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UNSUPERVISED HIERARCHICAL AND NON-HIERARCHICAL CLUSTERING TECHNIQUES ON BIOMECHANICAL VARIABLES FOR LONG AND SHORT COUNTERMOVEMENT COMPARISON WITH NO COUNTERMOVEMENT

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Summary: Muscle stretch shortening cycle (SSC) is a natural human action with preceding eccentric stretch for efficient submaximal and powerful maximal concentric contraction. At lower limb muscle SSC can be observed on gait, running, and jumping, with higher expression and accessibility of in-vivo SSC at standard maximum vertical jump (MVJ) the most adequate for comparison of long SSC on countermovement jump (CMJ) and short SSC on drop jump (DJ) to squat jump (SJ) without SSC. Despite each form of standard MVJ presents typical movement characteristics and biomechanical parameters with subjects instructed to perform specific MVJ type, DJ and SJ jumping style can resemble CMJ trial, with the need to detect cluster structures based on kinematic and dynamical variables, explaining MVJ trial grouping on elite (E) and non-elite (NE) subjects. For this purpose, clustering analysis was performed on detailed data communities of (i) time-force-impulse, (ii) force-velocity-power and (iii) force-displacement-work in a total of forty-six variables. Whole body center of gravity data was considered from best MVJ repetition of each SJ, CMJ and DJ trials on non-elite group of nNE=6 male sports students without specific train or sport modality (S1-S5) and elite group of nE=16 athletes of the Portuguese national volleyball male team (S1-S16). Hierarchical method with Ward average linkage was applied to each variable community on E and NE groups, separately and jointly considered, to determine the number of clusters and its centroids applying non-hierarchical k-means algorithm to obtain optimal clusters. Agglomeration schedule was used to describe combined cluster on each stage with linkage between groups and squared Euclidean distance computed after Z-scores standardization, along with dendrogram to represent aggregation process and rescaled distance of cluster combine. Time-force-impulse variable community presented on E and NE groups jointly considered as well as E group clear clustering on SJ, CMJ and DJ than NE with S5-CMJ preferable cluster to SJ. Force-velocity-power variable community presented at NE group mixed clustering of SJ and CMJ trials, whereas E group and joint E and NE group presented clear clustering of SJ, CMJ and DJ. NE group presented on force-displacement-work initial clustering on SJ, as well as on CMJ with subsequent SJ and CMJ cluster combined with DJ. As regards to E group and jointly E and NE groups the force-displacement-work variable community presented clear clustering on SJ and CMJ, with exception of NE-S5 SJ and CMJ early cluster, and final SJ-CMJ agglomeration with DJ. Global set of time-force-impulse-velocity-power-displacement-work variables presented on E and NE, individual and joint groups, three cluster agglomeration corresponding to SJ, CMJ and DJ without case exception. Optimal clusters from non-hierarchical k-means algorithm conduced to distinct cluster centroids on each E and NE group and data community. Presented method conduced to detection of different clusters associated to each MVJ type and data community, pointing clustering as an adequate method explaining SJ, CMJ and DJ trial grouping on E and NE based on kinematic and dynamical variables. Hierarchical and non-hierarchical clustering proved as an adequate unsupervised learning tool capturing MVJ biomechanical group differences and similarities.