can be triggered by multiple factors, including the content and complexity of the work, feeling of incapacity, physical conditions of the environment, organizational elements and economic pressures. These components have a cumulative effect and tend to affect individuals who already have personal vulnerabilities more intensely.

2.7 STRESS PREVENTION

Occupational stress is recognized as a relevant risk factor for physical and mental health, with repercussions on productivity, safety and quality of life of workers (IIDA, 2005; MATTOS, 2011). From an ergonomic perspective, preventing stress implies analyzing and reorganizing the work environment, tasks, and organizational processes, in order to reduce stressors and promote a better balance between demands and available resources.

Grandjean (2018) highlights that preventive strategies must include organizational and individual interventions. At the organizational level, it is recommended to reduce excessive loads and establish goals compatible with the actual ability to execute. The planning of breaks and shifts, ensuring time for physical and mental recovery, as well as the improvement of the design of the workstation (furniture, lighting, temperature and noise), contribute to reducing occupational tension. Added to this is the need for clarity in attributions and responsibilities, reducing ambiguities and interpersonal conflicts, as well as training and qualification actions to deal with pressure, simultaneous demands and multitasking contexts.

At the individual level, time management strategies and prioritization of activities can be adopted, with the potential to reduce cognitive overload. Relaxation techniques and *Mindfulness*, useful for controlling anxiety and reducing mental fatigue, as well as promoting healthy habits, including regular physical exercise, balanced diet and adequate sleep (MATTOS, 2011; SMITH; MARRAS; KARWOWSKY, 2006). In general, organizational programs structured for stress prevention demonstrate a high cost-benefit ratio, with an estimated return of up to five times the amount invested, evidencing the importance of institutional policies aimed at mental health and ergonomics at work (IIDA, 2005).

2.8 MENTAL FATIGUE

Fatigue can be understood as a consequence of prolonged performance of work activities, resulting in a temporary and reversible reduction in the body's functional capacity and a qualitative deterioration in performance. It is a multifactorial phenomenon, whose effects tend to accumulate over time (IIDA, 2005).

In this sense, mental fatigue refers to the decrease in cognitive performance resulting from prolonged exposure to complex tasks or the continuous execution of multiple simultaneous activities. Among its effects, reduced attention, memory lapses, increased frequency of errors, irritability, and decreased performance stand out (HART; STAVELAND, 1988). Environments characterized by high intellectual demand are more likely to generate cognitive overload, with direct impacts on mental health and well-being (SILVA et al., 2020).

The signs of mental fatigue usually manifest themselves in a diffuse way, not limited to a specific place in the body, but involving a general feeling of tiredness, greater irritability, disinterest, and increased sensitivity to external stimuli, such as hunger, cold, or postural discomfort. This condition can be related to factors such as monotony, motivation, general health conditions, and quality of social interactions. Iida (2005) points out that, in the face of high cognitive demands, mental blockages or lapses become more frequent, which intensify with the worsening of fatigue, also increasing the probability of errors.

Finally, the author emphasizes that fatigue is one of the most relevant factors for the reduction of productivity, and should be monitored by management, preferably through preventive actions (IIDA, 2005).

2.9 PREVENTION OF MENTAL FATIGUE

In the field of ergonomics, preventing mental fatigue requires an articulated set of measures. From the perspective of work organization, it is recommended to implement regular and scheduled breaks, favoring cognitive recovery and avoiding the accumulation of

mental load (GRANDJEAN, 2018). Task switching (*job rotation*) is also indicated, as it reduces monotony and avoids overload concentrated in certain functions (MATTOS, 2011). In addition, realistic and well-defined goals contribute to reducing excessive pressure and the need for constant multitasking, reducing the likelihood of stress and exhaustion (IIDA, 2005).

Regarding the ergonomic design of systems, the adequacy of the human-machine interface is highlighted, with the elimination of redundant, ambiguous or excessive information that increases the cognitive load (IIDA, 2005). It is also recommended to use mental load monitoring tools, such as NASA-TLX, which allow the identification of critical points of overload and guide adjustments in the work system (HART; STAVELAND, 1988; GALE; SMITH, 2021). Improved environmental conditions (lighting, temperature, noise, and furniture) also reduces additional factors of mental fatigue (GRANDJEAN, 2018).

