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Significance of Achieving Target Heart Rate Zones during Aerobic Exercise Using Wearable Device to Improve Cardiac Health

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Abstract

Background: Physical activity is an important part of daily life, which emphasize the importance of a healthy motive among people of various cultures and traditions. Physical inactivity and a sedentary lifestyle contribute significantly to cardiovascular risk. Maintaining cardiorespiratory fitness through physical activity necessitates working out in the recommended target heart rate zones. In this study, we investigated the significance of target heart rate zones during aerobic exercise using wearable fitness devices among both active and sedentary individuals. The primary goal of this study is to use wearable fitness devices to monitor target heart rate zones and to improve aerobic exercise level in order to promote cardiac health.

Method: In this study, Participants were divided based on Global Physical Activity Questionnaire (GPAQ) Proposed by World Health organization (WHO) into active and sedentary individuals. In accordance with the American Heart association (AHA) and American college of sports medicine (ACSM) recommendation, all the participants were asked to do aerobic physical activity for at least 30 minutes five days a week using wearable fitness device and aerobic exercises were monitored. Parameters like BMI, Rating of perceived index (RPE), resting heart rate, Average heart rate, Maximum heart rate and Target heart rate zones were observed and assessed.

Results: Participants in active group (0.69±0.12) achieved recommended target heart rate zones whereas in sedentary group (0.54±0.1) could not achieve with a P-Value of <0.001. Statistically significant results were also seen in average heart rate during exercise among active (133±24) bpm and sedentary (102±19) bpm. The maximum heart rate during exercise in active (160±21) bpm and sedentary (131±17) bpm was observed.

Conclusion: Sedentary people can improve their aerobic exercise by monitoring target heart rate zones. These individuals were unable to reach their target heart rate zones, but this wearable technology will assist them in significantly improving better cardiac health.

Keywords: Heart rate zones; Sedentary lifestyle; Wearable fitness devices; Physical activity; Cardiovascular health

Introduction

Physical activity is an important aspect of one's daily life. It emphasizes the importance of a sturdy healthful cause amongst human beings of various cultures and traditions. People who engage in daily physical activity have a happier and healthier lifestyle, while people who do not engage in regular exercise are much more likely to be afflicted by numerous cardiovascular illnesses. Physical activity consists of play, games, sports, transportation, recreation, physical education, or deliberate exercising, within side the context of family, school, and community activities [1]. The Physical Activity Plan for 2018-2030 by the World Health Organization stressed on: more active people for a healthier world (GAPPA) [2] was launched in 2018 to support countries to achieve a 15% relative reduction in prevalence of insufficient physical activity by 2030. According to the 2007 American Heart association (AHA) and American college of sports medicine(ACSM) recommendation all healthy adults need moderate-intensity aerobic physical activity for a minimum of 30 min on 5 days each week or vigorous-intensity aerobic activity for a minimum of 20 min on 3 days each week in order to promote and maintain their health [3] Despite on-going awareness among major organizations about the significance of physical activity, there is still a widespread ignorance among diverse populations around the world. Physical activity and cardiorespiratory fitness levels are related to decrease over all- cause and cardiovascular mortality. Physical activity can also help to prevent the development of chronic diseases like hypertension, diabetes, stroke, and cancer. Additionally, physical activity can promote healthy cognitive and psychosocial function [4]. Maintaining a good cardiorespiratory fitness is important for many adults, especially working professionals who lead sedentary lives. One of the exceptional techniques to enhance and to maintain cardiovascular fitness is to monitor target heart rate. According to the American heart association, Target heart rate is generally expressed as a percentage (usually between 50% and 85%) of your maximum safe heart rate [5]. The most widely used age-based HR_{max} prediction equation is HR_{max}=220-Age [6]. Target heart rate during moderate intensity activities is about 50-70% of maximum heart rate, while during vigorous physical activity is about 70-85% of maximum [7]. These target HR ranges are intended to place individuals in various "training zones," with each zone corresponding to particular exercise intensity. Training in specific heart rate zones will assist individuals in monitoring heart rate; if one's heart rate and exhaustion is higher, this target heart rate zone will eventually make

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them slow down. In another scenario, if the heart rate is too low and the intensity of the workout routine feels "light" to "moderate," one can push themselves to exercise a little harder, specifically if they may be collaborating in a weight reduction or health programme, especially if they are participating in a weight loss or fitness programme.

