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Reviwe Article

The role of the technology in the exercise: utilization of wearable technology and digital sport

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Abstract
The scientific community has consistently shown interest in exercise research due to its broad use in areas such as athletic training, health enhancement, and illness prevention. Over the course of several years, a variety of methods have been employed to examine the various physiological adaptations that are brought about by exercise stimulus. Technology in the realm of sports is rapidly evolving, with current technologies surpassing the capabilities and functionalities that were envisioned merely a few years ago. In this review, we presented the role of the utilization of wearable technology for monitoring training activities. Moreover, we discussed the field of sport science has undergone significant transformations in the contemporary era of digital sport.

Keywords: Exercise, Athletic Training, Advancement Of Technology, Monitoring Training Activities.

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Introduction

The advancement of technology in sports is progressing rapidly, with contemporary technologies exhibiting capabilities and functionalities previously envisioned only a few years ago (1). In previous times, the analysis of gymnasts' movements was limited to film recordings, offering only a restricted level of detail. However, contemporary advancements have enabled gymnasts to utilize motion sensor-equipped suits to capture and document their motions (2). The analysis of an athlete's motion in three-dimensional space can be extensively studied using kinematic models (3). Analogous instances could be identified within various other sporting disciplines (4). In recent years, affordable wearable monitoring devices and gadgets designed to track activity levels have emerged and have been offered to the consumer market (4). Gadgets, such as wristbands, smartwatches, or pendants, provide statistical measurements and track occurrences of specific physical activities. As an illustration, individuals engage in quantifying daily step or stair counts, with the capability to identify instances of falling, approximate the quality of sleep, and assess stress levels. These devices often capture the user's movements or physiological processes with low frequency and precision, proving sufficient for their intended use (4, 5). On the other spectrum of sporting technology are intricate and costly systems that collect and analyze substantial volumes of data in parallel. An illustrative instance is implementing a system designed to facilitate the instantaneous monitoring of a football match, as well as the subsequent analysis of training sessions (5, 6).

The majority of technological applications in the realm of sports can be categorized as falling within the intersection of the two aforementioned divisions. Smartphones constitute significant components of technological devices (7). Virtually all contemporary smartphones are equipped with diverse sensors, including accelerometers, gyroscopes, microphones, GPS, cameras, magnetometers, and more. Furthermore, smartphones have various feedback mechanisms, such as loudspeakers, screens, and vibration features. Due to the substantial processing capabilities possessed by smartphones, they can be effectively utilized for the execution of autonomous mobile apps (7, 8). This implies that the smartphone collects activity parameters, performs calculations, and provides feedback via one of its feedback mechanisms. According to professionals in sports, feedback is considered to be the most crucial factor in the learning process, second only to the act of practicing itself (9). During practice, individuals receive inherent feedback information internally through their human sense organs (9). Other entities, such as instructors and trainers, typically deliver augmented feedback (10). Contemporary technological apparatus can assist both the performer and the instructor by offering further feedback data that cannot be acquired through conventional observation techniques. Acquiring motor skills is fundamental in developing proficiency in various physical activities, ranging from basic locomotion, such as walking, to more complex forms of movement, like ballet (11).

The significance of physical activity is progressively growing in our society (12). Physical fitness is an indispensable and obligatory component of a well-balanced lifestyle, and its undeniable role in enhancing our overall welfare is well acknowledged (12, 13). The definition of sport as a form of physical exercise during leisure may no longer hold (13). The spare time physical activity can be broadly classified into three main categories: recreational sport or recreation, amateur sport, and professional sport. Each of the three categories possesses a distinct societal position and encompasses individuals with diverse objectives. However, a shared characteristic across all individuals is the necessity and inclination to quantify their physical activity (14). The inclination towards comparison, quantification, and rivalry appears to be inherent to human nature. Sport is an ideal platform for all the aforementioned purposes (15). A direct comparison is the most straightforward method and requires no technological assistance (16). In the context of direct comparison, it is quite straightforward to ascertain the relative speed, throwing distance, strength, and similar attributes between individuals (17). In addition, it is necessary to employ a kind of quantification that is predominantly facilitated through technological methods in the majority of instances (18). This includes activities such as determining the duration of a run, assessing the distance covered in a leap, and tracking the velocity of a tennis serve (19). These technologies have been used for a significant duration and are commonly employed in both instructional and competitive settings. For instance, a rudimentary, manually controlled stopwatch is commonly employed to track and assess activities and advancements throughout training sessions across various sports disciplines (20).

The equipment may range from a rudimentary baseball bat to an intricate Formula 1 automobile (21). Technology has been pivotal in attaining a competitive edge over adversaries in intricate sporting equipment (22). As an illustration, a bobsled with higher technological capabilities can prevail against a bobsled with weaker technological attributes, even when the latter crew may not possess comparable skills or expertise (23). Technological advancements are increasingly being integrated into basic sporting equipment. Various sports equipment manufacturers have introduced a range of intelligent sports equipment, including smart tennis rackets, smart basketballs, and smart running shoes (23). Although the development of basic sporting equipment may not necessitate intricate technology, its design can provide challenges due to limitations in size and weight, potential for violent impact (e.g., golf ball), or other factors that may impede the design process (24). The final goal of any sports training, whether recreational, amateur, or professional, is to gain an advantage (25). In leisure sports, the primary objective is to enhance overall well-being, fitness, and health. However, the primary objective in amateur and professional sports is to obtain a competitive edge over opponents (26). A significant proportion of those engaged in recreational sports is expected to express contentment with using activity-tracking devices and smartphone applications. Amateur individuals will also depend on more sophisticated smartwatches, sports watches, and corresponding applications (27).