At the individual level, interventions include training in time management and prioritization of activities, avoiding overload due to the accumulation of demands (MATTOS, 2011). The promotion of healthy habits — such as adequate sleep, regular physical activity, and a balanced diet — contributes to greater cognitive resilience (SMITH; MARRAS; KARWOWSKY, 2006). Relaxation techniques and *Mindfulness* they are also recommended for favoring attentional recovery and reducing the effects of prolonged mental effort (GALE; SMITH, 2021). Thus, the prevention of mental fatigue should be understood as a multifactorial approach, integrating organizational, environmental, and individual measures to reconcile cognitive demands and human processing limits.

2.10 BURNOUT

When mental fatigue is maintained for long periods and is not adequately managed, it can progress to Burnout syndrome, an occupational disorder characterized by emotional exhaustion, depersonalization, and reduced professional fulfillment (MASLACH; LEITER, 2016).

The concept of Burnout was initially presented by Freudenberger in 1974 to describe the loss of satisfaction and pleasure at work, associated with the absence of stimuli, decreased emotional energy, and consequent exhaustion (MATSUZAKI et al., 2020). Subsequently, Maslach, Schaufeli and Leiter (2001) expanded this conception by defining Burnout as a response to chronic stressors, especially of an interpersonal and emotional nature, experienced in the work environment (PATRÍCIO et al., 2020).

It is an individual experience directly related to the work context, whose origin is not primarily linked to personality traits, but to situational and social conditions that can be

modified through appropriate interventions (MASLACH; LEITER, 2008). In general, symptoms can appear in individuals with no previous history of psychopathologies; however, its evolution can trigger psychological problems and significantly compromise mental health and professional performance (PATRÍCIO et al., 2020).

Among the most accepted explanatory models is the Model of Demands and Resources of Work, proposed by Demerouti *et al.* (2001), according to which burnout results from the imbalance between high demands and insufficient resources to cope, generating emotional tensions and exhaustion (COSTA et al., 2020).

Some studies suggest differences in manifestation according to sex. Arnten, Jansson, and Archer (2008) indicate that women tend to have higher levels of anxiety, stress, and depression, while Bostjancic, Kocjan, and Stare (2015) point to a higher prevalence of exhaustion among women and greater depersonalization among men (COSTA et al., 2020). There is also evidence of higher risk in occupations with high responsibility and qualification (HOLMES et al., 2014), although other research indicates higher levels of occupational stress among less qualified workers (LUNAU et al., 2015; MARINACCIO et al., 2013 apud COSTA et al., 2020).

Maslach and Jackson (1981) were pioneers in systematizing the *Burnout* in three dimensions: emotional exhaustion, depersonalization, and low accomplishment at work (PATRÍCIO et al., 2020). O *Burnout* It has direct effects on mental health, increasing the incidence of anxiety, depression, and other disorders related to occupational stress. In this sense, well-structured cognitive ergonomics strategies are essential to interrupt the progression of mental fatigue and reduce the probability of progression to mental fatigue. *Burnout* (MATSUZAKI et al., 2021; MASLACH; SCHAUFELI; LEITER, 2001; HART; STAVELAND, 1988; GALE; SMITH, 2021).

2.10.1 Emotional exhaustion (EE)

Emotional exhaustion refers to the exhaustion of physical and psychic resources in the face of high demands and stressful circumstances at work, and is considered the individual component of Burnout (MATSUZAKI *et al.,* 2021). For Maslach and Leiter (2016), this dimension involves an intense feeling of physical and mental fatigue, accompanied by a noticeable reduction in energy and vitality during the execution of professional activities. The authors emphasize that emotional exhaustion directly influences the other dimensions — depersonalization and low achievement — occupying a central role in the development of the syndrome (COSTA *et al.,* 2020).

