Migration Letters

Volume: 21, No: S2 (2024), pp. 1707-1715

ISSN: 1741-8984 (Print) ISSN: 1741-8992 (Online)

www.migrationletters.com

Prediction Of Athletes' Performance Through Harnessing Wearable Technology And Sedentary Lifestyle: Trainer Motivation As Mediator

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ABSTRACT

The development of wearable technology has revolutionized the way, the athletes monitor and enhance their performance. This study aims to predict athletes' performance by examining the interplay between wearable technology usage and sedentary lifestyle behaviors, with a focus on the mediating role of trainer motivation. By integrating data from wearable devices that track physical activity, sleep patterns, heart rate, and other performance indicators, the study explores how consistent monitoring can counteract the negative effects of a sedentary lifestyle on athletic outcomes. Additionally, the role of trainer motivation is examined to understand how motivation from coaches or trainers can bridge gap between wearable technology and improved performance. [1]A survey was conducted among athletes from males and females as physically active athletes of fitness centers of central Punjab, by gathering data on use of wearable technology, daily activity, sedentary habits, and their trainers' motivational strategies. The results indicate that athletes who effectively harness wearable technology, in conjunction with trainer motivation, reveal superior performance. The study highlights critical role of personalized training programs, supported by accurate data from wearable technology and standing of trainer influence in enhancing athletes' overall performance.

Keywords: *Harnessing Wearable Technology, Sedentary Lifestyle, Trainer Motivation & Athletes' Performance.*

INTRODUCTION

The integration of wearable technology in sports has become a pivotal tool for enhancing athletes' performance, enabling real-time monitoring of physical activities. These devices offer athletes and coaches valuable information to optimize training routines and improve health and performance outcomes [1]. As technology advances, athletes are increasingly relying on wearable technology to maintain a competitive edge, allowing for the precise tracking of performance metrics that were previously difficult to monitor [2]. Though, despite the benefits of wearable technology, sedentary lifestyle prevalent in modern society poses challenges to athletes' growth and peak performance. The prolonged inactivity, even in highly trained individuals, can lead to detrimental physical and psychological effects, such as decreased

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endurance, muscle atrophy, and a lack of motivation [3]. The research has shown that sedentary behavior negatively influences both physical conditioning and mental health, limiting capacity to perform at optimal levels [4]. The trainer motivation plays a crucial role in bridging the gap amid advantages of wearable technology and the risks posed by sedentary lifestyle.

The motivational coaching can counteract negative effects of inactivity by encouraging athletes to maintain high levels of engagement with their training programs, set performance goals, and stay disciplined [5]. This article explores diverse applications of wearable tech in sports, shedding light on how these devices are transforming the landscape of athletic training and competition. The wearable technology role in performance tracking goes beyond mere data collection in diverse circumstances [6]. It empowers athletes and coaches to make informed decisions, tailor training programs and refine strategies, ultimately pushing the limitation of athletic achievement wherein these technologies continue to advance, depth and accuracy of performance tracking are poised to revolutionize the world of sports [7]. In modern sports, wearable technology is considered as integral part for improving the performance and achievement level in competitions. In this linking, keeping in view the dire need of this modern technology the researcher selected this particular problem for research in order to explore the phenomena and extract desired information so as to contribute knowledge.

Objective & Hypothesis

1. To examine the association between harnessing wearable technology, sedentary lifestyle, trainer motivation & athletes' performance (H_1).
2. To examine the mediating role of trainer motivation in linking the harnessing wearable technology and athletes' performance (H_2).
3. To examine mediating role of trainer motivation in linking the sedentary lifestyle and athletes' performance (H_3).

