INFORMATION TECHNOLOGY IN SPORTS SESSION

APPLICATION OF PRESENCE SENSORS WITH MOTIONXRAYS TECHNOLOGY DURING RECREATIONAL RUNNING

Đorđe Hadži Pavlović*,
[0009-0006-5755-4970]
Kristina Nikolić
[0009-0002-4439-6767]

Faculty of Sport and Physical Education,
University of Belgrade,
Belgrade, Serbia

Abstract:

Modern technology enriches the world of physical activity on a daily basis. By synthesizing information technology and a scientific approach to training, boundaries are being pushed not only in elite sports, but also in recreational activities. In this study, we analyzed various parameters using the "Smart4Fit Gym" android application and wearable sensors ProSense with MotionX-Ray technology during treadmill running. The study involved 20 male participants who ran on the treadmill according to a predetermined protocol. The protocol included treadmill activities lasting 3 minutes: a minute of warm-up, followed by one minute of running at speeds of 10 and 12 km/h. During testing, parameters of both lower extremities were monitored. The analysis included separate speed of movement of both extremities dominant and non-dominant, ground reaction force upon contact with the treadmill, length of individual steps, and number of steps per minute.The results show that all tested parameters increased with the increase in treadmill speed and running speed. Differences were also observed between the speed of movement for the individual leg and its ground reaction force upon contact with the treadmill. In both cases, the values for the non-dominant leg were higher compared to the dominant one.The results obtained by the mentioned system confirm that it provides new opportunities in the world of recreational running.

Keywords:

Wearable devices, Treadmill, Dominant and non-dominant leg.

INTRODUCTION

The application of modern technologies is well-documented in two major fields of physical culture: sports and physical education. However, with technology becoming more widespread, it is becoming accessible to everyone. Due to its accessibility, recreational athletes can use modern technology to analyze their performance more deeply. Information technologies are becoming increasingly prevalent in the world of sports and recreation, bringing along many new possibilities.[1]

Numerous devices have become accessible to individuals. The revolution is represented by so-called wearable devices that track various parameters. By combining these devices with smartphones, recreational athletes can monitor their performance during physical activity and analyze various parameters after their workout. [2]

Correspondence:
Đorđe Hadži Pavlović

e-mail:
djolehadzi99@gmail.com

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These devices are usually connected to mobile apps and utilize different technologies, including linear position transducers, linear encoders, and movement or inertial sensors, to track various parameters during exercise. [3]Although most of these devices show good reliability and validity in tracking velocity, force, or power, the issue of cost-effectiveness remains in question. [3]

Running is the most common physical activity practiced by the majority of recreational athletes. Due to its excellent impact on mental and physical health, running has become the most widespread physical activity. [4] We witness an increase in recreational runners who are constantly seeking new aids. They represent the largest user base of wearable devices. In this study, we have showcased the results collected using the new portable device ProSensewith Motion X-Raystechnology(e.g., Motion X-Rays, Movella).

It should be noted that in this study, only a limited number of data were presented, while the equipment itself offers additional tracking capabilities that need further investigation.

2. METHODS AND MATERIALS

The study involved 20 male participants aged 22 (±1.46) with moderate levels of physical fitness. The participants are healthy adults, and they reported no chronic diseases, heart problems, or any musculoskeletal injuries in the six months preceding the study. They signed a written consent form to participate in this pilot study. Both the consent and the experimental procedure are by The Declaration of Helsinki. Our lightweight sensors are placed above the ankle joint of the participant as shown in Figure 1.

To obtain valid results, it is necessary to enter the participant's height and weight into the application. Participant weight, height, BMI, SMM, and body fat percentage were collected using the InBody 720(Biospace Co. Ltd., Seoul, Republic of Korea).

InBody 720 is a body composition analysis device that uses bioelectrical impedance analysis (BIA) technology to provide detailed information about body composition. It operates by measuring the impedance or resistance of electrical flow as it travels through body tissue. Results obtained from it indicate the good physical condition of the subjects.[5],[6]

At the beginning of the testing, the participants were instructed to be barefoot and wear athletic attire. For participant identification purposes, the participant's number, body height, and age were entered. Following the manufacturer's instructions for the bioimpedance analyzers, participants were instructed to stand upright, place their feet on the analyzers, and hold the handles of the analyzers. This correct positioning ensured contact of the body with 8 electrodes (2 for each arm and leg). Once positioned correctly on the bioimpedance analyzer, participants were required to remain still and look straight ahead.[6]

The protocol used in this study involves treadmill running and was modeled after previous research. [7] The total duration of the protocol is 3 minutes, including a one-minute warm-up on the treadmill with a gradual increase in running speed, followed by running at speeds of 10 km/h and 12 km/h, each for 1 minute.