2.10.2 Depersonalization (DP)

Depersonalization is the interpersonal component of Burnout, manifested by cynical attitudes, negative responses, affective hardening and dehumanization of relationships in the work environment (MATSUZAKI *et al.,* 2021). According to Maslach *et al.* (2001), this dimension is characterized by impersonal behaviors and emotional detachment from colleagues, users, customers and the organization itself.

2.10.3 Reduced professional achievement (RRP)

Reduced professional accomplishment corresponds to the self-evaluation component of Burnout, characterized by a tendency to negative self-evaluation, associated with feelings of frustration and dissatisfaction with performance. Gil-Monte (2003) and Maslach (2009) indicate that this situation can be intensified by the scarcity of resources in the work environment, absence of social support, and limited opportunities for professional development (MATSUZAKI et al., 2021). For Maslach and Jackson (1981), this dimension involves perception of incompetence at work and predisposition to self-deprecation (PATRÍCIO et al., 2020).

2.11 RISK FACTORS

Burnout syndrome occurs in individuals subjected to prolonged occupational stress and results from the interaction of multiple factors. Moreira *et al.* (2018) classify risk factors as facilitators and triggers. Facilitators correspond to individual characteristics that modulate the stress response, such as resilience, job satisfaction, fatigue, and anxiety. Triggers, on the other hand, involve conditions in the work environment, including interpersonal relationships, availability of resources, pressure for results, and organizational support. Among the elements associated with the *Burnout* loss of autonomy, excessive rules, salary dissatisfaction, and frustration stand out (MATSUZAKI et al., 2021).

2.12 BURNOUT PREVENTION

Preventive actions aimed at *Burnout* they can focus on the individual, the organization, or both. In general, individual interventions involve behavioral measures aimed at coping with difficulties at work, such as strengthening social support and relaxation practices. At the organizational level, Awa *et al.* (2010) highlight interventions related to changes in work processes, restructuring of tasks, adequate evaluation and supervision, with the objective of reducing demands, increasing autonomy and favoring worker participation in decision-

making. West *et al.* (2016) point out that both approaches can reduce Burnout rates, and combined interventions tend to generate better results (MATSUZAKI et al., 2021).

Iserson (2018) groups studies on prevention and treatment in three directions: (i) reduction in the emergence of new cases through the elimination or modification of stressors; strengthening individual skills to deal with stress more efficiently; and actions aimed at treating individuals already affected, with the development of effective coping tools (LIMA, 2021).

However, a significant part of the strategies is still based on the assumption that Burnout has a predominantly individual origin, disregarding the contribution of dysfunctional work environments. In this sense, it is essential to invest in actions that expand professional self-awareness, engagement, and appreciation of work. Maslach, Schaufeli and Leiter (2001) indicate that the perception of accomplishment and recognition can contribute to a greater sense of reward, favoring tolerance to greater demands (LIMA, 2021).

Moreno et al. (2011) emphasize that prevention should not be treated as the exclusive responsibility of the individual, but as a result of the worker-work process relationship. When programs prioritize the occupational context, they focus on changes in the way activities are performed, improving the environment, reducing stressful situations, and qualifying human relations. Thus, it is recommended to review the organization of work to promote well-being and prevent illnesses, ensuring sufficient resources to carry out activities, expanding autonomy, encouraging participation in decisions and structuring periodic evaluations of production modes. Career policies, suitability between skills and tasks, fair conflict management and compatible incentives are also relevant.

Finally, an integrated approach simultaneously considers changes in working conditions and actions aimed at strengthening individual strategies, understanding illness as a product of the interaction between the subject and the work environment (LIMA, 2021). Maslach and Jackson (1981) also emphasize the importance of good social relationships at work and preventive collective actions, such as meetings and discussion spaces, to raise awareness and participate together in the prevention of Burnout (LIMA, 2021).

