Identifying OHS hazards in university research laboratories from an ergonomics and human factors perspective

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Abstract: People working in research laboratories deal with numerous risk factors that are oftentimes emerging, thus not well documented. The goal of this study is to propose an approach that would make it possible to conduct a simple and rapid analysis of a work situation to identify and prevent these risks. A two-part analysis was conducted of a non-comprehensive list of existing ergonomics/human factors engineering evaluation tools. This analysis led to the creation of two kits that consist of proven and used evaluation tools and that combine both subjective and objectivation tools. These kits make it possible to establish a quick overview of a work situation; a more in-depth ergonomics/human factors engineering analysis can be conducted thereafter, if necessary.

Keywords: Occupational health and safety, ergonomics, human factors, academic lab, evaluation tools

1. Introduction

Research laboratories are particular organisations due to the scale and type of activity they conduct. In addition to this, universities are complex organisations due to their multiple services offices and departments and the coordination of these is often also very complex (Napon & Nadeau, 2018). In any sector of activity and in particular research laboratories, safety depends on work hazards being identified, evaluated and prevented as well as Occupational Health and Safety (OHS) measures. Be they of physical or cognitive nature, numerous risk factors are present.

And yet, to the best of our knowledge, current tools and methods of risk analysis were devised for industry. They are intended for operators and designed for mid to large-scale processes (repetition, quantity) (Napon & Nadeau, 2018).

In the scientific literature, we found research published on the integration of strategies to manage lab OHS hazards in pilot plants, which are midscale between research and plant laboratories (Aziz, Shariff, & Roslan, 2011) and laboratories that work with chemical products (Langerman, 2009). Several articles (Foster, 2003, 2004; Hill, 2016; Langerman, 2009; Meyer, 2017; Schröder, Huang, Ellis, Gibson, & Wayne, 2016) share the same view on the need for training to ensure the proper management of risk prevention in research laboratories both in and out of academic settings.

However, none of these publications answer the question of how to ensure the integration of OHS in university research laboratories and more precisely, which tools would be more useful and useable. Therefore, we propose a novel approach to facilitate the implementation of a procedure to quickly identify and assess OHS hazards in

university research labs. The approach relies on tried and tested tools used in the fields of ergonomics and human factors. Using a tool kit format, this approach will provide an overview assessment of a work situation, upon which a more in-depth evaluation using other tools and techniques can be performed when necessary.

The scope of this study is limited to the integration of risks and OHS from an ergonomics perspective and was conducted using a non-exhaustive list of known and documented tools.

2. Methodology

The first step in designing the tool kits was to conduct a search and analysis of existing ergonomic assessment tools through a literature review. By identifying tried and tested ergonomic assessment tools present in the documents of institutions such as the *Institut national de recherche et de sécurité pour la prévention des accidents du travail et des maladies professionnelles (INRS)*, the *Commission des normes, de l'équité, de la santé et de la sécurité du travail (CNESST)* and the *Institut de recherche Robert-Sauvé en santé et sécurité du travail (IRSST)*, we compiled a non-comprehensive list of tools to be analysed for this study.

This analysis was conducted in two parts. The first evaluated the number of risk factors covered by each tool and the second, their level of ease of use and deployment (national or international).

The first part consisted of reading a list compiled by France's health insurance of the various work hazards (TMSMM & L'assurance maladie-risques professionnels, 2010). Then we improved the list to make it more complete using the method of Aptel & Atain-Kouadio (2000), that is, mostly by specifying in greater detail the risk factors and adding the sections "means employed by the tool" and "time required for implementation". The criteria for tool selection are ease of use, level of prevention assistance provided, risk factors considered and time required for implementation. The second part of the analysis was to sort the tools into categories. More precisely, we wished to identify whether the tools are subjective in nature or for objectivation, if their reach is nationwide or international and if they are simple or complex to use. Tools are considered as easy to use if they require little time to implement (maximum half a day per tool), do not require advanced skills in ergonomics and human factors or require only minimal knowledge, due to their being well documented.

This analysis could be used with any other ergonomics or human factors engineering tool not mentioned in this study (Lowe, Dempsey, & Jones, 2019). Our goal was not to provide a comprehensive list of all the various traditions of ergonomics and human factors engineering research.

Base on this analysis, two tool kits were created to conduct a simple and rapid analysis of a work situation. The kits contain 3 or 4 tools covering the various physical and cognitive hazards present in university research laboratories.

3. Results

In this study, eleven tools were analysed: APACT sheet, RULA method, revised NIOSH lifting equation, Nordic questionnaire, Karasek questionnaire, Nasa TLX assessment tool, OREGE tool, VIDAR method, OSHA's checklist, WOCCQ questionnaire and QEC method.

