

THE ERGONOMICS ANALYSIS TOOLS FOR THE ASSESSMENT OF THE RISK OF MUSCULOSKELETAL DISORDERS DUE TO THE REPETITIVE MOVEMENTS OF THE UPPER LIMBS OF THE WORKERS EMPLOYED IN AGRICULTURE

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The [ISO 11228-3:2006](#) establishes ergonomic recommendations for repetitive work tasks involving the manual handling of low loads at high frequency. It provides guidance on the identification and assessment of risk factors commonly associated with handling low loads at high frequency, thereby allowing evaluation of the related health risks to the working population. The risk assessment is based on 2 procedures: a first screening based on the use of a check-list; a detailed procedure that refers to different methods of analysis (RULA, REBA, STRAIN INDEX; ...) with an expressed preference for the OCRA index method.

Various agricultural activities involve the biomechanical overload risk for the upper limbs (UL) due to repetitive movements: the reference activity for the present study is the [manual sorting of tomatoes during mechanical harvesting](#).

Aim of the research is to compare the results obtained with OCRA method with those obtained by means of the main assessment methods. **The reference activity for the present study is the manual sorting of tomatoes during mechanical harvesting.**

Manual selection onboard a tomato harvester: (a) worker's hand grabbing a tomato; (b) grabbed tomato released into a specially designed pocket; (c) two-hand grab (the right hand picks a green tomato and, at the same time, the left hand grabs another tomato to be discarded); and (d) repetition follow through



(a) (b) (c) (d)
(Cecchini et al., 2010)

In the case of tomato harvesting and sorting, the greatest disadvantage would seem to be the [frequency of movement](#).

Analogous results are shown in the literature for fruit sorting, which is very similar in terms of operational procedures (32 to 70 actions per minute for workers sorting and packing apples; Merseburger, 1996).

Two other important risks are [posture](#) and [repetition](#). Sorting forces workers to maintain an elbow pronation greater than 60° with respect to a resting position for 80% of the cycle time. Repetition is particularly risky due to very short cycles that are repeated for more than 50% of the working time.

The best evaluation method for underlining these risk factors seems to be the [OCRA index](#), which is also the method advised by the ISO 11228-3:2006 standard. The [Strain Index](#) and the [Hand Activity Level](#) of the ACGIH show the presence of high risk, but the HAL method is particularly suitable to be used for work which involves a high frequency of movements with negligible effort applied (such as the manual sorting of tomatoes).

Results showed that the task of selection involves an elevated risk of musculoskeletal disorders for the workers due to repetitive movements during the mechanized harvesting of tomatoes. An application of the [Strain Index showed an exposure index equal to 27](#), too much higher than the recommended limit of 7, and [OCRA method showed an exposure index equal of 23.81](#), which is much higher than the recommended limit of 3.5. The obtained values are particularly high due to the high frequency of movements (240 actions per minute during the selection).

The authors of Strain Index summarize the foundations, limitations and assumptions of the SI method (ISO 11228-3:2006): it only applies to the distal upper extremity (hand/forearm); it predicts a spectrum of upper limb disorders (disorders of muscle-tendon units as well as carpal tunnel syndrome), not specific disorders; it assesses jobs and not individual workers; the relationships between exposure data and the multiplier values are not based on explicit mathematical relationships between the task variables and the physiological, biomechanical, or clinical responses.

Other aspects of this method should be carefully considered when interpreting results: force is the most relevant factor considered, but it is generally assessed by an external observer by means of an empirical scale; the maximum level (5) of efforts per minute is given for more than the 20 efforts/min that is very common in manufacturing; the postures considered are mainly at wrist level; types of hand grip are less considered; additional factors are not considered; recovery periods, in terms of macro-breaks, are partially neglected; it applies to simple tasks and for monotask jobs, also if developments for a multitask analysis are expected in the near future.

The OCRA index method is more complete in its coverage of the various sources of risk, it is able to identify the best elements to consider when designing worker locations and tasks, and it allows damage prediction (Grieco, 1998).

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