Ergo + 50: Ergonomic Assessment Methodology Aimed at Older Workers

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Abstract. The ageing of population in Western societies has a marked impact on social reality and its effects affect many areas, including work.

Ageing has implications, both positive and negative, in people's abilities and skills. While some abilities (vision, hearing, strength …) may decrease, some cognitive functions, such as controlling the use of language or the ability to process complex problems, may improve with age.

Although the effects of ageing on skills have been widely studied, the variability of the evolution of people makes it necessary to have assessment methods that consider older workers and, in particular, that value the ability to work and guide towards criteria that favour labour insertion and ergonomic adaptation of jobs.

These are the principles that have guided the development of the "Ergo + 50" methodology, an ergonomic assessment procedure aimed at detecting working conditions that have a specific relationship with the ageing process. The methodology includes two interrelated modules that analyse, on the one hand, the characteristics of tasks and jobs (environmental conditions, cognitive aspects, physical load, design, organization, policies …) and, on the other hand, the perceived abilities of older workers, to carry out the tasks. The results obtained include the prioritized diagnosis of the situation, as well as recommendations for improvement.

Keywords: Ergonomics assessment · Older workers · Ageing · Workplace design · Workplace adaptation · Work ability

1 Introduction

1.1 The Ageing Workforce

As society ages, so does the workforce. According to data from the European Labour Force Survey [1], workers aged 55+ currently make up for 16% of the total workforce in the European Union. By 2030, workers aged 55–64 are expected to make up 30% or more of the workforce in many European countries. The retirement age is increasing in many countries and many workers are likely to face longer working lives [2].

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Ageing at work is, therefore, a reality that affects both the health and safety of workers and the productivity and competitiveness of companies. Ageing at work is conditioned by the **work ability**, which is determined by the interaction between the characteristics of the workers and the working conditions.

Work ability is a complex concept that encompasses the individual and occupational aspects that are essential when facing the demands of work [3]. Individual resources that influence work ability include the person's health, functional capacity (physical, mental, social), professional competence (training, skills, experience), motivation and job satisfaction. Regarding the occupational factors that influence the way individual resources are used, the demands of work (physical, mental), the environment, and the organization of work can be included.

As the World Health Organization [4] indicates: "changes that occur during ageing are not linear or uniform, and only vaguely associated with a person's age". Individual variables and life history make the difference in the forms of ageing: an elderly person may be full healthy and another may be dependent to carry out the activities of daily living. However, from a biological point of view, ageing reduces the physiological reserves and therefore there is a greater chance of having diseases and a reduced functional capacity.

Changes in the roles and social positions during the life cycle are very frequent, these changes are important and it is necessary to consider them to understand the process and the heterogeneity of the ageing process.

The functional capacity of a person is determined by physical, sensory and cognitive level, as well as the interactions associated with different environments throughout life.

- At the physical level, as people age, we can find a reduction in joint mobility, especially in the hands and neck, due to different factors such as loss of bone mass, loss of tissue flexibility, disorders of the nervous system and vascular disorders, among others. There are also other aspects such as decrease in strength, balance alterations or changes in gait, due to different pathologies [5–7].
- At the sensory level, we can highlight the reduction of visual acuity, changes in sensitivity to contrast or glare, worse adaptation to darkness and less colour discrimination, decreased hearing capacity and less tactile discrimination of forms [3, 8, 9].
- In the cognitive area, there is a reduction of the sustained attention and less flexibility in the areas of memory and learning [3, 8].

Nevertheless, these changes have many individual differences. That is what we know as "individual ageing" [10].

The association between work and ageing can be seen, therefore, from two complementary perspectives:

- First, due to the natural ageing process of all people, older workers may face problems related to the design of their jobs (for example, hand force decreases with age, therefore a 55 year old person is not going to be able to perform the same efforts as when he or she was young).

- On the other hand, certain jobs can be a major hazard on people, which can lead workers to face an accelerated process of ageing or deterioration (for example, shift work, work on heavy tasks, under extreme environmental conditions, etc.).

