Short Communication

ERGONOMICS AND EPIDEMIOLOGY IN EVIDENCE BASED HEALTH PREVENTION

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ABSTRACT

According to the definitions, ergonomics is a natural part of the health and safety activity but it has its own research methods and causal models. Public health, occupational and clinical medicines are closely related to epidemiology and differ from ergonomics by using a disease model with a wide web of causal factors. Evidence based medicine, mainly based on epidemiology, was established to improve the quality of the pharmacological treatments based on randomised controlled clinical trials. Later, evidence based medicine was extended to non-pharmacological public health trials, but the same success of health effects from the clinical trials could not be obtained. It is argued that the ergonomics design, Integration and Implementation can be strengthened by adapting the epidemiological methods and causal models. The ergonomics can then contribute to a common development of public health and occupational preventive methods. One important aspect is whether the randomised controlled study design should still be held as first priority for the evaluation of large scale health interventions, or the use of descriptive studies are the most useful. Randomised intervention trials are probably most useful for patients or for persons with pre-conditions of diseases like pre-hypertension and pre-diabetes and for the most vulnerable parts of the populations.

Keywords: epidemiology; public health; occupational medicine; intervention; evidence based medicine.

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INTRODUCTION

Ergonomics has been defined as the application of scientific information concerning objects, systems and environment for human use. This definition is adopted by the International Ergonomics Association in 2007 [1]. Ergonomics is widely used by the industrial companies to design tasks and work areas to maximize the efficiency and quality of their employees’ work. Ergonomics comes into everything which involves people, like work systems, sports and leisure. According to the definition and the practice, ergonomics is a natural part of the public health and occupational medicine. Still the ergonomics is often viewed as a specific auxiliary health profession with its own specific research methods.

Public health can be defined as the science and the art of preventing disease, prolonging life, and promoting physical health and mental health and efficiency through organized community efforts. Occupational medicine is a part of the public health and deals with the prevention and treatment of diseases and injuries occurring at work or in specific occupations. Epidemiology is the study of the occurrences of the health risk factors (determinants or exposures) and the health effects - and the study of the relations between the identified risk factors and the health effects. It is considered as a cornerstone methodology of public health-, clinical - and occupational health research and is highly regarded in evidence-based medicine for identifying risk factors for disease and determines the optimal treatment approaches for clinical practice and for public health.

Recognizing that ergonomics is a part of public health, occupational health and safety and epidemiology, the intention is to draw some perspectives between the ergonomics and the epidemiology with the aim to strengthen the research and practice of the ergonomics design, integration and implementation.

THE TARGET POPULATIONS

The primary target for epidemiology is the community, while the primary target for ergonomics is the individual. As a part of the health and safety activity in the community, there is no reason to believe that the same methods for research and practice could not be the same. Therefore, in order to inspire to a wide use of epidemiology in ergonomic research and practice, some basic concepts and examples of epidemiology related to the ergonomic practice and research, are presented.

EPIDEMIOLOGY AND DISEASE MODELS

Epidemiology is used to describe how people are influenced by the changing types and strengths of exposures and health conditions over the whole life time or shorter periods of life. The developing health effects are developed due to the impact from multiple risk factors at different levels at work and in the community during a short or long time.

The risk factors are weak or strong depending whether they occur isolated or as part of concerted actions. The impact on health from the different exposures vary across different strata in the community, like age groups, social groups, gender, occupations, educations and other characteristics. The basic concepts in epidemiology are the incidence and the prevalence...
The incidences rate is a measure of new cases of diseases and the prevalence rate is a measure of the existing health conditions and the exposures. The difference between the practice of ergonomics and the epidemiological health practice also lies in the different disease models that are used. The epidemiology includes variables from the causal web of health risk factors or exposures, all types of health effects, diseases and injuries, treatments or interventions and the prognosis [2]. Ergonomics is divided in the physical, cognitive and organisation characteristics of human activity. One main difference to epidemiology is that “relations” between health effects and exposures are not used to the same extent in ergonomics as in epidemiology. The risk factors in ergonomic studies of work-related musculoskeletal pain and the exposures are concentrated on work posture, force, repetition and vibration in addition to individual factors such as gender, age, previous diseases, strength training etc. As the factors are supposed to relate to the individual employees, the interventions will also be restricted to the individuals at the workplace. Earlier the public health was called community medicine or social medicine using primary, secondary and tertiary prevention.

The concept of “proactive” and “reactive” response has been launched as the most modern method in ergonomics [3]. The terms “re-active” and “pro-active” methods that are used in ergonomics are identical to “treatment of diseases” and “identification of risk factors” in public health. The use of “safety rounds” in industrial plants would be “pro-active” according to the ergonomic vocabulary and “identification of risk factors” in public health. Stress is considered to be caused by many different and interacting factors in the working environment, like work management, the personal influences on own work and the personal support [4]. The “ergonomic” mono-factor disease model implies that each person is the main responsible for his or her own health in the particular working environment and thereby lose the possibility to prevent some root and environmental causal factors. Despite the absence of evidence of any health effect by using individual adjustable office tables, still they are recommended and used widely. Only recently, evidence of the beneficial health effects was published, but only for high school adolescents [5]. Evidence of long term health effects by using these tables at work is still absent. There seems to be a need for changing the ergonomic practice by using the multifactor disease model and the epidemiology in the curriculum of the ergonomic education and research.