3 NASA-TLX

NASA-TLX (*Task Load Index)* is an instrument widely used for the subjective assessment of mental load in different work contexts, allowing the measurement of dimensions such as cognitive effort, stress, frustration, time demand, and complexity of the activities performed (HART; STAVELAND, 1988). In the field of cognitive ergonomics, its application favors the identification of overload situations, subsidizes adjustments in the

design of tasks and systems, and contributes to the monitoring of the effectiveness of interventions aimed at reducing mental fatigue and preventing burnout syndrome (GALE; SMITH, 2021).

The method was developed at NASA-Ames *Research Laboratory*, based on the use of bipolar scales aimed at identifying the minimum set of dimensions capable of representing individual variations in mental load. As a result of this process, in 1987 the NASA-TLX was proposed, an instrument adopted in the present study (CARDOSO, 2012).

Hart and Staveland (1988) point out that NASA-TLX has good sensitivity and reliability for application in different occupational environments, including high-tech sectors, industrial operations and activities that involve high cognitive complexity. Thus, the instrument allows the identification of factors that can be improved, strengthening ergonomic optimization actions and the promotion of workers' health.

As described by Laperuta et al. (2018), the method generates a global workload score based on a weighted average of six dimensions: mental demand, physical demand, time demand, performance (achievement), effort, and frustration. The author points out that NASA-TLX is particularly suitable for evaluating components related to mental load, in addition to enabling comparisons between individuals submitted to the same tasks. Chart 1 presents the definition of the six dimensions evaluated by the instrument.

Table 1

Definition of the 6 dimensions of NASA-TLX

Dimensions Definitions	Dimensions Definitions
Mental	Amount of mental and perceptual activity that the task requires (thinking, deciding, calculating, remembering, looking, searching, etc.)
Physics	Amount of physical activity the task requires (pulling, pushing, spinning, sliding, etc.)
Temporal	Level of time pressure felt. Ratio of time required to time available.
Satisfaction/Performance	To what extent the individual feels satisfied with the level of performance and performance at work.
Effort	Degree of mental and physical effort that the subject has to make to obtain his level of performance.
Level of frustration	To what extent does the subject feel insecure, stressed, angry, discontented, etc., during the performance of the activity.

Source: Cardoso and Gontijo (2012).

The calculation of the workload index occurs in two steps. Initially, the worker is presented with 15 pairs of previously defined scales (Figure 1), and the participant indicates,

in each pair, which dimension represents the greatest demand in his work. The number of times each dimension is selected determines its weight, ranging from 0 to 5 points.

Figure 1

Comparison of binary scales

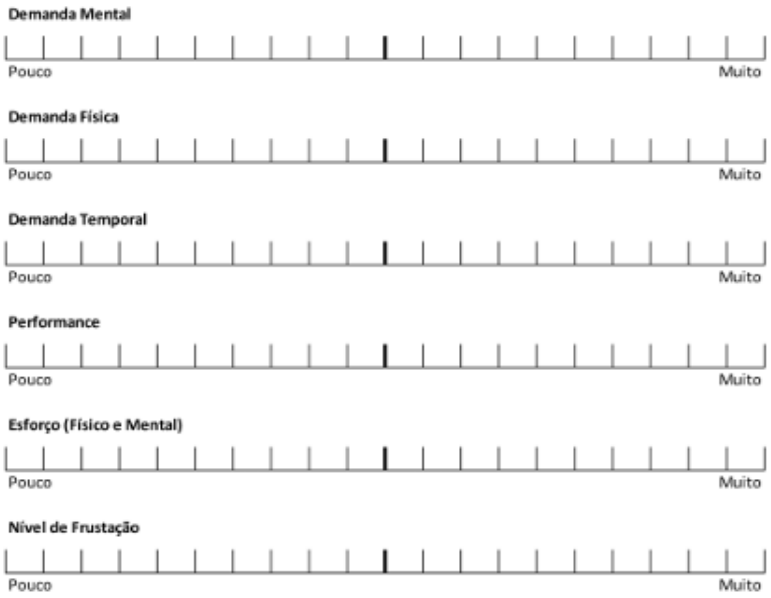
Source: Galvan (2015).

