55 - ERGONOMY IN MINING: CONTRIBUTION FOR WORKER HEALTH PROMOTION

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INTRODUCTION

Mining is economically one of the most important industries in the world, however, in the health scenario is critical, besides the occupational risks that are common in the work process, diseases and labor accidents are increasing year after year. Before the above, considerations emerged around the interventions work. Cruz (2010) detaches that the human being requires many resources to help him in his labor activities, either regarding to the proper environment, the work equipment, production means, or to the way that the task must be done, among others. This way, thinking about these variables, the study of ergonomics and its principles, aiming to modify and improve the working conditions (GUÉRIN et al., 2001).

The health of individuals, the efficiency of the activities and security of the premises became incorporated into the life of corporations (CRUZ, 2010; BRAGA, 2007). The primary ergonomic interventions occur on the physical work load and drudgery. To Kroemer; Grandjean (2005), the heavy work includes the use of too much physical effort, requiring a high energy expenditure, as well as cardiorespiratory and musculoskeletal system, and common aspects in mining activity. Such elements are present in the majority of the mining activities, contributing with musculoskeletal injuries appearance among the workers making possible to infer that, although the mining had become even more mechanized all over the world, in developing regions, as Brazil there is still high quantities of manual activities being practiced. This feature has allowed the development of cumulative traumatic disorders, constituting itself, according to the National Institute for Occupational Safety and Health (NIOSH, 2000), the major category of occupational disease in mining, which can result in prolonged disability.

Despite efforts in trying to apply the principles of ergonomics in the work process in mining, the results are still insufficient, perhaps due to the complexity of multifactorial occupational problems, such as age, sex, race, genetic factors, postural factors, among others (GRECCHI et al. 2006; KUMAR, 2001).

Over the prerogative, studies try to apply the ergonomy principles to the mining work process. Besides these efforts, still are insufficient. Nevertheless, the investigation accomplished show strong evidence over the high prevalence of work postures that have a pernicious effect over the mining sector workers musculoskeletal system (GRECCHI et al., 2006).

In front of these considerations, this study aimed to identify the specialized theoretical production profile over the ergonomy in mining, verify the contributions of ergonomy to health promotion (HP) of mining activity workers and investigate the suggestions proposed for work general aspects improvement.

METHOD

The study was characterized as a Literature Integrative Revision. This method makes possible data compilation for practice application in its effectuation. The following phases were conducted: indicator question elaboration, literature search or sample, data collection, critical analysis of the included studies; results discussion and revision presentation (SOUZA; SILVA; CARVALHO, 2010). The search for results was based on the indicator question: which are the ergonomy contributions for the health of the worker in mineral extraction sector?

This way, a research was concretized in the Health Virtual Library Research Portal. The data collection was carried out in July of 2013, using the association between the using as Descriptor Controlled Health Sciences (MeSH), ergonomy and mining. Altogether, 21 references were localized. Considering the inclusion criteria: scientific production from 2004 to 2013, in english, Spanish and Portuguese, in the form of article and related to the study objective, only 10 productions were selected, once five publications were before 2004, three were in russian, one in german, other in french and one in Italian.

With these scientific articles, the analytic reading was conducted and the sample data were disposed considering the variables: data base, language, authors, year, articles title, objectives, kind of research, main results and suggestions.

RESULTS AND DISCUSSION

In this revision study, 10 articles were analyzed which obeyed the inclusion criteria previously established. So, in the sequence, the obtained results are presented with this proposal.

Observing data base, 60% (n=6) was available in Electronic Medicos Index of National Library of Medicine (MEDLINE) e 40% (n=4) in Latin America and Caribe literature in Health Sciences (LILACS). The MEDLINE, through Pubmed interface is a data bank of international indexation that permits the bibliographic research in more than 17 million of works published in approximately 3.800 scientific periodic references (PEREIRA, 2012). This way, it is an important scientific communication vehicle in health area. One can't desist to mentionate the LILACS, in order to divulge studies in Latin America and Caribe.