Heart rate is a good indicator of physiological adaptation and effort intensity. Therefore, heart rate monitoring is an important component of cardiovascular fitness assessment and training programmes [8]. Fitbit evaluated the average resting heart rate among users in 15 countries. The analysis found users in the United States and Singapore had the highest average Resting Heart rate (RHR) at 65.9 BPM. Users in Italy had the lowest average Resting Heart rate (RHR) at 61.8 BPM [9]. Heart rate monitoring is most likely the most widely used method for exercising healthy adults and athletes. Variations in heart rate correspond to changes in exercise intensity.

A healthy person's heart rate increases linearly with increasing oxygen uptake and exercise intensity under submaximal load. By measuring heart rate during normal training with various apparatus, the exercise intensity of sports training and work can be estimated.

Wearable devices have grown in recognition as a method of measuring activity-based outcomes and facilitating behaviour alternate with the intention to reap weight reduction. Wearable health trackers are gadgets that can record and improve users' physical activity. Recently, photoplethysmography (PPG) devices that use optical heart rate sensors to detect heart rate in real time have become popular and help in monitoring and controlling exercise intensity [10].

In recent years wearable devices have attracted significant attention in the scientific community for the evaluation of heart rhythm over extended periods of time in out-of-laboratory settings due to their characteristics of non-invasiveness, flexibility, and compatibility with the skin [11]. These devices will eventually assist both active and sedentary people in maintaining cardiorespiratory fitness. It helps young adults stay aware of their workout routine to track frequency, intensity, and duration in order to achieve their fitness goals and to monitor target heart rate zones. As physical inactivity is a significant risk factor for cardiovascular disease, these wearable devices will motivate sedentary people and assist them in their weight loss journey and to reveal a prominent role in preventing cardiovascular risk. There is a growing interest in technologies related to remote patient monitoring (RPM) solutions, an interest that has largely been piqued amid the coronavirus disease 2019 (COVID-19) pandemic [12]. And during the coronavirus disease 2019 (COVID-19) pandemic, the potential of wearable health devices has become increasingly apparent [13]. It also encourages people to take a break from stressful jobs and engage in a workout routine in order to improve their physical fitness and live a healthier lifestyle.

In developing countries, where young people constitute the majority of the population, preventing cardiovascular disease has long been a priority for medical professionals. Once risk factors such as overweight and obesity, type 2 diabetes mellitus (T2DM), sedentary behaviour, and unhealthy diets emerge, which are becoming more prevalent at younger ages, it is less likely that individuals will be able to reverse ingrained poor health behaviours and subsequent deleterious downstream cardiovascular effects [14]. Moreover, Cardiovascular diseases impose a serious economic burden on public health: in 2017 medical direct costs related to Cardiovascular diseases amounted to $318 billion, and they are expected to reach $1.1 trillion in 2035 [15]. Cardiovascular diseases are becoming increasingly common in people over the age of 40, and these innovative technologies which are affordable, provide a significant boost to such adults in their efforts to reduce cardiovascular disease risk and to lead a healthier lifestyle.

Method

In this study, 40 participants of age between 25 to 35 years of both men and women are randomly assigned based on Global Physical Activity Questionnaire (GPAQ) proposed by World health organisation (WHO). Participants are basically working professionals of various fields mostly software and Doctors. They are divided into 20 active and 20 sedentary individuals based on (GPAQ). Participants with co-morbid conditions like Diabetes mellitus, Hypertension and neurological disorders are excluded from the study.

Experimental design

The participants were advised to do aerobic exercises like running and cycling at their own pace and intensity. Participants were encouraged to exercise with a time period for at least minimum of 30 minutes per day, and with a workout frequency of five days per week, according to guidelines proposed by the American College of Sports Medicine. Participants were instructed to wear their respective wearable fitness device throughout their workout. These wearable devices have activity monitoring specifications that track activity, such as walking or running distance, steps accumulated and energy expenditure. The device measures heart rate using a technique known as photoplethysmography (PPG). With each heartbeat, special LED lights and sensors measure the changes in blood flow. The smart watch then computes the number of times the heart beats per minute. An online questionnaire was sent to participants each day, and after the workout, they were asked to enter the details of the workout summary, which included (Anthropometrics, Type of activity, workout time, RPE, resting heart rate, average heart rate, and maximum heart rate) and data was collected.