**Basic Intervention Models**

The goal for health and safety activity is defined by the World Health Organisation, the International Labour Organisation and other international organisations. The goal is to obtain decent work for all with zero accidents, no dangerous exposures and a low incidence and prevalence of chronic diseases by building a health and safety culture for all. The basic problem solving model is part of the public health prevention model with the stages: Problem identification ➔ Causal analysis ➔ Treatment/intervention ➔ Implementation in practice ➔ Evaluation of the effect ➔ Corrections of the treatment/intervention (Figure 1). The white area above is the analysis and the grey areas indicate the intervention phase. This structure is the basis for more detailed health promotion models with causal factors split up in many different areas: human factors, the technical factors and the community factors (Figure 2).
Moreover, each of these is again divided into other sub-domains. See for example the Precede-Procede model [6]. The most important risk factors that need to be changed are identified in the analytical phase and the needed changes are performed in the intervention phases. The Haddon Matrix was developed for injury prevention and was based on the same three domains, the human, the technical and the environment with a time sequence: before, during and after the accident [7]. Haddon’s strategy for injury prevention includes the same basic structure for diseases prevention: problem description, analysis of the causes, and selection of remedy and application of remedy [8]. Based on the same framework, the models have been developed during the years, but still with the same content with the social medical perspective. One of the most recent developed injury prevention models, the “bow-tie” injury prevention model is claimed to be a “reactive” method while it does not include actively the whole organisation in the injury prevention [9]. The prevention circle method is also used for medical diagnosis and treatment of individual patients: 1. Decision about the diagnosis based on the symptoms, laboratory values etc. and the causal factors → 2. Find a treatment with known effect and with minor side effects → 3. Implement the treatment → 4. Follow the patient by regular controls, evaluate the health and side effects and make the needed corrections of the treatment. This circular rationality is also used in the Evidence Based Medicine, as described below.

**EVIDENCE BASED MEDICINE**

The principle of using the best knowledge for medical practice is as old as medicine but the concept of “Evidence-based medicine (EBM)” has been introduced within the latest fifty years [10]. The meaning of “the integration of best research evidence with clinical expertise
and patient values” EBM was primarily developed for clinical health care, but the concept “evidence based medicine” has also been introduced in the occupational health field and so this is also of high relevance for the ergonomics practice [11]. The main steps of the EBM process also correspond to the basic problem solving model [10]:

- Defining the question(s) that needs to be answered (clinical or in a population)
- Collecting the evidence to answer the question
- Critical appraisal of the evidence gathered
- Integration of the evidence and patient factors to implement the decision
- Evaluation of the whole process for future improvement

Instead of the patient in the clinical practice, the population is the subject for health improvement in the public health programs. If there is no evidence available or if the available evidence is insufficient, then we may have a relevant research question. So the use of these principles has two important issues: The critical use of the existing knowledge and formulating of new research questions. Introducing this concept in ergonomics could probably also inspire more ergonomics practicing to be engaged in epidemiological research projects.

**EPIDEMIOLOGICAL STUDY DESIGNS**

Corresponding to the evidence based medicine or evidence based principles for medical practice are the specific epidemiological design types briefly described in the following divided in three main study lines which are not always sharply defined so that each of the three types also can include elements from the other types of study.

1. The Descriptive Study Line

Prevalence and incidence studies are descriptive studies. Incidence studies describe the rates and rate-ratios of the new cases of health effects (diseases and symptoms) in specific populations over some specific time interval. The results are expressed as x cases (of a specified type and severity) per n persons in a specified time interval, like one year or other time interval. This is the cumulative incidence rate. Incidence is often calculated more precisely by use of the person time, as x cases per for example 10,000 hours (or days, years or some other time scale). The rate-ratios or the relative risks are used to compare the risk in one part of the population with another part. Incidence studies of death are mortality studies. Prevalence studies describe the status of the health and the risk factors and repeated studies or the follow-up in a cohort can describe the development of the disease and the exposures. Prevalence rates can be related to one particular moment (point prevalence) or to a long period, like the latest month, year or the whole life (period prevalence). The incidence and prevalence of chronic diseases, like low back pain, obesity, diabetes and cardiovascular diseases can be followed from the childhood to the retirement to identify the areas with the highest risk. Data comes from different sources, public registers and questionnaires. Part of
the population with the most serious and most frequent diseases can then be pointed out to prioritise specific causal studies and intervention programs [2;12].

2. The Causal Study Line

A cohort study is a research study that is used to test hypotheses about the causal relations of some specific exposures, like heavy manual work or lack of physical activity to low back pain. The possible causal relation between the diseases and the hazardous exposures includes the study of factors at work and outside the workplace. The impact of public health campaigns, like anti-smoking campaigns or other health campaigns can be estimated by use of cohort studies.