Considering the language, 60% (n=6) were available in english language, 30% (n=3) in Spanish and 10% (n=1) in Portuguese. Regarding to the publication period, the greater number was published in 2006 and 2004 with 30% (n=3), each one. The fact is worrying, once it tends to characterize the small theme interest and the loss of theoretical update, once 70% (n=7) are publications previous to 2008. Grecchi et al. (2006) affirmed that researches and theories construction of ergonomy and mining can be considered poor or not update.

Table 1: Distribution of scientific articles conforming authorship, title, objective, periodic and year

Authors	Title	Objective	Periodic	Year
Apud	Ergonomy in mining : the Chilean experience	To analyze the present state of knowledge about ergonomy in Chilean mining.	*Hum Factors*	2012
Rosa et al.	Furniture use evaluation in administrative places.	To evaluate if the worker uses the furniture correctly according to the rules and concepts of good posture at work.	*Fisioter. Bras;*	2009
Solari; Reyes; Solari	Contribution of ergonomy from physical aptitude analysis in a miners sample with/without lumbar pain syndrome (Antofagasta Region, Chile)	To Identify the physical conditions indicators related to lumbar pain syndrome.	*Rev. cienc. salud*	2009
Córdova et al.	Evaluation of system of turns in a mining company, in III Region - Chile	To evaluate the system of turns in a mining company, in III Region - Chile	*Cienc. Trab*	2007
Ruff	Evaluation of a system of proximity warning, based on a radar for tipper out of road.	To evaluate a sys tem of proximity warning, based o n a radar for tipper out of road.	*Accid Anal Prev*	2006
Plamondo n et al.	Manual movement materials in mining: the effect of the stock height and standing position in perforation stocks raising.	To exam the load experienced by perforation operator s changed when raised the vertical perforation stock (1.61m, 35 kg), using two sto ck heights and four different positions standing.	*Appl Ergon*	
Ramírez	High altitude Mining workers anthropometry	To characterize Turkey Andes mountain mining workers anthropometric data	*An. Fac. Med. (Per£)*	
Skoglind-Ohman; Shahnava z	Evaluation of future workshop utilization as an ergonomy tool	To evaluate future workshop (FW) utilization as a participative ergonomy method.	*Int J Occup Saf Ergon;*	2004
McPhee	Ergonomy in mining	To broach about t he job aspects and ergonomy in mining.	*Occup Med (Lond)*	
Donoghu e	Risks of occupational health in mining: a general vision.	To describe the physical, chemical, biological, ergonomic and psychosocial risks to mining and metallurgy occupational health.	*Occup Med (Lond)*	

Over the periodic in which the studies where published, it is noted that, among 10 works, nine were available in different journals, only the Occupational Medicine (London) published 20% (n=2) of the articles. The data are evidences of international interest by the study object, finally, as McPhee (2004) exposes, the abnormal load works and tensions are still worrying areas, although are available to interventions, especially ergonomic ones. However, it is detached the english interest, due to the fact that the related journal is from London. An evident preoccupation since the Ergonomic Research Society creation, in England in 1949, turned possible the appearing of the Ergonomy as a subject (BRAGA, 2007).

The articles, by the way, were conformed as transversal research modality (30%; n=3); of revision and experimental (20%, n=2), each; quanti-qualitative; documental; descriptive-prospective and observational (10%; n=1), for both. These results are worrying because it was not found in any published randomized controlled interventional study, which shows the lack of studies that are truly representative of the results in question.

Even more, comprehending that the fundamental characteristic of literature integrative revision that is to summarize previous researches searching for evidences to clear or situate how the theme is being approached to better understanding, the main contributions of the researches about ergonomy applicability to mining activity workers HP are detached from now. (TABLE 2).

Table 2: Contributions of ergonomy to mining worker HP

Authors/ year	Results
Apud (2012)	The results of chilean experience reveal the importance of the 'static' ergonomy concept overcoming with emphasis in work places, being valid for offices and machine operation, but not for a significant number of mining workers that will be moving themselves around the work stations located in different complexity systems . The consequence of these complex and dynamic work situations reflects in more than 50% of the absenteeism due to health reasons attributed to musculoskeletal injuries and there aren't pattern recommendations applied universally.
Rosa et al. (2009)	After each unit evaluation (place of work/employee interaction) , 12% were classified as horrible, 24% inadequate, 34% regular, 17% good, 10% optimal and 3% excellent.
Solari; Reyes; Solari (2009)	The global prevalence of lumbar pain was of 67,5%, the physical condition, abdominal strength, back muscles fatigue , general and lumbar flexibility, and the waist circumference were statistically related to lumbar pain.
Córdova et al. (2007)	The evaluation of the turns system of ENAMI Paipote (6x1; 6x3; 6x2) firm evidenced that this one doesn1t represent a significant risk regarding to health, well -being state, social life, adaptation and workers performance.

