Submitted: 07 August, 2021 Accepted: 23 August, 2021 Published: 30 September, 2021 DOI:10.31083/jomh.2021.105

JOMH Journal of Men's Health

Editorial

Sports biomechanics: monitoring health and performance

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Biomechanics is part of biophysics and aims to study the function and structure of biological systems based on the principles, laws, and methods of mechanics. The human body is a dynamic system in constant change, with internal (physiological) and external effects (mechanical). From an external point of view, every action/movement results from forces produced by the subject and by external forces acting on him/her. The study of these forces and their effects, such as movement, absence of movement, and deformations is the main focus of biomechanics. The amount of forces that act on the human system in each movement will also result in an internal response, so the higher the mechanical stress, the greater the physiological impact [1]. This association is observed in every physical or sports activity, highlighting the importance of biomechanics for a better understanding of the physiological response to exercise [2, 3]. When a sports professional is concerned by how the available energy is used to exercise at a specific intensity/volume, causing a chain of intersegmental movements, he/she is facing biomechanical issues. The boundary of the object of study between biomechanics and physiology in sport is so tangential that it is sometimes confused [4, 5]. In this way, biomechanical analysis can help to control physical demands and explain the athlete's state of well-being [6]. Therefore, it will play an important role in sports performance and the participants' health, in which mechanics and physiology are combined in sports biomechanics [7].

We can only understand the sport and be better professionals by better understanding the human movement. Therefore, sports biomechanics plays a key role in explaining performance results and reasons for success. Most research analyzing sports and exercise performance focus on kinetic, kinematics, and physiological variables [7–10]. Kinematics is responsible for describing and explaining human movement; kinetics explains the mechanical reason for the movement to occur, that is, how much the force produced influences the movement; and physiology aims to assess the human body's internal response (e.g., metabolic impact). Based on this, biomechanics seeks to achieve the best efficiency path for each athlete, specifically, performing a physical task with lower energy cost. Furthermore, body impact and load distributions during physical exercise might result in overuse and/or stress injuries [6, 11]. The repetition of a movement with inadequate technique may result in muscle-skeletal injuries, forcing the exercise to stop and leading to longer or shorter periods of inactivity. This compulsory exercise interruption will have health or performance implications [12]. Biomechanical professionals should be concerned about movement techniques, such as body alignment and articulation positions during exercise, and also provide the necessary feedback to the technical team, so that load and physiological impact are better controlled and according to the exercise purpose. This would prevent overtraining that could also compromise the athletes' health [1]. Again, biomechanics can be important to prevent the overtraining phenomenon and preserve a good state of well-being.

The areas of application of biomechanics are essentially developed around the technique of sports movement, equipment and materials, as well as the prevention/attenuation of sports injuries [13]. For these, physical activities and sports demands are assessed using a set of technology systems. Technology such as pedometers, accelerometers, global positioning system (GPS), micro-electromechanical systems (MEMS), local position measurement (LPM), and computerized video systems, allows the assessment of human movement behavior [1, 9, 14]. Variables such as the number of steps, counts, distances, velocity, acceleration/deceleration, time-motion analysis, neuromuscular function, angles and qualitative analysis are used to describe and quantify human movement intensity. Based on mechanical variables, a physiological impact is explained and predicted. Thus, heart rate, lactate levels, oxygen consumption, and other subjective measures, such as perceived exertion and well-being questionnaires are explained by the variables presented above [15].

As previously mentioned, biomechanics uses several technological instruments to assess athlete's performance. Those instruments may evaluate single or multiple variables and new methods have been created in recent years. Thus, future research may focus on creating and testing new technologies to assess biomechanics regarding athletes' performance and health. Researchers may seek simple, easy, and inexpensive methods to help coaches and analysts evaluate practitioners with valid and precise data. That said, different evaluation methods must be compared and tested for different purposes [16, 17].

Typically, biomechanical analyses are made by: observational and qualitative methods, based on visual analysis [18]; video and photogrammetry analysis, in which kinematic variables (time, velocity, position, distance) are assessed [9, 19]; experimental tests, in which different instruments, such as force plate, ergojump, speedometer, encoder, force sensors, radars, wind tunnels, inertial devices, and other tools, allow gathering information about kinetic and kinematic variables; and analytical procedures, which are a set of equations that typically permit to compute or estimate kinetics, kinematics, and performance [1, 20–23]. However, it is necessary to compare these different methods and to provide information about validity, accuracy, and reliability. So, testing different methods can be an important issue to support the choices of coaches and analysts when deciding how to assess the biomechanics and health status of athletes.

The analytical procedures may be the fastest and easiest way to gather insights about athletes' biomechanics during training and competition [8]. Some studies have compared analytical procedures with experimental and numerical methods [16, 17]; however, more comparisons are required. For instance, regarding cycling, there is a trend related to comparing the biomechanics of disabled and non-disabled athletes [24, 25]. This trend can be observed in different sports and contexts [10]. Moreover, the 2020 Olympic Games introduced new sports in which biomechanics analysis will be worthy of scientific knowledge, and novelty will characterize these future studies.

Biomechanical intervention should also be noteworthy concerning health issues, with an emphasis on research related to aging. Typically, functional fitness and quality of life are areas of interest in the research field [26–28]. Some measures included the number of repetitions, distance, velocity, time, strength, resistance, and flexibility measures. Through this, the intensity of the training sessions in the elderly is controlled by biomechanics variables. Different training programs may help to improve elderlies' functional fitness and thus the ability to perform daily life activities [29]. The greater the ability to perform daily life activities, the better the quality of life is, so testing the effects of physical activity or training on biomechanics variables will be of high interest regarding the health of the elderly [28]. This article provided a wide range of biomechanical applications regarding sportsmen's health and performance. Therefore, research with young people, adults, and the elderly, and methods, comparisons, and associations between different variables will be of valuable interest regarding sports biomechanics.

Author contributions

HPN and DAM designed the research study. PF wrote the manuscript. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

Ethics approval and consent to participate

Not applicable.

Acknowledgment

Not applicable.

Funding

This work was supported Portuguese Foundation for Science and Technology, I.P. (project UIDB04045/2021).

Conflict of interest

The authors declare no conflict of interest.

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