The case-control studies are used alternatively to the cohort studies to investigate the causal relations. A case-control study starts with the identification of a group of cases, individuals with a specific disease or health condition and a group of controls, individuals that are similar to the cases in most aspects, but without that specific health condition – and presumably with different exposure status. The cases and the controls are sampled without knowledge about the exposure status in a virtual population that would have been used, had a cohort study design been applied. The percentages of exposed and non-exposed are measured in the group of cases and the controls. The ratio of the percentages of exposures is called the odds (uneven). The ratios of the odds are calculated and yield the odds ratios that are used to estimates the prevalence rate-ratios. Most often, the case-control studies are used for rare diseases where it is impossible to gather sufficient large study populations. Case-control studies can most often not be used to estimate the incidence rates or prevalence rates, as only the proportion of the random sample sizes are known and the actual population sizes are unknown.

3. The Intervention Study Line

Intervention studies, or experimental studies, are research studies where the researchers manipulate at least one independent variable and observe the effect on one or more of the dependent variables. There are two types of experimental studies that differ concerning the characteristics of the study population. The first type of study is the randomised clinical controlled trials of pharmacological treatments among randomised groups of patients. The other type of intervention study is for the population that is still active at work or active at the daily activities. Part of the group already has the first stages of chronic diseases like obesity, diabetes and hypertension and the group is still changing from being completely healthy and into the group with the first stages of disease. To prevent further aggravations of the preconditions of the diseases, the causal factors need to be prevented by non-pharmacological interventions before more serious stages are developed. The choice of non-pharmacological treatment or intervention is based on the assumption, that the pharmacological treatment does not cure the causes with the consequences that the conditions will be aggravated over time. The populations that are used in the intervention studies can then be divided in three types: 1. Patients with diagnosed specific diseases. 2. Persons with pre-conditions of specific disease who are in a stage to be either patients or healthy persons. 3. Healthy persons without any
diseases or pre-conditions of diseases. There are sparse documentation of the health impact from public health randomised intervention studies especially for group 2 and 3 [13]. Therefore the use of randomised intervention studies should always be considered carefully and mainly used for populations related to group 1 or 2 and for the most vulnerable social groups of the population.

**CHANGE OF PARADIGM IN HEALTH SCIENCES**

The randomised clinical controlled experiment with diseased patients has been held as the finest and most valuable type of health research for a long time. The principle of the randomised clinical controlled experiment is founded in the paradigm of the positivism dominated by the philosophy by Carl Popper. The randomized controlled clinical trial was supported by the medico-pharmacy industrial interests, who wanted to increase their production and purchase of high quality medicaments [14]. Evidence based medicine was established to improve the quality of medical treatment of individual patients by securing high quality of experimental studies. The Cochrane Library has played an important role in this development and has been known as the state of art of evidence based medicine [15]. It contains a large number of quality-assessed reviews of successful intervention studies of medical treatments. Concerning the community randomised controlled experimental studies, there are successful intervention studies, but mainly for populations in transition to be patients, for example those with pre-hypertension and pre-diabetes [16]. There is evidence that interventions directed towards individual smokers also increase the likelihood of quitting smoking and that workplace tobacco policies and bans can decrease cigarette consumption [17].

The excellent results that were obtained from randomised controlled trials do not seem to be obtainable in the health promotion intervention studies. The clinical RCT study type was primarily used to test the effect of few or only one type of treatment where the health effect is seen in a short time. In the public health experiments, many different health risk interacting factors are included and a long time span is needed to show the health effect. So this is probably one of the main reasons why public health large-scale experiments with many risk factors, are difficult to perform as randomised experiments. There is a high need to continue with the RCTs, but for public health experiments it might be good to consider whether a more useful design should be used. Well-performed cohort studies and repeated prevalence and incidence studies where it is possible to measure the overall health effect over many years, could be used alternatively. Guidelines for reporting of descriptive studies, have been published recently.

This can contribute to an increased use of the descriptive design and can strengthen the research quality [18]. By improving the quality of the descriptive studies, this study design can be placed at the top of the hierarchy of research together with the randomised clinical studies. Vulnerable part of the populations and the areas with social inequality of health can be pointed out and the studies can be used as a base for planning and development of specific intervention programs.
CONCLUSION

Ergonomics is an important part of public health and occupational medicine but it has its own research and practice traditions. The objective of the ergonomics profession is identical to that of public health and occupational medicine and it should be a challenge for the ergonomics to adapt the epidemiological methods. The public health and occupational intervention programs together with the ergonomics programs can be strengthened by a conscious use of descriptive study design where the randomised controlled studies are considered impossible to perform. The ergonomics can then contribute to a common development of a new paradigm for preventive methods and the ergonomics design, integration and implementation can be strengthened. Due to lack of success from randomised intervention trials of health promotion in healthy populations, the use of the randomised public health intervention trials in public- and occupational health should be considered carefully. Randomised intervention trials should probably mainly be used for patients and populations with pre-diseases, like pre-hypertension, pre-diabetes and for the most vulnerable parts of the populations.

REFERENCES