Separate instructions were given to the participants on how to measure Rating of perceived exertion (RPE) and resting heart rate. After collecting the data, the percentage of average and maximum heart rates in relation to the American Heart Association's (AHA) recommended target heart rate zone of (50 to 85%) was calculated. The zones were found by the average heart rate that was maintained during the workout routine and the level of activity was determined (Figure 1).

The five zones are categorised as:

Zone 1 = 50-59% (Very light activity), Zone 2 = 60-69% (Light activity), Zone 3 = 70-79% (Moderate activity), Zone 4 = 80-89% (Hard activity), and Zone 5 = 90-100%. (Maximum activity).

Statistical Methods

Active and sedentary were considered as primary outcome variables.

Descriptive analysis was carried out by frequency and proportion for categorical variables and mean & standard deviation for continuous variable. Data was also represented using appropriate diagrams like pie diagram, bar chart.

The association between categorical explanatory variables was assessed by chi-square test. P value < 0.05 considered as association between variable.

The mean difference between explanatory variable and outcome variable was assessed by using independent t test.

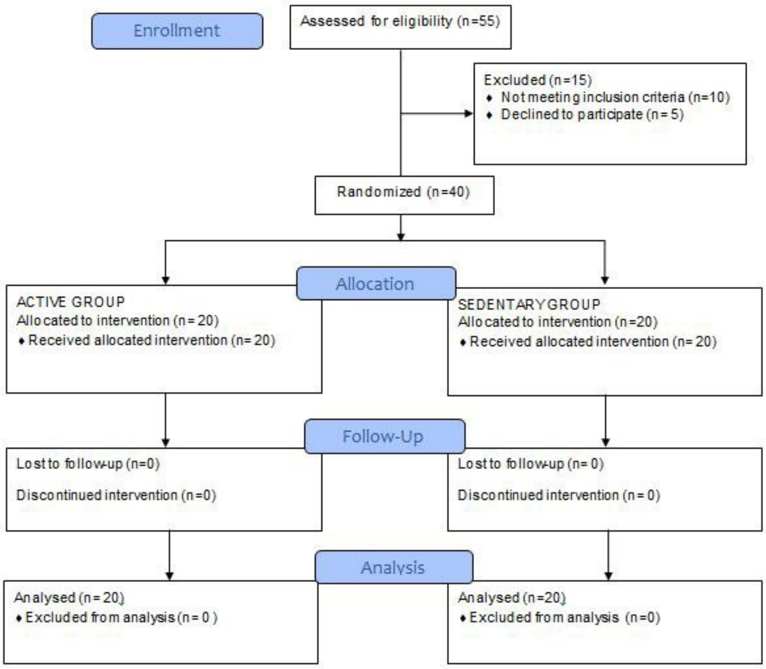

Figure 1: CONSORT flow chart describing participant flow during the study.

Table 1: Comparison of baseline parameters between study group (N=40).

Parameter	Study group (Mean± SD)		P value
	Active (N=20)	Sedentary (N=20)	
Age	28.65 ± 3.01	29.75 ± 2.84	0.243
Gender			
Female	8 (40%)	8 (40%)	1.000
Male	12 (60%)	12 (60%)	
Weight (kg)	73.75 ± 15.23	83.65 ± 9.71	0.019
Height (cm)	169.4 ± 6.96	172 ± 5.68	0.204
BMI	25.48 ± 4.03	28.36 ± 2.48	0.010
Predicted maximum heart rate (220-age) (bpm)	191.35 ± 3.01	190.25 ± 2.84	0.243
Recommended Target Heart Rate Zone (50 -85%) (Bpm)			
95-162	8 (40%)	10 (50%)	0.525
100-170	12 (60%)	10 (50%)	

P value < 0.05 was considered statistically significant. IBM SPSS version 22 was used for statistical analysis. (1)

1. IBM Corp. Released 2013 IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.

Results

Among the study population, 20 (50%) participants were active group remaining 50% were Sedentary group (Table 1).

On Comparing of anthropometric parameters between study group at different time periods. There was statistically significant difference observed between two groups were weight (in kg) and BMI at different time periods like at day1, day 2, day 3, day 4 and day 5 (P-value <0.05) was seen (Table 2).

In this study, on Comparing rating of perceived exertion (RPE) (0 to 10) among participants between study group at different time periods. There was a proportionally difference between the two groups and RPE (0 to 10) at various time intervals such as day 1, day 2, day 3, day 4, and day 5 (P value 0.05) (Table 3).

