FULL POPULATION TESTING FOR VALIDATION OF HUMAN RESTRAINT SYSTEMS ON COMMERCIAL AND NON COMMERCIAL ERGOMETERS

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INTRODUCTION: Human missions to Mars is one of the main objectives for scientific space international community and major goals on physiological and biomechanical space research is reduction of muscle atrophy (Fitts, 2000; Zange, 1997). MARES (Muscular Atrophy Research and Exercise System) system is an ergometer to be flown and installed in the International Space Station in the year 2007. This system will allow neuromuscular and gravitational physiology research on orbit. MARES consists of a control electronics that drives a motor, to which a subject is connected by means of a restraining system named HRS (Human Restraint System). This ergometer can be programmed to work in 14 different modes (Isometric, Isotonic, Isokinetic, Spring, Friction, Additional Moment of Inertia/Mass, Pseudogravitational, Position Control, Velocity Control, Torque/Force Control, Power Control, Physical Elements, Extended Torque/Force Control, Quick Release). All of this modes are available for 11 movements, corresponding to main body joints and movements.

METHODS: In order to verify the HRS specifications, a special test called "Population Testing" was performed on MARES prototype checking the compliance of several specifications:
1. Anthropometric range (AR). The system has to be compliant with population from 5 percentile Japanese female to 95 percentile American male.
2. Supported movements (SM). All the movements indicated shall be performed with no restriction for the specified population.
3. Nominal position (NP). There is a nominal position for each of the eleven movements that MARES can cope with. This position has to be possible for all the population.
4. Impairment (IP). No muscular group shall be impaired during exercise performing.
5. Body Position Reproducibility (BPR). The body position shall be kept the same for the same adjustments of the system.
6. Electrodes compatibility (EC). The restraining of the user shall not affect Electromyography and Electrocardiogram measurements.
7. Joint alignment stability (JAS). In order to assess the accuracy in the measurement of data on selected muscular groups, HRS must maintain joint axis and motor axis alignment during exercise phase.
8. Comfort (CM). Comfort perceived by the subject shall be over a minimum requirement.

RESULTS AND DISCUSSION: Results obtained on MARES Population testing are compliant with specifications in all studied categories (AR, SM, NP, IP, EC, CM). For JAS and EC results are being evaluated.
The discussion of full results of this test will allow scientific validation for MARES ergometer but will also provide a full test method to evaluate HRS performance on any commercial or non commercial ergometer. Some of the test items, as JAS and BPR, as studied by Núñez et al., will be critical for scientific data acquirements validation.

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