LITERATURE REVIEW

This study builds upon existing literature on wearable technology in sports, sedentary behavior, and impact of trainer motivation. Limb motion capture is essential in human motion-recognition, motor-function assessment and dexterous human-robot interaction for assistive robots. Due to highly dynamic nature of limb activities, conventional inertial methods of limb motion capture suffer from serious drift and instability problems [8]. Here, motion capture method with integral-free velocity detection is proposed and a wearable device is developed by incorporating micro tri-axis flow sensors with micro tri-axis inertial sensors. The device allows accurate measurement of three-dimensional motion velocity, rushing, and attitude angle of human limbs in daily activities, strenuous, and prolonged exercises [9]. It helps to verify an intra-limb coordination relationship exists between thigh and shank in human walking, and establish a neural network model for it [10]. Using intra-limb coordination model, active motion capture of human lower limbs including thigh and shank is tactfully realized by single shank-worn device, which simplifies capture device and reduces cost.

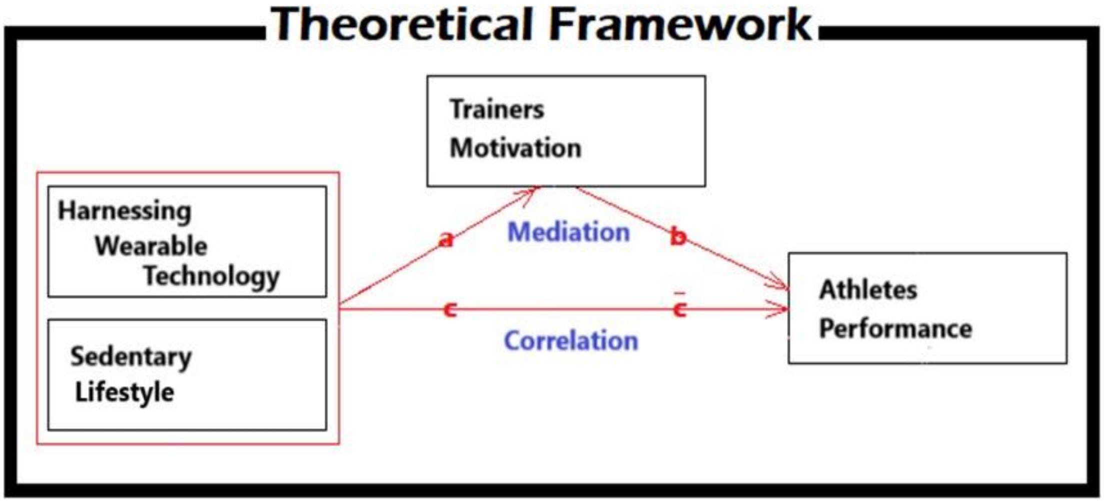
The experiments in strenuous activities and long-time running validate excellent performance and robustness of the wearable device in dynamic motion recognition and reconstruction of human limbs [11]. The motion capture technology plays crucial role in action recognition, motor function assessment and dexterous human-robot interaction for therapy robots and intelligent prosthetics. It allows machine to assist users and improve life quality like senior care, physical rehabilitation, daily life-logging, personal fitness, and assistance for people with cognitive disorders and motor dysfunctions [12]. Still, the high cost, complex setup and susceptibility to lighting the condition and occlusion limit their applications only for laboratory. The wearable motion sensors, such as force-based sensors, surface electromyography sensors, soft strain sensors micro inertial sensors, may overcome such problems [13]. In this connection, the wearable sensors provide promising tools for next generation rehabilitation exoskeletons, such as soft exposits, in which lightweight and comfort are concerned.

Consequently, among these sensors, body-worn inertial sensors including micro accelerometers and micro gyroscopes are most commonly used wearable movement sensors due to their ability of direct measurement on body segment movement, which is important for not only quantitative assessment of motor function, but interaction and control of rehabilitation robots and prostheses [14]. Although the popular uses of inertial sensors in motion capture, technique challenges still exist in detecting dynamic motion of human limbs. As a matter of fact, the accelerometer detects total acceleration of the gravity and motion accelerations that precludes it from determining motion velocity or attitude angle independently, and gyroscope-based attitude estimation suffers from integral drift error [15]. In this regard, motion velocity is usually estimated using the integral of motion acceleration. However, due to the lack of precise motion acceleration, even processed by noise filtering and fusion method, the motion acceleration determined by the inertial sensors still contains noises and errors that persuades the cumulative error in the integral for estimating the motion velocity.