In the second stage, the worker assigns a score referring to the perceived intensity of each dimension throughout the workday, distributed in 11 intervals (Table 5). This amount corresponds to the fee. To obtain the final index, the rate is multiplied by the weight assigned to each dimension, the products are added and, subsequently, the total is divided by the number of combinations (15), resulting in the individual workload index. Figure 2 presents the specification of each demand according to the NASA-TLX method.

Finally, Laperuta *et al.* (2018) highlight as an advantage of the instrument the ability to gather comprehensive information on the worker's mental load, allowing more detailed and in-depth analyses of the cognitive demands associated with work.

Figure 2

Classification of the magnitude of demand in the NASA TLX method



Source: Galvan (2015).

4 METHODOLOGY

4.1 STUDY DESIGN

It is a study of nature **qualitative**, with a design of **Integrative literature review,** focused on the analysis of scientific evidence on **Cognitive ergonomics applied to teleworking**, with an emphasis on identifying **Cognitive ergonomic risks** and in strategies for the evaluation and prevention of outcomes such as **stress, mental fatigue and *Burnout*.** The integrative review was chosen because it allows the synthesis of studies with different methodological approaches, enabling a comprehensive understanding of the phenomenon investigated.

4.2 SEARCH STRATEGY AND SOURCES OF INFORMATION

The bibliographic search was carried out in scientific databases relevant to the area of health, ergonomics and occupational sciences, including:

- Scopus
- PubMed
- Web of Science
- SciELO
- Google Scholar

In addition, institutional and normative documents related to work and occupational health were consulted, when pertinent to the topic.

4.3 DESCRIPTORS AND COMBINATION OF TERMS

Descriptors in Portuguese and English were used, combined using Boolean operators ***AND e OR***, in order to increase the sensitivity of the search. Among the main terms used, the following stand out:

"telecommuting" OR "remote commuting" OR "*home office*"

"cognitive ergonomics" OR "mental load" OR "cognitive demand"

"mental fatigue" OR "occupational stress" OR "*burnout"*

"NASA-TLX" OR "*task load index*"

4.4 INCLUSION CRITERIA

Studies that met the following criteria were included:

- Full scientific articles available in full;
- Publications in Portuguese, English or Spanish;
- Studies with an approach related to **cognitive ergonomics, mental load, psychosocial factors, cognitive risks** or **preventive interventions** in telework;
- Studies that addressed mental load assessment instruments, with emphasis on the **NASA-TLX,** when applicable.

4.5 EXCLUSION CRITERIA

The following were excluded:

- duplicate studies;
- Editorial, letter to the editor, opinion, simple summary and materials without explicit method;
- Research not directly related to telecommuting or cognitive ergonomics;
- Works focused exclusively on physical ergonomics without interface with cognitive/psychosocial aspects.

4.6 STUDY SELECTION PROCESS

The selection took place in three stages:

- **Reading of the titles** to verify adherence to the theme;
- **Reading of the abstracts**, applying the inclusion and exclusion criteria;
- **Full reading** of the eligible texts, defining the final sample.

The screening was carried out in a systematic manner, seeking to reduce selection biases and ensure traceability of the process.

4.7 DATA EXTRACTION AND ORGANIZATION

Data were extracted using a standardized instrument (spreadsheet) containing the following information:

- Author and year;
- Objective of the study;
- Population/sample and context of telework;
- Main cognitive ergonomic risks identified;
- Health-related outcomes (stress, mental fatigue, *burnout*);
- Evaluation strategies (including use of **NASA-TLX** and other instruments);
- Proposed interventions and recommendations.

4.8 SYNTHESIS AND ANALYSIS OF THE RESULTS

Data analysis was conducted by **Thematic analysis**, grouping the findings into categories, defined based on the conceptual convergence between the studies and the cognitive ergonomics framework. For the purposes of organization and discussion, the results were structured in analytical axes, such as:

- **Cognitive ergonomic risks in teleworking** (high mental demand, multitasking, time pressure, task ambiguity, informational overload);
- **Psychosocial outcomes** (stress, mental fatigue, and *burnout*);
- **Assessment tools,** with emphasis on **NASA-TLX;**
- **Preventive measures and interventions**, including work organization, breaks, time management, delimitation of home-work boundaries and adequacy of systems/interfaces.