The first part of the analysis highlighted the number and types of risk factors that each tool evaluates (Figure 1). Five of the eleven tools only assess one risk factor, four can consider three and only two can assess the four families of risks (APACT sheet, OSHA checklist). The second part of the analysis established that certain tools are both subjective and for objectivation (OREGE and QEC), but it mostly made it possible to classify the tools so that the kits could be created.

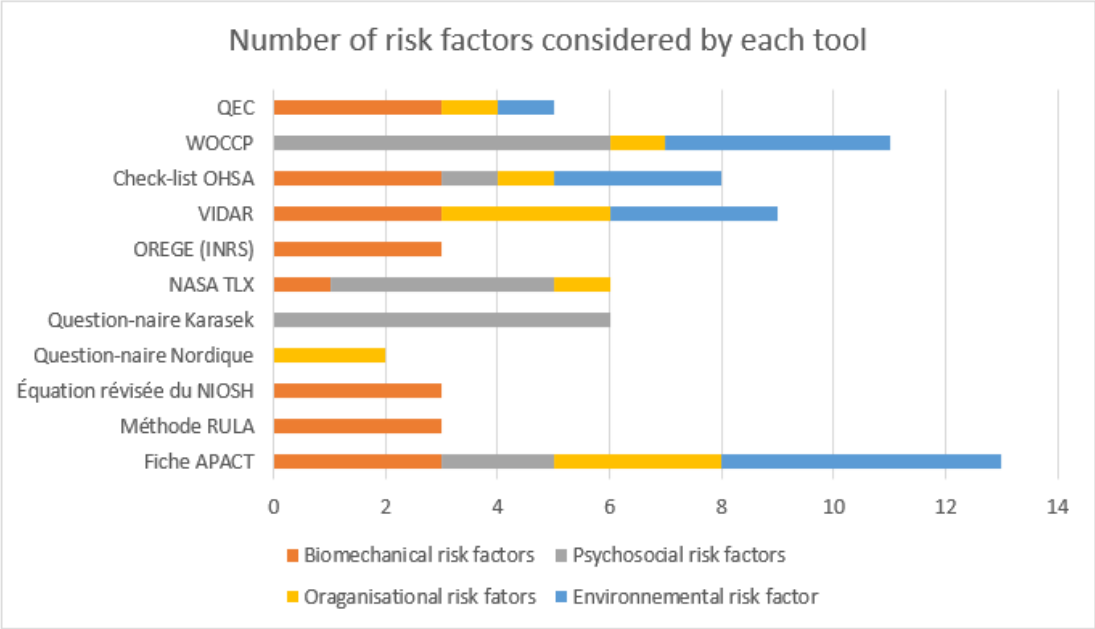

Figure 1. *Diagram of the number and types of risk factors assessed by each of the selected tools*

Based on this analysis, two kits were created containing the following tools:
- NASA TLX tool (subjective type), Nordic questionnaire (subjective type), APACT sheet (for objectivation), QEC method (objectivation);
- RULA method (objectivation), Kerasek questionnaire (subjective), OSHA checklist (subjective).

These tools were chosen for the kits because they are quick, simple and complementary as can be seen in the assessment of the risk factor coverage (Table 1).

A comparison of the two previously listed kits shows that for an almost equal amount of time spent to implement them (approx. 8 hours per kit), the number of factors they consider is not the same.

It is important to note that the objective of these kits is to provide a quick overview of a work situation. Given that some of the tools in these kits are subjective, an objectivation is necessary for any concerns that have been identified by these tools.

Table 1. *Comparison of the kits*

Evaluation of the tools	Kit 1	Kit 2
Biomechanical risk factors		
Physical demand	X	X
Joint position	X	X
Repetitiveness	X	X
Psychosocial risk factors		
Intensity and duration of work	X	X
Emotional demand	X	X
Lack of autonomy	X	X
Degradation of social relations at work	X	X
Value conflict	X	X
Job insecurity	X	X
Organisational risk factors		
Work pace	X	X
Night shift	X	
Working in isolation	X	
Maintenance organisation	X	
Environmental risk factors		
Temperature	X	X
Humidity	X	
Lighting	X	X
Vibrations	X	X
Noise	X	

The user is free to use whichever kit he deems the most appropriate to the situation he wishes to evaluate, be it kit 1, 2 or a kit of his own creation, making sure to cover all possible risks.