Nevertheless, these methods restrict only for foot-mounted or shank-mounted applications, and large acceleration interference caused by foot strike degrades the velocity tracking performance. To estimate attitude angles, various data fusion solutions using accelerometer and gyroscope have been investigated, such as acceleration threshold-based method and model-based method using Kalman filters or complementary filters [16]. The threshold-based method regulates the weight of the accelerometer in data fusion according to intensity of acceleration. In capturing high dynamic motion of human limbs, the attitude angles are mainly estimated by integral of gyroscope output rather than gravity hastening via accelerometer due to highly dynamic interference and therefore suffers from drift problem [17]. The model-based data fusion method treats attitude estimation as separation problem of gravity acceleration from motion acceleration according to their discrepant dynamic models [18]. However, it is hard to establish robust acceleration model that is applicable for diverse scenarios because the model is actually motion type dependent in different situations for diverse outcomes.

In this linking, various improved data fusion methods by incorporating the model-based method with the threshold approach have been reported in recent years. The adaptive filter methods adopt adaptively regulating covariance matrix of noise to regulate the weight of the accelerometer in a model-based data fusion algorithm, which are able to deal with transient or short-term dynamic motion capture [19]. Still, similar to threshold-based method, attitude estimation using adaptive filter mostly or even only relies on integral of gyroscope in highly dynamic motion. Thus, adaptive filter methods using low-cost micro inertial sensors suffer from serious drift problem in capturing long-term dynamic motion [20]. Although great efforts made in data fusion algorithm for inertial sensors, inherent problems of instability in long-term monitoring of highly dynamic limb motions still exist, for example, the limb posture capture in running [21]. To avoid dynamic interference, inertial sensors are usually mounted on trunk of human or robots instead of limbs. Current reports of soft exposit show utilization of inertial sensors in leg movement monitoring, but only for gait diverse recognitions.

Figure 1 Theoretical Framework



RESEARCH METHODOLOGY

The current study is quantitative in nature and aims to examine certain relationship in chasing hypotheses of studies to reach conclusion and making suitable decisions about the hypothesized relationships among research variables like harnessing wearable technology, sedentary lifestyle, trainer motivation and athletes' performance. The research design used is cross-sectional survey that was used for collection of the desired data. The population includes all males and females physically active athletes (participants) of the fitness centers of central Punjab, Pakistan wherein total population includes 1478 whereas sample of 315 was selected by using the sampling formula. Similarly, the simple random technique was used to access the population of study which comes under non-probability technique to ensure the required data from different dimensions. Similarly, secondary and primary data were used to collect data from the respondents and from the existing knowledge databased to analyze data to reach desired conclusion. The scales were adopted from previous research studies. Similarly, 5-point Likert scale was used to record the responses of the respondents about research issues in particular context to access the respondents and attaining the desired outcomes. thus, 315 questionnaires were distributed wherein 300 were recollected and used for data analysis.

RESULTS OF STUDY

The results of study are presented in this section that are mainly the outcomes of the statistical procedures that are used to examine relationships among the research variables of study in order to extract the desired information and making the required decisions about relationships among research variables.

Table 1 Descriptive Statistics

	N	Minimum	Maximum	Mean	SD
Harnessing Wearable Technology	300	1.30	4.80	3.2526	.75734
Sedentary Lifestyle	300	1.80	4.60	3.1901	.84680
Trainer Motivation	300	1.70	4.70	3.4910	.58534
Athletes' Performance	300	1.63	4.62	3.4058	.59960
Valid N (listwise)	300				

About describing the variable, the descriptive statistics provides the important information with respect to sample-size, minimum and maximum response rates, mean and standard deviation, and the results revealed that all the variables have sufficient values in describing the research issues regarding the required threshold values in determining the research variables to obtain desired leading information.

H1: To examine the association between harnessing wearable technology, sedentary lifestyle, trainer motivation & athletes' performance.