Ruff (2006)	Data showed that the detection system is reliable, alerting about small vehicles, persosns and other equipment. Despite this, the alarm s for objects that din1t represent any danger also were common.
Plamondon et al. (2006)	It was verified that the vertical height of the stock had the more significant effect over the load towards the back, while the foot initial position regarding to the stock was limited by the technique adopted by the perforators. Besides this, it was verif ied that some subjects used techniques less exhausting for the back part than others. Finally , the asymmetrical elevation component was pointed as being the more negative aspect of a perforation stock.
Ramírez (2006)	The Andes mining worker has different dimensions than the sea level man.
Skoglind-Ohman; Shahnavaz (2004)	A good participants involvement was observed during the future workshops. The evaluations, immediately after the workshops and 3 months later showed that participants' perception was very positive. The interviews revealed the problem identification and the development of changes to be implemented. Proper perceptions of FW influence in participants creativity retract their faith in ideas and developed solutions, in order to identify and solve work place problems.
McPhee (2004)	In some cases, the sedentary work and machine operation substituted completely the hard physical work. The link between prolonged sitting posture, poor equipment design, and the vibration has been recognized in literature as back and neck pain causative agents.
Donoghue (2004)	It was certified that there are risks of traumatic injuries, ergonomic risks and of noise.

Considering table 2, it is certified that the studies evidenced that the work ergonomic analysis leads to the identification of the reality experienced by the workers. This analysis begins with the observation of the worker characteristics (anthropometry and biotype, for example) to after planning the work that he can execute. It searches to adapt work conditions, labor journey, with work load, machines, instruments, without changes in the products, corporative income, but above all else, aims to promote health, security and satisfaction to the worker (CRUZ, 2010; FIEDLER et al., 2008).

Porto; Freitas (1997) detach , as in some of the selected studies in this revision, the mining job characteristics that need ergonomy actions: exaggerated physic effort, due to long distances walking (mining ground or underground mining), the use of long ladders manual break of rocks and "chocos"; and weight lifting, use and conveyance of heavy tools (hammers, drilling machines, integral drill); inadequate postures in labour activity performance in irregular topography areas, work in inadequate machines and seats of equipments, productivity control, excessive work rhythm, monotony and repetition, work in turns and work journey prorogation. These elements, then can turn possible perniciousness over mining workers musculoskeletal system.

Concluding, it was searched in the selected studies to inquire the suggestions proposed for general aspects improvement (table 3).

Table 3: Suggestions proposed for general aspects of work improvement

Authors/year	Suggestions
Apud (2012)	There is a need of going on advancing from diagnosis studies to participative interventions. At the same time, is imperative that all the new enterprises include the ergonomic precepts since the initial phases of planning. It is also important to increase the ergonomic formation inside the firms, including not only the managers that make important decisions, but also the workers that are directly affected by the ergonomy lack.
Rosa et al. (2009)	To invest in education and training for adequate places according to technical norms and ergonomy concepts being used in a correct form by their users.
Solari; Reyes; Solari (2009)	The ergonomy offers alternatives with scientific rigor that permit an adequate therapeutic and prophylactic management of lumbar pain related to the work.
Córdova et al. (2007)	The evaluation of the work system in turns and at night is useful , once, depending on the work journey characteristics can occur health, welfare and work performance compromising, therefore, to apply the ergonomy is viable.
Ruff (2006)	Systems based in proximity alert sensors must be used in combination with other devices, as cameras, that permit to the operator to verify the origin of any alarm.
Plamondon et al. (2006)	Application of ergonomy principles.
Ramírez (2006)	To realize anthropometrical measures, to apply ergonomic parameters, besides executing investigations about andean workers in altitudes.
Skoglind-Ohman; Shahnavaz (2004)	The future workshop is considered a useful tool for the ergonomy, and his qualities are related to the structure and practical performance.
McPhee (2004)	Participative approaching to solve problems, looking at the ergonomy area.
Donoghue (2004)	Vigilance actions are useful to guarantee the control and exposition to risks.