In contrast, competitive athletes endeavor to capitalize on any potential enhancements in their training regimen, execution of movements, and utilization of equipment that may provide them with a competitive edge. Augmented or enhanced motor learning can be vital (28). The utilization and assistance of technology in this context can be particularly significant for individuals lacking access to personal coaching, such as hobbyists (28).

- **The utilization of wearable technology for monitoring training activities:**

Internal load in athletics refers to the cumulative impact of physiological and psychological factors from training exercises (29). The excessive incorporation of several gadgets and measurements can disrupt an athlete's training regimen and pose difficulty in collecting data (30). The quantification of internal load holds significant importance as it enables practitioners and coaches to measure the effects of external load and training prescriptions on different physiological systems (30). Furthermore, it facilitates the customization of training exercises and the recognition of potential health hazards and maladaptive responses. The topic of interest pertains to quantifying and evaluating cardiovascular and respiratory parameters (30). The quantification of heart rate responses to training might be seen as one of the earliest instances of quantifying internal burden. Since the advent of electrocardiography in the early 20th century, the ability to measure heart rate while exercising has been made possible. Over the course of time, a multitude of investigations have been undertaken to evaluate the veracity and dependability of these apparatuses (31). The overarching consensus is that heart rate monitors (HRMs) employing chest electrodes have the capacity to exhibit both validity and reliability when employed during physically and cognitively demanding activities (31). The utilization of heart rate monitors (HRMs) has facilitated the creation of diverse training-load indices, which serve to quantify the cardiovascular load encountered by athletes during both training sessions and competitive events. Many of the training-load indices employed in research and practice rely on the assumption of a linear relationship between heart rate and VO2 observed during incremental tests. These indices aim to determine intensity zones and the duration spent in each zone, typically expressed as a percentage of maximum heart rate. Various methods exist to quantify training load using these approaches (26). The utilization of lightweight wrist photoplethysmography is gaining traction in academic research, however, its accuracy and validity have yielded conflicting outcomes.

Currently, near-infrared spectroscopy (NIRS) is well recognized as a reliable method for evaluating muscle oxygenation in living organisms. Clinical investigations indicate that this technology has the potential to be effectively utilized in several sports disciplines, including water sports (32). The current market trend indicates a rise in the popularity of portable near-infrared spectroscopy (NIRS) devices (33). However, we posit that with additional technological advancements, these devices could become more affordable, easily accessible, and less intrusive (33). Furthermore, such advancements could also facilitate prompt feedback.

Consequently, this area of research and application holds potential for further exploration into the effects of different training regimens on adaptation (34). Recent developments in the field of "omics" have indicated the potential to obtain more information regarding biological responses to exercise by analyzing very tiny samples of blood, sweat, and/or urine (34). The latest laboratory advancements have proven the potential to integrate ultrathin devices into human skin (34). Recent validation studies have demonstrated encouraging outcomes regarding using epidermal sensors for quantifying biological parameters in vivo during exercise activities (35). These findings suggest that wearable sensing, which can enhance our comprehension of the body's response to different exercise stimuli, is not implausible (35). In the absence of more cost-effective and less intrusive technologies and methodologies, our comprehension of the physiological reactions to training will continue to be constrained, limiting the potential impact on the daily practices of sports scientists and coaches (36). One notable advancement is integrating electromyographic (EMG) sensors into athletic apparel, enabling the measurement and analysis of muscle activity during physical exertion.

- **The field of sports science has undergone significant transformations in the contemporary era of digital sports.**

The utilization of technology-driven digital solutions has the potential to expand the scope of information acquisition beyond the limitations imposed by traditional assessment methods (36). Advancements in technology have led to the development of compact and precise positioning systems, inertial movement units, and diverse sensors capable of accurately capturing physiological reactions during athletes' training sessions and competitive events (37). For diverse objectives, numerous digital tools are employed within sports practice (37). These include the assessment of individual or collective behavior during training or competitions, the establishment of sport-specific benchmarks, and facilitating load management, training prescription, and recovery strategies. Collecting comprehensive and complementary data from the daily training and testing process involves the measurement of physiological and performance indicators in sport-specific conditions (37). The advancement of digital twins, which are models capable of representing an individual's physiological condition, offers personalized decision assistance. This support is conveyed through "digital coaches" specifically designed to push individuals to modify their behavior, ultimately leading to enhanced performance (37). It is vital to recognize that a proficient coach can discern subtle intricacies that quantitative assessments are incapable of detecting. Information provided by technology can lack the holistic context for making optimal decisions among athletes and coaches. Researchers specializing in the domain of sports physiology and performance are expected to have a significant part in the collaborative efforts necessitated by technologically advanced projects within the realm of sports (37).

Declaration

Competing interests

There is no competing interest to disclose.

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