Table 2 Correlation Analysis

		[1]	[2]	[3]	[4]
Harnessing Wearable Technology [1]	Pearson Correlation	1	.389**	.603**	.641**
	Sig. (2-tailed)		.000	.000	.000
	N	300	300	300	300
Sedentary Lifestyle [2]	Pearson Correlation	.389**	1	.352**	.333**
	Sig. (2-tailed)	.000		.000	.000
	N	300	300	300	300
Trainer Motivation [3]	Pearson Correlation	.603**	.352**	1	.646**
	Sig. (2-tailed)	.000	.000		.000
	N	300	300	300	300
Athletes' Performance [4]	Pearson Correlation	.641**	.333**	.646**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	300	300	300	300
**. Correlation is significant at the 0.01 level (2-tailed).					

In order to obtain outcomes about association among research variables, the results of correlation revealed important information that was hypothesized through first hypothesis with the aim to examine association among independent, mediator and dependent variables of current study. The results naked important information about association and reaching decisions where harnessing wearable technology has significant association with athletes' performance (R = 0.641 & P = .000), and sedentary lifestyle with athletes' performance (R = 0.333 & P = .000), and trainer motivation with athletes' performance (R = 0.646 & P = .000). Thus, results provide significant information about association and thus hypothesis is accepted based upon the result obtained through the correlation procedure.

H2: To examine the mediating role of trainer motivation in linking the harnessing wearable technology and athletes' performance (H2).

Table 3 Mediation Analysis

Criterion	Predictors	R	R^2	Coefficient	P-Value
Model 1 (Path a)					
Trainer Motivation	Constant	. 6030	. 3636		
	Harnessing Wearable Technology			. 4660	.0000
Model 2-3 (Path b & ć)					
Athletes' Performance	Constant	.7184	.5161		

	Harnessing Wearable Technology			.3129	.0000
	Trainer Motivation			.4172	.0000
Model 4 (Path c)					
Athletes' Performance	Constant	.6408	.4106		
	Harnessing Wearable Technology			.5073	.0000

The mediation model was about the role of trainer motivation in linking the harnessing wearable technology and athletes' performance, using Hayes Process Macro procedure. The path-a revealed that trainer motivation was predicted over harnessing wearable technology where 36.36% change occurred in trainer motivation through harnessing wearable technology with significant impact (β = .4660 & P-value = .0000). The second and third paths provides the details about the indirect relationships among research issues wherein 51.61% variance occurred in athletes' performance through harnessing wearable technology and trainer motivation with significant impact through coefficient of regarrison wherein harnessing wearable technology (β = .3129 & P-value = .0000) and trainer motivation (β = .4172 & P-value = .0000). The fourth path revealed information that there is 41.06% variance occurred in athletes' performance over harnessing wearable technology with significant impact (β = .4106 & P-value = .0000). The results revealed that trainer motivation partially mediated relationship amid harnessing wearable technology and athletes' performance due to decrease in coefficient values from (.5053) in direct relationship to (.3129) in indirect relationship which confirmed partial mediation and from these results of mediation, hypothesis is therefore accepted.

H3: To examine the mediating role of trainer motivation in linking the sedentary lifestyle and athletes' performance (H3).

Table 3 Mediation Analysis

Criterion	Predictors	R	R^2	Coefficient	P-Value
Model 1 (Path a)					
Trainer Motivation	Constant	. 3520	. 1239		
	Sedentary Lifestyle			. 2433	.0000
Model 2-3 (Path b & ć)					
Athletes' Performance	Constant	.6553	.4294		
	Sedentary Lifestyle			.0852	.0126
	Trainer Motivation			.6179	.0000
Model 4 (Path c)					
Athletes' Performance	Constant	.3327	.1107		
	Sedentary Lifestyle			.2356	.0000

The mediation model was about the role of trainer motivation in linking the sedentary lifestyle and athletes' performance, using Hayes Process Macro procedure. The path-a revealed that trainer motivation was predicted over harnessing wearable technology where 12.39% change occurred in trainer motivation through sedentary lifestyle with significant impact (β = .2433 & P-value = .0000). The second and third paths provides details about indirect relationships among research issues wherein 42.94% variance occurred in athletes' performance through sedentary lifestyle and trainer motivation with significant impact through coefficient of regarrison wherein sedentary lifestyle (β = .0852 & P-value = .0000) and trainer motivation (β = .6179 & P-value = .0000). The fourth path revealed information that there is 11.07% variance occurred in athletes' performance over sedentary lifestyle with significant impact (β = .2357 & P-value = .0000). The results revealed that trainer motivation partially mediated relationship between sedentary lifestyle and athletes' performance due to decrease in coefficient values from (.2356) in direct relationship to (.0852) in indirect relationship which confirmed partial mediation and from results of mediation, hypothesis is therefore accepted.

