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Ergonomics — Application of ISO 11226, the ISO 11228 series and ISO/TR 12295 in the agricultural sector

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 3, *Anthropometry and biomechanics*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Agriculture is by far the biggest working sector in the world. It is estimated that 2,6 billion people or 40 % of the world's population are farmers. Agriculture is one of the most hazardous sectors in both the developing and the developed worlds. Work-related musculoskeletal disorders (WMSDs) are the most common work-related diseases in farmers. In Europe more than 50 % of farmers report disorders of their lower back or limbs related to their working conditions. WMSDs are caused mainly by manual handling, heavy physical work, awkward postures and repetitive movements. Increasing attention is being drawn to the application of practical actions in agricultural settings to help reduce work-related accidents and illness and WMSDs in particular. ISO 11226, the ISO 11228 series and, more recently, ISO/TR 12295 are useful for this specific scope.

Experiences in the application of these standards have been acquired in different parts of the world, but rarely in agriculture. This document extends the scope and methods included in existing standards to different agricultural contexts (e.g. smallholdings, industrialized farms) based on emerging application experiences. Special attention is devoted to rendering this document accessible also to non-experts. Reference is made to easily applicable, non-commercial online tools (simple tools in spreadsheets) that may be useful for the purposes of this document, making possible the application of the criteria provided here and therefore the real numerical estimate of the biomechanical overload risks.

The ISO 11228 series, ISO 11226 and ISO/TR 12295 establish ergonomic recommendations for different manual handling tasks, repetitive movements and working postures. All their parts apply to occupational and non-occupational activities. The standards provide information for designers, employers, employees and others involved in work, job and product design, such as occupational health and safety professionals.

ISO 11228 series consists of the following parts, under the general title *Ergonomics — Manual handling*:

— Part 1: Lifting and carrying;

— Part 2: Pushing and pulling;

— Part 3: Handling of low loads at high frequency.

ISO 11226 provides recommended limits for static working postures with no or minimal external force exertion, while taking into account body angles and duration.

ISO/TR 12295 serves as an application guide of the ISO 11228 series and ISO 11226. It offers a simple risk assessment methodology for small and medium enterprises and for non-professional active.

This document is intended to be used alongside ISO/TR 12295, ISO 11226 and the ISO 11228 series in the agricultural sector, where the risk from biomechanical work overload from repetitive movements, from manual handling of loads, from towing and pushing carts and awkward postures is universally present.

In addition to having deeply used the standards previously mentioned, an extensive review of the literature on methods for risk assessment of biomechanical overload applied in the agricultural setting for the prevention of musculoskeletal disorders (MSDs) has been conducted, of which the most salient data are reported.

Regarding crop production (not cattle), the assessment of biomechanical exposures at work results in 800 studies where 58 studies were selected on the basis of title and abstract. Only studies regarding crop production and reporting on risk assessment of biomechanical exposures at work were included in the analysis.

The design of the selected studies was mostly cross-sectional (70 %) and Asia was the world region from where the majority of the studies came (41 %). In addition, 10 studies were carried out in South America, 13 in North America (Canada and the USA), 10 in Europe and two in Africa. Most of the selected studies were field studies (68 %); only 8 % were carried out in a laboratory and seven studies were classified as surveys.

Regarding the applied methods, 14 studies used direct measurements (e.g. electromyography, accelerometer) and 12 studies used different types of questionnaires (self-compiled or filled in by an Ergonomist).

Six studies used the RULA (Rapid Upper Limb Assessment)[45] method.

OWAS (Ovako Working Posture Analysing System)[42] was used as a risk assessment method in five studies.

The OCRA (Occupational Repetitive Actions[21],[22]) checklist, the REBA (Rapid Entire Body Assessment) [39] method and the QEC (Quick Exposure Check)[29] method were used in nine studies (three studies).

Most of the applied methods are observational and attention is drawn to the problems related to their reliability, especially when the movements are fast.