Table 2: Comparison of anthropometric parameters between study group at different time periods (N=40).

Parameter	Study group (Mean± SD)		P value
	Active (N=20)	Sedentary (N=20)	
Weight(kg) at day1	73.75 ± 15.23	83.65 ± 9.71	0.019
Weight(kg) at day 2	73.75 ± 15.23	83.65 ± 9.71	0.019
Weight(kg) at day 3	73.73 ± 15.25	83.65 ± 9.71	0.019
Weight(kg) at day 4	73.52 ± 15.16	83.65 ± 9.71	0.016
Weight(kg) at day 5	73.5 ± 15.16	83.65 ± 9.71	0.016
BMI at day 1	25.48 ± 4.03	28.36 ± 2.48	0.010
BMI at day 2	25.47 ± 4.04	28.36 ± 2.48	0.010
BMI at day 3	25.47 ± 4.04	28.36 ± 2.48	0.010
BMI at day 4	25.4 ± 4.01	28.36 ± 2.48	0.008
BMI at day 5	25.4 ± 4.01	28.36 ± 2.48	0.008

Table 3: Comparison of mean of RPE (0 to 10) between study group at different time periods (N=40).

Parameter	Study group (Mean± SD)		P value
	Active (N=20)	Sedentary (N=20)	
RPE (0 to 10) at day 1	5.65 ± 0.81	6.8 ± 0.89	<0.001
RPE (0 to 10) at day 2	5.75 ± 0.97	6.55 ± 0.94	0.012
RPE (0 to 10) at day 3	5.95 ± 0.76	6.85 ± 0.75	<0.001
RPE (0 to 10) at day 4	5.7 ± 0.8	6.5 ± 0.69	0.002
RPE (0 to 10) at day 5	6 ± 0.86	6.7 ± 0.8	0.011

The resting heart rate, average heart rate and the maximum heart rate among study participants showed statistically significant results at day1, day 2, day 3, day 4 and day 5 (P value <0.05) respectively (Table 4).

There was a statistically significant difference between the two groups and the recommended average target zone achieved (50-85%) by American Heart association (AHA) at various time intervals such

Table 4: Comparison of mean of resting heart rate (bpm), average heart rate (bpm) and maximum heart rate (bpm) between study group at different time periods (N=40).

Parameter	Study group (Mean± SD)		P value
	Active (N=20)	Sedentary (N=20)	
Resting heart rate (bpm) at day 1	67.05 ± 5.66	75.65 ± 4.77	<0.001
Resting heart rate (bpm) at day 2	66.9 ± 5.77	75.65 ± 4.77	<0.001
Resting heart rate (bpm) at day 3	66.95 ± 5.55	75.65 ± 4.77	<0.001
Resting heart rate (bpm) at day 4	66.65 ± 5.85	75.65 ± 4.77	<0.001
Resting heart rate (bpm) at day 5	66.7 ± 5.88	75.65 ± 4.77	<0.001
Average Heart rate (bpm)			
at day 1	131.8 ± 25.43	100 ± 20.39	<0.001
at day 2	131.6 ± 22.92	101.25 ± 20.2	<0.001
at day 3	135.75 ± 22.6	103 ± 18.51	<0.001
at day 4	132.5 ± 25.01	102.75 ± 20.46	<0.001
at day 5	136.6 ± 21.99	104.2 ± 19.17	<0.001
Maximum heart rate (bpm)			
at day 1	161.4 ± 23.24	128.55 ± 19.77	<0.001
at day 2	159.85 ± 21.4	130.85 ± 17.81	<0.001
at day 3	161.85 ± 20.37	131.45 ± 15.59	<0.001
at day 4	160 ± 20.51	132 ± 16.85	<0.001
at day 5	161.5 ± 20.95	132.4 ± 15.44	<0.001

Table 5: Comparison of mean of recommended average target zone achieved (50-85%) by American Heart association (AHA) and Maximum target zone achieved between study group at different time periods (N=40).