According to table 3, the authors detach various strategies, with emphasis for the application of the ergonomy principles. Camfield et al. (2006), when talking about ergonomy, emphasize that it reflects the adaptation of the man to the work, not only comprising machines and equipment used, but contemplating all situation that involve worker and labour activities, as: organizational aspects, physical environment, programming and control to product the objectives desired. It is summed, with real importance, the proletariat characteristics (CRUZ, 2010; FIEDLER et al., 2007).

Such results, therefore, can conduct to the perception of the area interference needs, contemplating specially ergonomic measures, which are necessary to validate results for the mining industry and minimize the occurrence of lumbar pains and traumatic injuries. (SARIKAYA et al., 2007; DONOGHUE, 2004).

CONCLUSION

Before the search performed, it was possible to determine the profile of the selected publications, as well as to identify the ergonomy contributions to the mineral extractive sector worker health promotion and the suggestions for general aspects improvement in the mining sector, detaching, among the articles, the application of the ergonomy principles, perceived as an strategy that turns possible the therapeutic and prophylactic management adequate to minimize the pernicious effects of pathologies related to the mineral sector work. However, we found few papers on the subject and none of them had high scientific rigor, suggesting the need for more studies and research within this theme.

REFERENCES

APUD, E. Ergonomics in mining: the Chilean experience. Hum Factors.,v. 54, n. 6, p. 901-7, Dec.2012

BRAGA, C. O. Análise ergonômica do trabalho e exigências laborais em unidades de beneficiamento de tomate de mesa [dissertação]. Campinas, SP: Universidade Estadual de Campinas, Faculdade de Engenharia Agrícola; 2007.

CAMFIELD, C. E. R. et al.Avaliação dos aspectos ergonômicos e das condições de trabalho em organizações madeireiras da quarta colônia. Anais do XIII SIMPEP Bauru-SP, 2006. Disponível em: <http://www.simpep.feb.unesp.br/anais/anais_13/artigos/925.pdf>. Acesso em: 21 maio 2013.

CÓRDOVA, P. et al. Evaluación del sistema de turnos de una empresa minera de la III Región – Chile / Evaluation of the shift system of a mining company in the IIIrd Region – Chile. Cienc. Trab., v. 9, n. 25, p. 121-8, jul.-sept. 2007.

CRUZ, J. A. Análise dos fatores ergonômicos do ambiente e sua relevância para a melhoria das condições de trabalho e do clima organizacional: um estudo de caso no Fórum da Comarca de Gloria – BA [monografia]. Paulo Afonso: Faculdade Sete de Setembro; 2010.

DONOGHUE, A. M. Occupational health hazards in mining: an overview. J. occup. med., v. 54, p. 283-9, 2004.

FIEDLER, N. C. F.; ALVES, R. T.; GUIMARÃES, P. P.; WANDERLEY, F. B. Análise da carga física de trabalho dos operadores em marcenarias no sul do Espírito Santo. Floresta,v. 38, n. 3, p. 423-9, 2008.

GRECCHI, A. et al. Application of the OWAS method in the study of work postures among quarry manual workers. Med Lav., v. 97, n. 5, p. 707-14, Sep-Oct 2006.

GUÉRIN, F. et al. Compreender o trabalho para transformá-lo: a prática da ergonomia. São Paulo: Edgar Blucher; 2001.

KROEMER, K. H. E.; GRANDJEAN, E. Manual de Ergonomia: adaptando o trabalho ao homem. 5. ed. Porto Alegre: Bookman, 2005.

KUMAR, S. Theories of musculoskeletal injury causation. Ergonomics, v. 44, n. 1, p. 17-47, 2001.

MCPHEE, B. Ergonomics in mining. Occup Med (Lond)., v. 54, n. 5, p. 297-303, Aug. 2004.

