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### Metabolic exercise assessment: Methodological recommendations for clinicians, health and exercise professionals

Stoichiometric indirect calorimetry is the most commonly used method for assessing the oxidation of fatty acids (FAO) and carbohydrates (CHO). It relies on gaseous exchange measurements of oxygen uptake ( $VO_2$ ), carbon dioxide production ( $VCO_2$ ), and respiratory exchange ratio (RER) for accurate estimations of FAO and CHO. During exercise protein utilization contributes minimally compared with FAO and CHO contribution. Hence, common mathematical estimations are based on FAO and CHO relative contribution at various exercise intensity domains. The utilization of FAO predominates at low exercise intensities, and its relative contribution gradually decreases as exercise intensity increase in favour of CHO contribution. Higher exercise intensities beyond  $RER \geq 1$  reflect an excess non-oxidative  $CO_2$  from bicarbonate buffering, which further elevates  $VCO_2$  and caused an overestimated CHO and underestimated FAO. Therefore detecting meaningful effects on FAO is often measured below the severe exercise intensity domain and corresponds to exercise intensities below approximately 85% of maximal  $VO_2$  ( $VO_{2\max}$ ). The most common diagnostic indices derived from FAO, CHO and corresponding power output include: 1) maximal fat oxidation (MFO), thought to correspond to approximately 30-75% of  $VO_2$  max, and is defined as the power output or exercise intensity at which FAO becomes maximal. 2) the cross-over point (COP), defined as the power output at which energy expenditure at which energy derived from CHO predominates over that from FAO. Prolonged single-intensity testing protocols have long been shown to provide a valid estimate of FAO and CHO because they allow a steady-state attainment for the gaseous exchange attainment. However, they require several laboratory visits, and so they can be less practical compared with the incremental exercise protocols commonly being used. However, it is important that incremental protocols consider the selection of an appropriate initial workload, stage increment, and stage duration. The reliability of metabolic exercise testing may also be affected by exercise testing modality (e.g. cycling vs. running or walking protocols), or cadence (e.g. cycling at fast vs. low cadence), primarily due to the effects on muscle recruitment patterns. Selecting an appropriate respiratory sampling and averaging method is equally important to prevent over- or under-estimation of FAO and CHO and related estimations. Valid and reliable exercise testing protocols are devised individually because of the numerous factors that affect human substrate metabolism, including muscle glycogen content and activity, preceding diet, and muscle fibre composition, daily physical activity levels, aerobic capacity, gender and exercise intensity and duration. To conclude, assessments of FAO and CHO provide an excellent non-invasive diagnostic method to determine several metabolic exercise and health outcomes, and clinicians and health professionals need to carefully consider an appropriate exercise assessment protocol to obtain successful outcomes.

### Biography

Ahmad Alkhatib is the Head of Sport and Exercise Science Division at Abertay University in the UK. He is a Fellow of the Royal Society of Medicine, an accredited UK nutritionist (RNutr), a clinical physiologist, a certified international sports nutritionist (CISSN), and also a Fellow of the UK Higher Education Academy (FHEA). He obtained his PhD in Exercise Physiology and Metabolism, and MSc in Exercise Sciences (Health and Fitness) from the University of Essex, UK. His current research focuses on prescribing effective exercise and nutritional interventions for weight loss, disease prevention and sports performance. He has over 100 publications and won several research and academic excellence awards.

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