5 RESULTS AND DISCUSSIONS

The findings of the literature review indicate that telework, although widely disseminated as a viable and contemporary alternative for work organization, evidences relevant weaknesses when analyzed from an ergonomic perspective. The literature consulted points to consistent impacts of the home office in multiple dimensions of work, covering physical, organizational and, especially, cognitive aspects. In this context, cognitive ergonomics emerges as a central axis for understanding psychosocial risks and the effects on performance, since remote work tends to intensify mental demands related to sustained attention, continuous information processing, and decision-making in environments often permeated by interruptions and multiple tasks.

5.1 COGNITIVE OVERLOAD IN TELEWORKING AND HEALTH REPERCUSSIONS

In the field of cognitive ergonomics, the studies analyzed show that teleworking can favor conditions of **Mental overload,** mainly due to the intensification of the workday, the accumulation of tasks and the difficulty of delimiting personal and work life (MOREIRA; FERREIRA, 2021). The absence of clear boundaries in the home office tends to prolong the connection time and reduce opportunities for recovery, which increases the likelihood of mental fatigue and occupational stress.

The literature also points out that this scenario can have a more pronounced impact on workers who simultaneously reconcile domestic and professional responsibilities, especially women, which highlights gender inequalities related to well-being and productivity in remote work. Thus, telework, when implemented without adequate organizational structure and without ergonomic support, can intensify pre-existing vulnerabilities, contributing to greater mental exhaustion and reduced occupational balance.

5.2 DIFFERENTIATION BETWEEN STRESS, MENTAL FATIGUE AND *BURNOUT*

The results indicate that, although often treated as similar phenomena, **stress, mental fatigue and burnout** They have relevant differences in terms of duration, reversibility, and triggering mechanisms, and it is essential to distinguish them in order to support effective ergonomic interventions.

In general, the **Stress** can be understood as a physiological and psychological response to the imbalance between demands and available resources, manifested by tension, anxiety, physiological changes and temporary impairments of attention and performance (LIDA, 2005; MATTOS, 2011). The **mental fatigue** refers to the temporary exhaustion of cognitive processes due to prolonged exposure to tasks of high intellectual demand, characterized by attentional lapses, irritability, decreased productivity and increased errors, and is generally reversible through rest and reorganization of work (SMITH; MARRAS; KARWOWSKY, 2006; MATTOS, 2011).

In turn, the **Burnout** It differs by its more persistent and profound character, being associated with prolonged exposure to chronic occupational stressors. It is a syndrome marked by emotional exhaustion, depersonalization, and reduced professional fulfillment, with lasting repercussions on mental health, motivation, and performance (MASLACH; LEITER, 2008; DEMEROUTI et al., 2001). Understanding these distinctions is fundamental for ergonomics, as it allows directing specific strategies for the prevention and mitigation of cognitive risks in telework.

In summary, the analysis of cause and effect evidenced in the literature allows us to understand that: stress is related to the immediate imbalance between demands and resources; mental fatigue results from continuous cognitive overload; and Burnout results from the prolonged maintenance of adverse conditions, with more severe and persistent impairment.

5.3 ERGONOMIC STRATEGIES AND INTERVENTIONS IDENTIFIED IN THE LITERATURE

The review identified a consistent set of cognitive ergonomics interventions aimed at preventing stress, mental fatigue and burnout, as well as promoting mental health and safe performance. Among the most recurrent strategies, actions at four complementary levels stand out:

a) **Work organization:** Measures such as scheduled breaks, balanced workload management, clear definition of roles and responsibilities, alternation of tasks and expansion of worker autonomy were relevant to reduce ambiguity, time pressure and mental overload. These practices also favor greater predictability and perceived control over activities, elements recognized as protective against occupational burnout.