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH). Injuries, Illnesses, and Hazardous Exposures in the Mining Industry, 1986–1995: A Surveillance Report. Washington DC: NIOSH, 2000.

PEREIRA, M. G. Artigos científicos: como redigir, publicar e avaliar. Rio de Janeiro: Guanabara Koogan, 2012.

PLAMONDON, A. et al.Manual materials handling in mining: the effect of rod heights and foot positions when lifting [quot] in-the-hole[quot] drill rods. Appl Ergon., v. 37, n. 6, p. 709-18, Nov. 2006.

PORTO, M. F. S.; FREITAS, C. M. Análise de riscos tecnológicos ambientais: perspectivas para o campo da saúde do trabalhador. Cad. Saúde Pública, v. 13, suppl.2, p. 59-72, 1997.

RAMÍREZ, A. V. Antropometría del trabajador minero de la altura. An. Fac. Med. (Per£), v. 67, n. 4, p. 298-309, oct.-dic. 2006.

ROSA, L. A. M. et al. Avaliação da utilização do mobiliário em postos administrativos. Fisioter. Bras. v. 10, n. 4, p. 235-40, jul.-ago. 2009.

RUFF, T. Evaluation of a radar-based proximity warning system for off-highway dump trucks. Accid Anal Prev., v. 38, n. 1, p. 92-8, Jan. 2006.

SARIKAYA, S. et al.Low back pain and lumbar angles in Turkish coal miners. Am J Ind Med., v. 50, n. 2, p. 92-6, Feb. 2007.

SKOGLIND-OHMAN, I.; SHAHNAVAZ, H. Assessment of future workshop's usefulness as an ergonomics tool.Int J Occup Saf Ergon., v. 10, n. 2, p. 119-28, 2004.

SOLARI, G.; REYES, J.; SOLARI, B. Contribución a la ergonomia desde el análisis de la condición física en una muestra de trabajadores mineros con/sin síndrome de dolor lumbar (Región de Antofagasta, Chile). Rev. cienc. salud., v. 13, n. 1, p. 16-32, 2009.

SOUZA, M. T.; SILVA, M.D.; CARVALHO, R. Revisão integrativa: o que é e como fazer. Einstein, v.8, n.1, p. 102-106, 2010.

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ERGONOMY IN MINING: CONTRIBUTION FOR WORKER HEALTH PROMOTION

ABSTRACT

Objectives: To identify the specialized theoretical production profile over the ergonomy in mining, verify the contributions of ergonomy to health promotion of mining activity workers and investigate the suggestions proposed for work general aspects improvement. Method: An Integrative Review of the Literature searches performed from the Search Portal in the Virtual Health Library, using the association between Descriptors in Health Sciences: ergonomics and mining. Altogether, 21 references were found, of which 10 met the inclusion criteria. Results: 60% (n=6) were available on the Index Medicus of the National Library of Medicine (MedLine), 60% (n=6) in the english language, 20% (n=2) were published in Occupational Medicine (London) and 30% (n=3) were characterized as search section. Furthermore, studies have shown that the ergonomic analysis leads to the identification of the reality experienced by employees, which allows intervene appropriately, and ergonomics identified as the most viable alternative. Conclusion: Ergonomics is perceived as a strategy that enables the management and prophylactic therapy appropriate to minimize the harmful effects of pathologies related to work in the mining industry.

KEY-WORDS: Work. Mining. Ergonomy.