These studies represent a summary of the papers published in the last decade in the agriculture sector. The available research has shown a lack of high-quality studies (generally using statistical "prospective" studies) to evaluate the dose-response relationship between the level of biomechanical exposure at work and the outcome (MSDs). It is necessary to consider in fact that, given the lack of results of clinical studies in agriculture (due to the widespread difficulty in subjecting workers to health surveillance), occupational exposure limits connected with the probability of generating MSDs in the agricultural setting are not available.

The OCRA checklist method, in its multi-day cycle risk assessment version,[22] is currently the only risk assessment method available in literature capable of offering criteria and application experiences to address multitask analysis (supported by a specific simple tool in the form of free download spreadsheets for final risk calculation).

ISO/TR 12295 had already adopted this multitask method of exposure analysis.

Clinical evaluation of exposed workers, conducted in multitask studies in agriculture with the OCRA method and with other methods, are still limited to few longitudinal studies due to great difficulty in having case studies subjected to health control, as there are rarely fixed-term workers, but more often seasonal workers, with high turnover, without regular work contracts and underpaid. For this reason, the prospective studies are difficult and very rarely can be concluded.

After all, the development of a method capable of predicting the appearance of pathologies (real risk assessment method) can be conquered only after years of use and improvement. The development of a new TR which, offering evaluation solutions for biomechanical overload study in agriculture, can stimulate many more valid epidemiological studies in the future, is therefore desirable. The concept of doing nothing, while waiting for sufficient and perfect published methods, means not doing prevention.

The NIOSH itself, due to the formula for calculating the lifting index (LI), changed the maximum limit value of its first formula several times over the years, through years of application experience. Recently the NIOSH added the formula for calculating the variable lifting index (VLI) for the evaluation of manual lifting tasks of complex loads, with many different weights and geometries[20],[63]. The gained experience in this type of analysis was introduced in ISO/TR 12295 and ISO 11228-1.

For the study of working postures it is important to point out the new TACOS (Timing Assessment Computerized Strategy for posture)[24] strategy, which adds to all the experience gained from the RULA and REBA methods and from ISO 11226, a more adequate timing assessment (therefore not only qualitative studies of work postures, but also studies of their real duration).

The mathematical criterion for the extension of the calculation of any risk factors for the study of biomechanical overload, not only for the working day cycle but also for cycles different in duration (e.g. annual cultivation cycles) was also discussed within a specifically activated writing group of experts for the preparation of this document. The transition is indispensable for the extension of the evaluation models already present in the specific International Standards (all used in this document) to the risk evaluation in multitask exposition with annual turnover needed for risk studies in agriculture (see Annex B).

Any other risk assessment methods that include a multitask analysis procedure can adopt the criteria here proposed, extending multitask annual exposure risk study, for instance to:

— repetitive movements (e.g. strain index, method present in ISO 11228-3);

— manual handling of loads (NIOSH formula in ISO 11228-1).

Ergonomics — Application of ISO 11226, the ISO 11228 series and ISO/TR 12295 in the agricultural sector

1 Scope

This document is intended to be used alongside ISO/TR 12295, ISO 11226 and the ISO 11228 series in the agricultural sector. This document gives information on how existing standards can be used in a global sector such as agriculture where, albeit with different characteristics, biomechanical overload is a relevant aspect, WMSDs are common and specific preventive actions are needed.

The proposed project aims to:

1) define the user(s) and fields for its application (including non-experts in ergonomics);

2) provide examples of procedures for hazard identification, risk estimation or evaluation and risk reduction in different agricultural settings, through:

   — more synthetic procedural schemes (main test);

   — more analytical explanations of the procedures, through mathematical models and application examples, also with the use of specific free simple tools, in:

      — Annex A (pre-mapping with ERGOCHECK);

      — Annex B (evaluation of Multitask risk of biomechanical overload on typical agricultural macro-cycles, considering upper limbs repetitive movements, manual lifting and carrying, pushing-pulling);

      — Annex C (study of awkward postures with criteria derived from the actual standards and scientific literature as TACOS method).

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/