b) **Physical environment and ergonomic design**: Despite the cognitive focus, the literature emphasizes that physical conditions in the home environment directly influence mental performance. Adequate lighting, ventilation, noise and temperature control, as well as adjustable furniture and equipment, contribute to reducing discomfort and distractions, positively impacting attention, efficiency, and well-being. Likewise, clearer and more intuitive digital interfaces reduce cognitive effort, reducing errors and frustrations.

c) **Organizational support** Psychosocial support programs, transparent communication, healthy leadership, and professional recognition actions appear as relevant protective factors, as they reduce organizational stressors and strengthen social support — a component associated with the prevention of mental illness in remote work.

d) **Individual strategies:** Training in time management, task prioritization, self-care practices (sleep, physical activity, eating), and relaxation techniques, or *Mindfulness* are cited as complementary resources to strengthen self-regulation and reduce the effects of prolonged mental effort.

In general, studies converge in indicating that the effectiveness of interventions is greater when there is integration between organizational, environmental and individual actions, avoiding the exclusive responsibility of the worker for the illness.

5.4 ASSESSMENT OF MENTAL LOAD AND USE OF NASA-TLX

Among the instruments analyzed, the **NASA-TLX** stands out as a widely used tool for subjective measurement of cognitive load in high-demand activities (HART; STAVELAND, 1988). The literature indicates that the method allows the evaluation of dimensions such as mental effort, time demand, frustration and perceived performance, providing relevant subsidies to identify critical points of overload and guide ergonomic adjustments.

The reviewed studies demonstrate that the systematic application of NASA-TLX contributes to monitoring the mental load in teleworking, favoring interventions aimed at reducing cognitive fatigue and preventing Burnout (GALE; SMITH, 2021). Laperuta *et al*. (2018) highlight the instrument as particularly suitable for comparing individuals submitted to the same task and for identifying relevant variations in the perception of mental load.

Thus, the measurement of cognitive load, associated with cognitive ergonomics interventions, has the potential to reduce occupational stressors and prevent the progression of mental fatigue to Burnout, with positive impacts both on health and on indicators of productivity and quality of work (SILVA et al., 2020; MASLACH; LEITER, 2016).

6 FINAL CONSIDERATIONS

This integrative review showed that cognitive ergonomics is a fundamental axis to understand and intervene on the impacts of telework on the health and performance of workers. Although the *Home Office* Representing a flexible and consolidated alternative for work organization, the literature shows that its implementation, when not accompanied by guidance, support, and preventive policies, can intensify relevant ergonomic risks. The findings indicate that the intensification of mental demands, the pressure to perform, the informational overload, the need for self-management, and the absence of clear boundaries between personal and professional life are central risk factors for the development of stress, mental fatigue, and *Burnout* in the context of remote work, with direct repercussions on motivation, productivity and well-being.

The analysis allowed us to differentiate these outcomes in terms of nature and evolution, highlighting that stress may represent an initial response to imbalances between demands and resources; mental fatigue is a manifestation of prolonged cognitive overload; and the *Burnout* It is a more persistent and complex problem, associated with chronic

exposure to adverse work conditions. This distinction is fundamental for the design of adequate and evidence-based preventive interventions.

The reviewed literature converges in indicating that isolated strategies are insufficient to cope with cognitive risks in telework. Effective interventions require an integrated approach, involving the reorganization of tasks, balanced management of workload, strengthening organizational support, improving environmental conditions, and promoting individual self-regulation and self-care strategies. In this context, mental load assessment instruments, such as the NASA-TLX, stand out as relevant tools for the systematic monitoring of cognitive demands and for subsidizing targeted ergonomic adjustments.

From the point of view of workers' health, the results reinforce the need for institutional policies that transcend individual accountability and incorporate cognitive ergonomics as a structuring component of the organization of remote work. The promotion of cognitively sustainable work environments is essential to prevent mental illnesses, reduce absences and preserve the quality and safety of professional performance.

Finally, it is recommended that future research advance in the realization of longitudinal empirical studies that investigate the effectiveness of specific ergonomic interventions in telework, expanding the evidence base for the formulation of guidelines and practices aimed at protecting mental health in the contemporary work context.

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