Parameter	Study group (Mean± SD)		P value
	Active (N=20)	Sedentary (N=20)	
Recommended average target zone achieved (50-85%) by American heart association (AHA)			
at day 1	0.68 ± 0.13	0.53 ± 0.11	<0.001
at day 2	0.68 ± 0.12	0.53 ± 0.11	<0.001
at day 3	0.7 ± 0.12	0.54 ± 0.1	<0.001
at day 4	0.69 ± 0.13	0.54 ± 0.11	<0.001
at day 5	0.71 ± 0.11	0.55 ± 0.1	<0.001
Mean target zone achieved (50-85%) (AHA)	0.69 ± 0.12	0.54 ± 0.1	<0.001
Maximum target zone achieved			
at day 1	0.85 ± 0.1	0.68 ± 0.1	<0.001
at day 2	0.83 ± 0.11	0.69 ± 0.09	<0.001
at day 3	0.84 ± 0.1	0.69 ± 0.08	<0.001
at day 4	0.83 ± 0.1	0.69 ± 0.09	<0.001
at day 5	0.84 ± 0.11	0.7 ± 0.08	<0.001

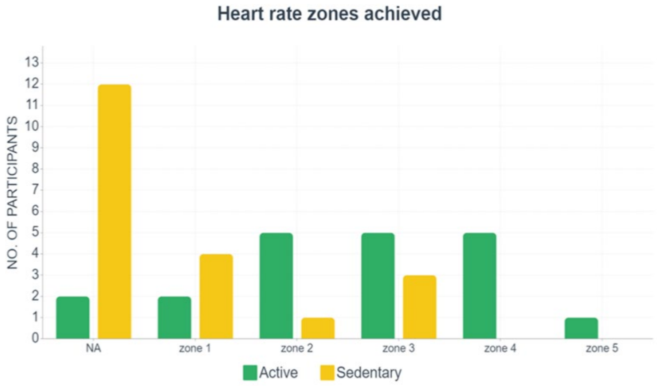

Figure 2: Target Heart rate zones achieved in active and sedentary individuals.

as on day 1, day 2, day 3, day 4, and day 5 (P - values <0.05) (Figure 1). There was a statistically significant difference between the two groups, as well as the maximum target zone achieved at various time intervals such as day 1, day 2, day 3, day 4, and day 5 (P - values <0.05) (Table 5 and Figure 2).

Discussion

In our study, nearly half of the study subjects were sedentary. This was supported by the study conducted by Poddder V, et al. where they revealed a greater frequency of inactivity (50%) in four geographical areas of the nation [16]. Nearly two-thirds of them were males. There was no statistical significance found between active and sedentary group with respect to predictive and target heart rate at the baseline. This was corroborated by study conducted by Leonard et al. where they found that Average Measured Maximal Heart Rate (MMHR) was 192 ± 6.6 bpm and average Predicted Measured Heart Rate (PHMR) was 193±1.3 bpm [17]. There was no statistically significant difference between the MMHR and the PMHR. This explains that the participants were similar in both the groups at baseline i.e. they were not comparable at the baseline.

The weight measured at baseline in active group was very minimally reduced after 5 days. However, the weight measured in sedentary group remained same. This replicates that use of the wearable fitness device had its impact on physical activity level among the participants. This result was corroborated by the study conducted by Cayir Y, et al. [18] where they investigated the effect of utilising pedometers as a motivational tool to improve physical activity among obese women on weight loss. They observed that after the programme, the mean weight in the pedometer group dropped from 88.9 ±8.4 kg to 80.2 ± 8.7 kg. The average daily step count in the pedometer group increased from 8817 ± 2725 at the beginning to 9716 ± 2811 at the conclusion of the trial. However, in our study the duration was very less compared to the above stated study and hence there was no statistical difference in weight from baseline to end line assessment.

In our study, the mean BMI was higher in sedentary group than compared to active group. This was supported by Bennet et al. [19], where they found that there was an association between BMI and Physical activity level. This could be explained by the fact of motivation provided through the fitness wearable devices. Using data from a cross-sectional examination of 405,819 participants in the European Prospective investigation in to Cancer and Nutrition-Physical Activity, Nutrition, Alcohol, Quitting Smoking and Eating out [20]. According to a study on obesity, going from being inactive to being moderately active or from being moderately active to being active was related with a 0.25-unit lower BMI and a 1.0-cm smaller waist circumference [21].

In our study, the sedentary group participants had relatively higher resting heart rates than that of the active group subjects. According to Biswajit et al. [22] active women (73.06±5.61) had lower resting heart rates than sedentary women (74.06±6.68). However, this difference was not statistically significant but, in our study, it was dissimilar to this. It could be due to the smaller sample subjects. Also, there was no significant change in the activity with respect to cycling and running from baseline to end-line. However, there was an increase in the cycling activity among the active group, whereas in the sedentary group remained in the same level of activity.