A ProSense sensor was utilized by Motion X-ray to track body motion. Motion X-ray is a physical movement analysis technology that uses acceleration and gyroscope data for recognizing athletes' complex motion

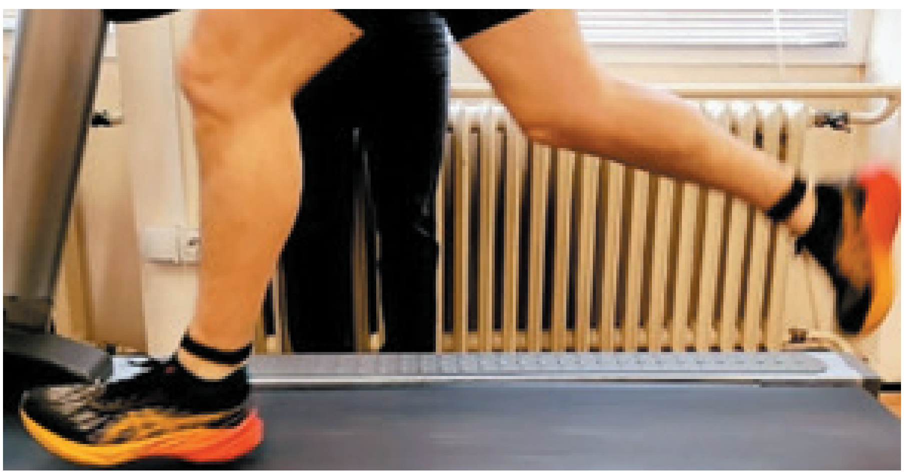

Figure 1. Display of the 'Proses' sensor during treadmill running.

patterns, calculating their biomechanical parameters (like velocity, force, etc.), and discovering (even small) instabilities and variations to be improved for achieving peak performances. A ProSense sensor is equipped with an accelerometer, gyroscope, and magnetometer for measuring acceleration, angular velocity, and the magnetic field (of Earth) with a sample rate of 50Hz. An android device is used to record data from the sensor and send it to the Motion X-Ray service. Motion X-Ray could estimate kinematic parameters (velocity, position, and time) and kinetic parameters (force, energy, power, etc.). To estimate kinetic parameters, Motion X-Ray required the height and weight of the participant, the mass of the weights, and the name of the exercise that the participant was performing during the test. The analysis includes body mass, and the mass of each body part is calculated by the Dempster model. [8]

The study presents four parameters: Separate speed of movement for each extremity (m/s), number of steps per minute, length of step (m), and average ground reaction force (N) upon contact of the foot and treadmill. Previous research has already observed changes in certain variables depending on others [9], which prompted us to collect the aforementioned ones.

Initially, we calculated descriptive statistics for all utilized variables as the mean and standard deviation. Alpha level was set at $p < 0.05$, while all statistical tests were done using Microsoft Office Excel 2019 (Microsoft Corporation, Redmond, WA, USA)

3. RESULTS AND DISCUSSION

Participant characteristics are shown in Table 1.

As shown in Table 1, the sample is the most homogenous in BMI (SD=3.09), with an average value of 23.

The studies showed different values between the dominant and non-dominant leg.

Figure 2 shows the values of segment movement speed, where there is a visible tendency for an increase depending on the treadmill speed. Interestingly, the movement of the non-dominant leg is slightly faster compared to the dominant leg.

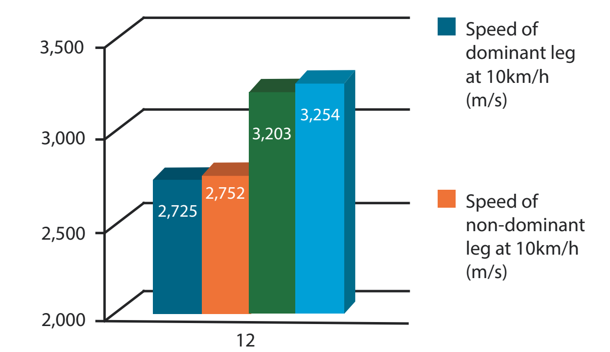

Figure 2. Leg movement speed depending on treadmill speed.