DISCUSSION

The limb motion capture is essential in human motion-recognition, motor-function assessment and dexterous human-robot interaction for assistive robots. Due to highly dynamic nature of limb activities, conventional inertial methods of limb motion capture suffer from the serious drift and instability problems [14]. In this linking, the motion capture method with integral-free velocity detection is proposed and a wearable device is developed by incorporating micro tri-axis flow sensors with micro tri-axis inertial sensors [21]. The device allows accurate measurement of three-dimensional motion velocity, acceleration, and attitude angle of human limbs in daily activities, strenuous, and prolonged exercises. Moreover, we verify an intra-limb coordination relationship exists between thigh and shank in human walking and running, and establish a neural network model for it [22]. Using intra-limb coordination model, dynamic motion capture of human lower limbs including thigh and shank is tactfully implemented by the single shank-worn device, which simplifies the capture device and reduces cost. Elevation angles of leg are estimated only in static or quasi-static cases.

In addition, complexity and cost of wearable device is another sensitive issue to be considered. Thus, reducing wearing nodes and lightening weights are important for the next generation of wearable system [17]. To solve problem, wearable motion capture device using dual-axis velocity sensor integrating with inertial sensors has been proposed to detect two-dimensional motion of limb in our previous articles. A micro flow sensor was used to detect a motion-induced surface flow which two-dimensional motion velocity was determined [23]. The experiments in strenuous activities and long-time running validate excellent performance and robustness of the wearable device in dynamic motion recognition and reconstruction of human limbs [24]. In the recent years, marked progress has been made in the wearable technology for the human motion and posture recognition in the areas of assisted training, medical health. The systematically reviews the status quo of wearable sensing systems for human motion capture and posture recognition from three aspects, which are monitoring indicators, sensors, and system design. Finally, it is concluded that future research in this area will emphasize monitoring accuracy, data security, wearing comfort, as well as durability.

CONCLUSION

The present study highlights significant impact that wearable technology and sedentary behavior have on the athletes' performance, with trainer motivation acting as a key mediator. The findings indicate that diverse wearable technologies offer valuable insights into athletes' physical metrics, contributing positively to performance optimization. However, when athletes maintain sedentary lifestyles, the benefits of wearable technology can be diminished, as inactivity leads to decreased physical conditioning and mental engagement. The trainer motivation emerged as vital mediator in this relationship, effectively helping athletes leverage the full potential of wearable technology. In conclusion, while wearable technology provides the tools to enhance the performance, it is the combination of active training and motivational leadership that maximizes the athletes' potential. Sedentary behavior remains a critical obstacle, but with effective trainer intervention, athletes can overcome this challenge and achieve higher levels of performance. This study emphasizes the need for holistic approach, combining technological innovation as well as human motivation, to drive athletic successes.

Recommendations

1. The athletes and trainers should integrate wearable technology into their regular training regimes to monitor physical metrics such as heart rate, sleep patterns, and activity levels for diverse outcomes.
2. To counteract detrimental effects of sedentary lifestyles, athletes should be encouraged to adopt active habits both inside and outside of formal training sessions in order to ensure desired developments.
3. The trainers should focus on employing motivational strategies that ensure athletes stay engaged and consistent with their training thereby fostering conducive environment of encouragement for athletes.
4. The trainers should use the data provided by wearable technology to tailor individualized training programs that align with each athlete's unique needs, strengths, and weaknesses and minimize risks.
5. For wearable technology to be fully effective, there must be strong collaboration between athletes and trainers by devices, while trainers should regularly review the data and adapt training regimens.

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