The work ability is not only related (negatively) with the age deterioration and the lack of adaptation of the environment. The performance of the career can provide certain advantages to older workers, such as experience, ability to solve complex problems, tricks and shortcuts in certain tasks, global vision of the company and their job, etc. These aspects are very important because, being well managed, they can be an important asset when assigning tasks, organizing work or redesigning jobs, so that workers are able to adapt satisfactorily to work.

1.2 The Ergonomics Perspective on Ageing

In a broad sense, we could define ergonomics as the multidisciplinary field of knowledge that studies the characteristics, needs, abilities and skills of human beings, analysing those aspects that affect product design or production processes. All the applications have a common objective: to adapt the products, tasks, tools, spaces and the environment to the ability and the needs of people to improve the efficiency, safety and welfare of users or workers [11].

The poor ergonomic conditions in the workplace can cause lack of efficiency, low productivity, errors or discomfort. However, the most visible and problematic effects of the absence of ergonomics in the workplace are musculoskeletal disorders [12, 13].

Ergonomics plays an important role in this association between work and ageing. Ergonomics, from a work perspective, deals with the adjustment between the demands of the job and the worker's abilities, so demands are never higher than capacities and, therefore, work performance is healthy, comfortable and efficient.

Ergonomic assessment aims to detect the mismatches that exist between the characteristics of the work and the worker's abilities and assess the potential risks that the work may cause to the worker. In this sense, it is important to consider the workers' diversity and pay special attention to those that can be sensitive to working conditions. Age is an example of the human diversity and, therefore, should be take into account in the ergonomic studies. The two most relevant aspects when considering older workers in the ergonomics assessment are:

- Assess the actual capacity (not the age) and compare it with the job requirements.
- Focus especially on risks that are more likely to affect older workers: physical (repetitiveness, efforts), organizational (shift and night work), environmental (extreme temperatures), psychosocial (obsolete skills, lack of updated training), etc.

The **ergonomics assessment methods** make possible the identification and evaluation of the risk factors present at the workplaces in order to put forward redesign options to reduce the risk to an acceptable level for workers:

- For an **initial assessment**, the use of **checklists** is recommended. Checklists are quick methods of assessing ergonomics and psychosocial working conditions. They are used to determine qualitatively the conditions of the workstation or a worker's activities that could contribute to an injury.

- The specific (or quantitative) ergonomic methods make an **objective assessment** of the ergonomics conditions of a workplace. The goal of these methods is to identify ergonomic risk factors, quantify them, and then make measurable improvements in the workplace. There are many methods, normally classified depending on the physical strain (or the type of task) to be assessed: load handling, postures, repetitiveness, etc. The NIOSH equation [14], REBA [15], ERGO-IBV [16] or OCRA Index [17] are examples of quantitative methods.

Both checklist and quantitative methods are normally addressed to general population, so they don't consider that some workers (e.g.: older workers) can have limited or different capabilities. In some cases, there are different strategies or recommendations to adapt these methods to older workers, for example [18]:

- Lowering the "recommended weight limit" to calculate the risk of manual material handling tasks.
- Adding additional penalty factors to the postures assessment (e.g.: kneeling, crouching, long-term standing/sitting…).
- Adding a multiplicative corrector of 0.6 to the risk index when the worker affected is over 50 years.

These approaches, although interesting, are not completely useful, as they don't consider the individual capacity. To solve these issues, some methods try to specify which the work ability of specific individuals is. One of the most known proposals to do that is the **Work Ability Index** (WAI) [19].

The work ability index gives an idea of individuals' perceived work ability and involves a questionnaire complemented by an interview; it can also provide an indication of the potential for disability in the future or early retirement. The WAI questionnaire covers several dimensions of individuals (current work ability, number of diagnosed illnesses or limiting conditions, own prognosis, etc.).

Each answer has a different score. The minimum total score is 7 (bad work ability), the maximum is 49 (very good work ability).

The WAI can be used for individual employees and groups of workers. However, it can also be applied as an analysis tool to the whole company or the whole workforce of a company. It offers the possibility of comparing individual departments or company sections as well as individual groups of employees and age groups according to their WAI values.

Although being widely used, WAI has several disadvantages:

- It is founded on subjective data collected by a self-assessed questionnaire.
- There is no direct comparison between specific demands and specific capacities. Therefore, it is not possible to locate the exact source of the problems and propose accurate adaptation measures.