The RPE scale is used to assess exercise intensity. The RPE scale is 0 to 10. The numbers below correspond to phrases used to rate how easy or difficult an activity is. For example, 0 (nothing at all) describes how you feel when sitting in a chair, while 10 (very, very heavy) describes how you feel at the end of an exercise stress test or after a particularly difficult activity. In our study, RPE was comparable among group at the end line. This proves the effect of effect of provision of wearable fitness devices on RPE. Cenk et al. conducted a study where examined the transitions in response to a physical activity (PA) programme as opposed to a health education (HE) programme, as well as the relationship between rating of perceived effort (RPE) of walking and major mobility disability (MMD) [23]. Intervention increased the mean duration of physical activity from baseline in active group. This was supported by the study conducted by Pal S et al. At the conclusion of the 12 weeks, the pedometer group had dramatically increased their duration of activity by 36%, whereas the control group's physical activity levels had stayed constant [24].

Target heart rate can be divided into five zones to help you achieve different exercise goals. With each higher zone, the heart rate rises.

Zone 1: 50%-60% of the maximum heart rate. Zone 1 activities are categorised as "very light."

Zone 2: 60%-70% of the maximum heart rate. Zone 2 activities are considered "light."

Zone 3: 70%-80% of the maximum heart rate. Your activity level in zone 3 is "moderate." This level of exercise improves lung and heart endurance—the amount of time you can exercise without stopping.

Zone 4: 80%-90% of the maximum heart rate. Exercise in Zone 4 is a "hard effort" activity. This is not an exercise that can be done for an extended period of time.

Zone 5: 90%-100% of the maximum heart rate. Zone 5 exercise is defined as "maximum effort."

In order to create exercise prescriptions, establish target heart rate zones for exercises, and track workouts while in those target heart rate zones, maximal heart rate is frequently used. While a maximal aerobic capacity exercise test, often known as a VO2max test, can measure maximum heart rate, this is not always possible. In addition, a fitness expert could determine maximum heart rate using submaximal exercise testing or outdoor tests. However, a lot of health and fitness experts, including personal trainers, group fitness instructors, and exercise physiologists, employ an estimate of age-predicted maximal heart rate due to its simplicity and convenience (APMHR). APMHR = 220 - age is the most widely used equation to measure heart rate. It's vital to keep in mind that the calculated maximum heart rate is only an estimate of the maximum heart rate, which could vary by 12 to 15 beats per minute. The majority of wearable devices utilises this formula to estimate heart rate as a default (APMHR = 220 age), requiring the user to enter an age or birthday before using that information to determine APMHR. The formula for calculating target heart rate is the same whether maximum heart rate is measured or anticipated: target heart rate = maximum heart rate measured or predicted × % of desired intensity [25]

In our study, participants in the active were comparable with sedentary group with respect to the Recommended average target zone (50-85%). i.e. There was statistical difference among the groups from baseline till endline. Intensity of the activities was slowly and relatively progressive. When considering intensity, hard intensity gradually progressed among the active group participants while the light exercise progressed among the sedentary group participants.

Luban et al. found that the use of activity trackers significantly improved the physical activity level, since there was the technique of self-monitoring by the participants and they also noted that there was an increase in step-counts [26].

Conclusion

In the past decade there was not much of an influence on exercise benefits using Wearable fitness technology. But in recent times particularly after COVID pandemic, there was a wide spread awareness among sedentary individuals to increase their physical activity level and to lose weight. It paves the way for a better, healthier lifestyle for everyone turning 40. It is a major element for those between the ages of 20 and 35. This more recent technology helps people of all diversity to reach their recommended target heart rate zones, improve their cardiorespiratory fitness promote cardiac health and to prevent their risk of developing cardiovascular disease in the future.

The wearable fitness devices were used majorly in developed nations, but in developing countries the prevalence is comparatively less. Hence encouraging people to use this affordable device during exercise particularly working out in moderate-intensity level for lowering overall cardiovascular risk. Every physical activity improves cardiovascular health. Future research employing this cutting-edge technology should focus on individuals with existing cardiac conditions.

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Conflict of Interest: "The authors declare no conflict of interest."

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