ERGONOMIE DANS L'INDUSTRIE MINIÈRE: CONTRIBUTIONS À LA PROMOTION DE LA SANTÉ DU TRAVAILLEUR

RÉSUMÉ

Objectifs: Identifier le profil de la production théorique spécialisé sur l'ergonomie dans l'industrie minière, vérifier les contributions de l'ergonomie afin de promouvoir la santé des travailleurs dans l'industrie minière et trouver des suggestions pour améliorer les aspects généraux du travail, pour la santé, la sécurité et la satisfaction des travailleurs. Méthode: Revue intégrative de la littérature effectuées par les recherches dans le Portail de Recherche de la Bibliothèque Virtuelle de Santé, menées par l'association entre les suivants descripteurs sur les sciences de la santé: “ergonomia” and “mineração”. Au total, nous avons trouvé 21 références, dont 10 répondirent aux critères d'inclusion. Résultats: 60% (n=6) étaient disponibles dans l'Index Medicus de la National Library of Medicine (MedLine), 60% (n=6) en anglais, 20% (n=2) ont été publiés dans la Occupational Medicine (Londres) et 30% (n=3) ont été caractérisés comme recherche transversale. Aussi, des études ont montré que l'analyse ergonomique du travail conduit à l'identification de la réalité endurée par les travailleurs, ce qui permet d'intervenir de façon appropriée, et l'ergonomie est indiquée comme l'alternative la plus viable. Conclusion: L'ergonomie est perçue comme une stratégie qui permet la gestion thérapeutique et prophylactique appropriée pour minimiser les effets néfastes des maladies reliées au travail dans l'industrie minière.

MOTS CLÉS: Travail. Industrie minière. Ergonomie.

ERGONOMÍA EN LA MINERÍA: CONTRIBUCIONES PARA LA PROMOCIÓN DE LA SALUD DEL TRABAJADOR

RESUMEN

Objetivos: Identificar el perfil de la producción teórica especializada acerca de la ergonomía en la minería, verificar las contribuciones de la ergonomía para la promoción de la salud de los trabajadores de la industria minera y averiguar las sugerencias propuestas para la mejora de los aspectos generales del trabajo, en favor de la salud, la seguridad y la satisfacción de los trabajadores. Método: Revisión integradora de literatura realizada por medio de búsquedas en el Portal de Investigación de la Biblioteca Virtual en Salud, mediante la asociación entre los siguientes descriptores en ciencias de la salud: “ergonomia” and “mineração”. En total, se encontraron 21 referencias, de las cuales 10 cumplieron los criterios de inclusión. Resultados: 60% (n=6) estaban disponibles en el Index Medicus de la National Library of Medicine (MedLine), 60% (n=6) en inglés, 20% (n=2) fueron publicadas en la Occupational Medicine (Londres) y 30% (n=3) se caracterizaron como investigación transversal. Además, los estudios han demostrado que el análisis ergonómico del trabajo conduce a la identificación de la realidad experimentada por los trabajadores, lo que posibilita intervenir de manera apropiada, y la ergonomía es apuntada como la alternativa más viable. Conclusión: La ergonomía es percibida como una estrategia que posibilita el manejo terapéutico y profiláctico apropiado para minimizar los efectos nocivos de patologías relacionadas con el trabajo en la industria minera.

PALABRAS CLAVE: Trabajo. Minería. Ergonomía.

ERGONOMIA NA MINERAÇÃO: CONTRIBUIÇÕES PARA A PROMOÇÃO DA SAÚDE DO TRABALHADOR

RESUMO

Objetivos: Identificar o perfil da produção teórica especializada sobre a ergonomia na mineração, verificar as contribuições da ergonomia para a promoção da saúde dos trabalhadores da indústria da mineração e averiguar as sugestões propostas para a melhoria dos aspectos gerais do trabalho na área. Método: Revisão Integrativa da Literatura realizada a partir de buscas no Portal de Pesquisa em Biblioteca Virtual de Saúde, utilizando a associação entre os Descritores em Ciências da Saúde: ergonomia and mineração. Ao todo, foram localizadas 21 referências, das quais 10 atenderam aos critérios de inclusão. Resultados: 60% (n=6) estavam disponíveis no Index Medicus da National Library of Medicine (MedLine), 60% (n=6) na língua inglesa, 20% (n=2) foram publicadas na Occutional Medicine (Londres) e 30% (n=3) caracterizaram-se como pesquisa transversal. Além disso, os estudos evidenciaram que a análise ergonômica do trabalho leva a identificação da realidade vivenciada pelos trabalhadores, o que possibilita intervir adequadamente, sendo a ergonomia apontada como a alternativa mais viável. Conclusão: A ergonomia é percebida como uma estratégia que possibilita a gestão terapêutica e profilática adequada para minimizar os efeitos nocivos de patologias relacionadas ao trabalho na indústria da mineração.

PALAVRAS-CHAVE: Trabalho. Mineração. Ergonomia.