To solve these issues, some ergonomic tools consider that it is necessary to analyse work and worker features using similar criteria and common assessment levels to facilitate their comparison and interpretation of results. These are the job matching methods. The ultimate purpose is to match the worker capacities with the work

requirements, in order to ensure the best possible job placing under given circumstances.

Job matching methods try to determine the relationship between work demand (W) and the capacity of a person (P). As shown at Table 1, there are three possible relations between these two factors:

Table 1. Relation between demand and capacity in job matching methods

Relation	Meaning
W = P	Ideal
W < P	Sub-demand
W > P	Over-demand

When discrepancies between demands and capacities appear, and before taking the final decision about the case, the analyst must consider whether the work demands can be modified (by decreasing the workload, providing new equipment, adapting the workflow, etc.) and/or if is possible to improve the worker's ability (through training, personal assistive devices, etc.).

Job matching methods are intended mainly for workers with functional limitations: impaired workers (back-to-work situations, e.g. NedLabor method [20]) or workers with disabilities (e.g.: IMBA [21], JobFit [22], ErgoDis [11]). Nevertheless, they can also be used with older workers to identify if there are functional limitations associated with age that may be causing mismatches with the work requirements.

These are the principles that have guided the development of the "Ergo + 50" methodology, an ergonomic assessment procedure aimed at detecting working conditions that have a special relationship with the ageing process (ergonomic assessment) and compare them with the perceived abilities of older workers.

2 Results. The Ergo+50 Methodology

Ergo+50 is an ergonomic assessment tool intended to help with age management in companies. The tool allows identifying the main working conditions that are related with age. The methodology includes two interrelated modules that analyse, on the one hand, the characteristics of tasks and jobs and, on the other hand, the perceived abilities of older workers, to carry out the tasks. The results obtained include the prioritized diagnosis of the situation, as well as recommendations for improvement.

The tool is structured in two questionnaires:

- The questionnaire to **assess working conditions** must be filled out by the company. It contains items related to the working conditions, the workplace design, the environment, the task organization and the age management activities.
- The questionnaire for the **self-evaluation of older workers' abilities** is individual, voluntary and confidential. It is filled out by the older workers of the company. It contains items aimed at the assessment by the staff of their ability to carry out the

work requirements and at the assessment of the measures of the company related to age management.

Both questionnaires are optional, meaning that it is possible to fill in only one of them or both. The results and recommendations will be different depending on this choice.

The tool offers a report for each one of the questionnaires, including recommendations to help controlling the detected risks and, in case of completing both questionnaires, a report that links the working conditions with the evaluations of the workers.

The Ergo+50 tool is a module integrated at ErgoIBV [23], a software that allows evaluating ergonomic and psychosocial risks associated with the job.

2.1 Working Conditions Questionnaire

This questionnaire includes 48 questions structured in the following sections:

- (1) Physical load: Manual material handling & efforts.
- (2) Physical load: Postures and movements.
- (3) Cognitive aspects.
- (4) Workplace design: Anthropometry, space and equipment.
- (5) Vision.
- (6) Hearing.
- (7) Environmental conditions.
- (8) Work organisation.
- (9) Age Management

The first eight sections include questions about the working conditions. The questions that have been selected include aspects in which there is a greater probability of age being a risk factor. For example:

- Tasks that require a high and continuous effort.
- Prolonged standing/sitting.
- Exposure to a lot of information and/or stimuli.
- Side reach or reaching behind the body.
- Situations of direct or indirect glares.
- Sound signals and/or noise that can mask important auditory messages.
- Shift work (including night shifts).
- Etc.

The ninth section includes questions about how the company is managing age. Topics treated here include:

- Health promotion.
- Health surveillance.
- Return-to-work policies.
- Training.
- Hiring and recruitment policies.
- Transition to retirement.

The first eight sections can be addressed to a specific task, workplace or department and should be filled in by OSH technicians. The ninth section inquire aspects about the whole company (although could be restricted to specific departments or workplaces) and should be filled in by managers or human resources' staff.