4. Conclusion

The literature on OHS risk management reveals that current tools, taken individually, are not appropriate for research laboratories, be they in a university or any other setting. However, this study shows that by combining several tools that assess risk factors from an ergonomics and human factors perspective, it is possible to cover the specificities of research laboratories, particularly those in a university setting.

By using a two-part analysis that highlighted the risk factors covered by each tool as well as their scale of deployment (national or international), it was possible to propose two kits. Each kit uses three or four assessment tools that are either subjective or for objectivation, making it possible to cover all the risks factors present in a university research laboratory. The goal of these kits is not to conduct an in-depth ergonomic assessment, but to quickly establish an overview of a work situation. Given that the kits use tools that are subjective, it is important to subsequently perform an objectivation for any concerns highlighted by these tools. These kits, by their practicality and

simplicity of use, provide an approach that meets the objective of this study. These kits cannot however perform a complete ergonomic evaluation, they can be used, for instance, to conduct a preliminary analysis in view of determining whether or not a more in-depth analysis is needed.

The methodology used in this project could be used to create new tool kits, namely to use the ergonomics and human factors engineering tools not mentioned herein.

5. References

Aptel, M., & Atain-Kouadio, J. J. (2000). *OREGE, un outil simple d'évaluation des facteurs de risque biomécaniques des TMS du membre supérieur*. *NS 196 Note scientifique et technique.*

Aziz, H. A., Shariff, A. M., & Roslan, M. R. (2011). Application of process hazards management in lab-scale pilot plant. Dans *2011 National Postgraduate Conference (NPC 2011). Energy & Sustainability: Exploring the Innovative Minds, 19-20 Sept. 2011* (pp. 3 pp.). IEEE Computer Society. doi: 10.1109/NatPC.2011.6136276. Repéré à http://dx.doi.org/10.1109/NatPC.2011.6136276

Foster, B. L. (2003). Principles of laboratory safety management in academia. *Chemical Health and Safety, 10*(2), 13-16. doi: 10.1016/S1074-9098(02)00457-4. Repéré à https://www.scopus.com/inward/record.uri?eid=2-s2.0-0037374217&doi=10.1016%2fS1074-9098%2802%2900457-4&partnerID=40&md5=f7807bbd5a4a515b37bcfc92466757f7

Foster, B. L. (2004). Laboratory safety program assessment in academia. *Chemical Health and Safety, 11*(5), 6-13. doi: 10.1016/j.chs.2004.05.016. Repéré à https://www.scopus.com/inward/record.uri?eid=2-s2.0-11144267262&doi=10.1016%2fj.chs.2004.05.016&partnerID=40&md5=11dfdd458b1788403d3a2b6cfca68441

Hill, R. H. (2016). The impact of OSHA's Laboratory Standard on undergraduate safety education. *Journal of Chemical Health & Safety, 23*(5), 12-17. doi: 10.1016/j.jchas.2015.10.017. Repéré à <Go to ISI>://WOS:000437614600004

Langerman, N. (2009). Lab-scale process safety management. *Journal of Chemical Health & Safety, 16*(4), 22-28. doi: 10.1016/j.jchas.2008.09.013. Repéré à http://dx.doi.org/10.1016/j.jchas.2008.09.013

Lowe, B. D., Dempsey, P. G., & Jones, E. M. (2019). Ergonomics assessment methods used by ergonomics professionals. *Applied Ergonomics, 81*.

Meyer, T. (2017). Towards the implementation of a safety education program in a teaching and research institution. *Education for Chemical Engineers, 18*, 2-10. doi: 10.1016/j.ece.2015.06.003. Repéré à http://dx.doi.org/10.1016/j.ece.2015.06.003

Napon, F., & Nadeau, S. (2018). Vers une intégration des risques opérationnels, de santé et de sécurité du travail en milieu universitaire.

Schröder, I., Huang, D. Y. Q., Ellis, O., Gibson, J. H., & Wayne, N. L. (2016). Laboratory safety attitudes and practices: A comparison of academic, government, and industry researchers. *Journal of Chemical Health and Safety, 23*(1), 12-23. doi: 10.1016/j.jchas.2015.03.001. Repéré à https://www.scopus.com/inward/record.uri?eid=2-s2.0-84960387437&doi=10.1016%2fj.jchas.2015.03.001&partnerID=40&md5=f3466a517cdbd65c30191f72f901138d

TMSMM, & L'assurance maladie-risques professionnels. (2010). Grille d'analyse des outils et methodes utilisés par les preventeurs des CARSAT, CRAM et CGSS pour l'intervention en prévention du risque TMS. Repéré à https://docplayer.fr/1053015-Grille-d-analyse-des-outils-et-methodes-utilises-par-les-preventeurs.html

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