Figure 3 shows the step rate (number of steps per minute). Here is also an evident increase in the measured values depending on the speed of movement.

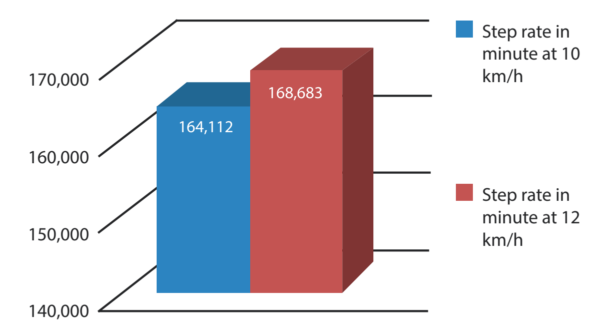

Figure 3. Step rate depending on treadmill speed.

As can be seen in Figure 4, step length also increases with increasing speed.

Table 1. Sample characteristics.

Variable	Minimum	Maximum	Range	Mean	SD
Body weight (kg)	62	108	46	83	11.36
Body height	176	194	19	183	4.40
BMI (kg)	20	31	11	25	3.09
BMI (kg)	20	31	11	25	3.09
Body fat percentage (%)	4	24	21	12	5.45

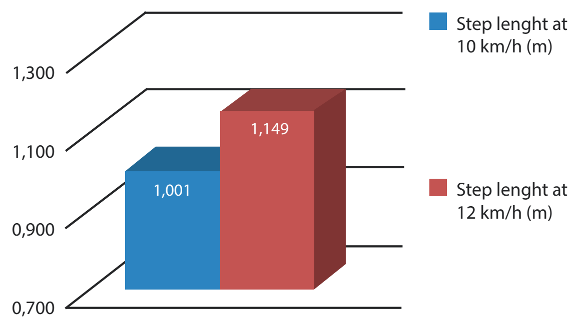

Figure 4. Step length depending on treadmill speed.

Ground reaction force also tends to increase depending on the speed of movement. Again, there is a difference in results between the dominant and non-dominant leg. The non-dominant leg exhibits greater force upon contact with the ground regardless of the speed of movement.

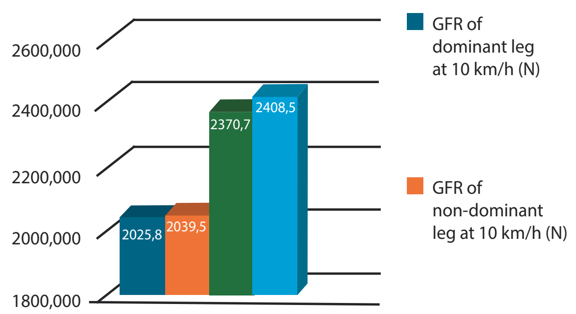

Figure 5. Ground reaction force (GRF) depending on treadmill speed.

It can be noticed that the values of the non-dominant leg are slightly higher compared to the dominant leg. This can be explained by the fact that the dominant leg is the one with which the participant would kick a ball in a given situation. [10] Taking this into account, the non-dominant leg represents the standing leg during a football kick or the take-off leg. Due to the biomechanical predisposition of the non-dominant leg, the results of the tested variables are slightly higher compared to the dominant leg. Previous studies comparing similar parameters have recorded higher values for the dominant leg compared to the non-dominant leg. [11], [12]. In comparison to those studies, which mainly examined acyclic activities, running represents a specificity as it is a cyclic activity that displays repetitive parameters. Differences have already been established in the execution of non-cyclical movements indicating an increased risk of injury [13].

Based on the data, one could raise the question of the probability of injury to the dominant versus the non-dominant leg. [11], [14]. In our study, there is a noticeable difference in values between the dominant and non-dominant leg, which could provide an excellent topic for further research and refinement of the equipment used for analysis.

4. CONCLUSION

The data collected by ProSense sensors and analyzed using MotionX-Ray technology provide potentially valuable information to the user. In the study, the reliability of the sensors is clearly demonstrated by registering changes in all parameters which depend on running speed. They also detect differences in the performance of the dominant and non-dominant legs, confirming their sensitivity. These data can be extremely important for both recreational runners and athletes, as well as their coaches, aiming to improve training outcomes and prevent injuries. Thanks to their accessibility, they have the potential to replace expensive equipment currently in use. This data collection and analysis system will open up new possibilities for all recreational runners.

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