All the questions are structured in the form of a checklist, in which any marked condition implies a potential problem to be solved. Additionally, some questions include performing simple calculations or an extended questionnaire:

- Manual material handling: calculation of the acceptable mass. The program calculates the acceptable mass by multiplying the recommended theoretical mass, depending on the handling zone, by a series of correction factors associated with the vertical displacement of the load, trunk twisting, coupling, duration and frequency of the handling. Once these data have been entered, the program automatically displays the value of the acceptable mass. Thus, when the actual mass handled in the task is higher than the calculated acceptable mass the item should be ticked to indicate that the risk factor in question exists. The procedure is based on the Spanish Technical Guide for Manual Material Handling [24].
- Reaches. The program calculates if the reaches that are performed by the worker are comfortable, forced or not accepted. To do that, reach depth and height (cm) must be introduced. The calculations distinguish the acceptable reaches for men and women. The calculations are based on a study to identify the design criteria for the elderly [25].
- Work tools (extended checklist)
- Working space (extended checklist)
- Lighting levels. The program analyses if lighting levels in the workplace are adequate. To do that, it is necessary to select the type of task and/or the area where the work is performed and the actual lighting level (in Lux). Calculations are based on international standards [26].

After completing this questionnaire, the company can obtain a report that includes the potentially negative items and recommendations for improvement.

2.2 Self-Evaluation of Older Workers' Abilities

Although the Working Conditions Questionnaire is aimed to detect aspects that are highly related with age, many conditions will be a real problem depending on the specific capabilities of the older workers. To find out what capabilities are those, the Self-evaluation of older workers' abilities questionnaire can be used.

This questionnaire is individual, voluntary and confidential. It is filled out by the older workers of the company (or of the specific workplaces or sections that are being analysed). It contains items aimed at the assessment by the older staff of their ability to carry out the work requirements and the assessment of the measures of the company related to age management.

The assessment of own ability to carry out the tasks contains similar items to those inquired at the working conditions, but in this case each worker has to assess their perceived capacity to accomplish the requirements. The assessment is done using the following scale:

- Not applicable = this requirement does not exist in my workplace
- Bad (it's very hard for me or I cannot)
- Moderate (I can do it, but with problems or discomfort)
- Good (I do not have limitations)

The second part of the questionnaire includes questions so that the worker can assess the company's measures related to age management. The questions are similar to those asked at the working conditions questionnaire. The assessment is done using the following scale:

- Disagree (these measures are not implemented in the company or, even if they are, they do not benefit me)
- Neutral (they do not affect or interest me, regardless of whether they have been implemented or not)
- Agree (the measures have been implemented and benefit me)

After this questionnaire has been fulfilled by the workers, the company can obtain a report that includes the percentages of perceived capacity of the staff.

2.3 Joint Results

If the two questionnaires have been fulfilled, Ergo+50 software offers the following results:

- The potentially negative items that have been detected at the working conditions and recommendations to improve them.
- The percentages of perceived capacity of the staff.
- The relationship between the working conditions and the perceived capacity of the workers. Here the Ergo+50 tool works can be used as a **Job matching method**, allowing the detection of mismatches between requirements and capacities. The possible results are three:
- MATCH: Working condition is adequate; or working condition is not adequate but the worker has good capability.
- MODERATE MISMATCH: Working condition is not adequate and the worker has capacity problems or discomfort.
- HIGH MISMATCH: Working condition is not adequate and the worker has a bad capacity.

The match/mismatch results are shown as a percentage of the workers that have fulfilled the questionnaire.

The Ergo+50 tool offers the results ranked depending on the mismatch severity, the percentage of workers having capacity problems/mismatches and the occurrence of negative working conditions. Recommendations are provided for each result.

3 Conclusions and Further Work

Ergo+50 is an ergonomic assessment tool intended to help with age management in companies. This tool merges the ergonomic assessment with the evaluation of the workers capacities. The combination of both aspects allow detecting the mismatches between working conditions and workers capacities. The results obtained include the prioritized diagnosis of the situation, as well as recommendations for improvement.

The tool will be tested in different companies, in order to validate the methodology used and the results developed. The validation process will allow refining the evaluation procedure and will facilitate the development of new applications and recommendations to help companies managing the ageing of their workers.

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