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Assessing the impact of the A-Trainer exercise machine on cardiovascular health and muscle activation: A mixed-methods study

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ABSTRACT

Recent advancements in fitness technology have introduced innovative equipment like the A-Trainer, which integrates aerobic and anaerobic exercises for targeted muscle or whole-body engagement. This development holds significant potential for delivering impactful, low-impact, high-intensity workouts, enhancing rehabilitation and overall well-being. The objective of this mixed-method observational study was to evaluate the impact of this novel exercise machine on muscle activation and cardiovascular effects, as well as to understand user perspectives through interviews. Surface electromyography (sEMG) sensors were used to monitor specific upper body muscles, while a physical activity wearable tracker measured heart rate activity. Semi-structured interviews provided insights into participants' experiences with the exercise machine. Fifteen adults participated in this study. Results indicated a significant difference in sEMG muscle activity between the isometric pre-workout and post-A-Trainer workout strength assessments across all muscle groups, suggesting a substantial enhancement in muscular engagement. The wearable tracker also reported considerable calorie burn during short exercise sessions. However, this study focused on a single intensity and resistance level, which limits generalisability. Interviews highlighted the A-Trainer's effectiveness for cardiovascular training and accessibility for all ages.Future research should investigate the A-Trainer's effectiveness across varying intensities and resistance levels to achieve a comprehensive understanding of its benefits.

Introduction

Recent advancements in fitness technology have ushered in a new era of exercise equipment, designed to optimise workout routines and provide objective feedback for fitness enthusiasts [1,2]. Furthermore, strength and conditioning coaches are constantly integrating different training modalities into periodised programs in order to increase their trainee's strength, stamina, and muscle endurance.

Among the latest innovations in fitness technology is the A-Trainer (Fig. 1) (Advanced Cardio Equipment Ltd, Reigate, London, United Kingdom), an exercise machine designed to integrate cardiovascular training, muscular endurance, and muscle building into a single workout. This versatile piece of equipment allows users to engage in targeted upper-body exercises or full-body workouts by adjusting resistance levels and speed, making it suitable for a wide range of training goals.

The A-Trainer is engineered to provide a comprehensive upper-body workout, enabling users to customise their training programmes based on their fitness objectives. For cardiovascular training, the machine can be used at lower resistance levels with moderate revolutions per minute (RPM), facilitating sustained, low-intensity workouts that promote fat burning and endurance. Conversely, at higher RPMs, it allows users to engage in short bursts of intense activity, improving both aerobic and anaerobic fitness. Muscular endurance training begins when resistance levels are increased, engaging either isolated muscle groups or multiple groups simultaneously. By varying resistance and speed, users can tailor their workouts for sustained endurance training or structured interval sessions. At higher resistance levels, the A-Trainer functions similarly to weightlifting exercises, requiring intensive effort over short durations to stimulate muscle growth. Users can focus on individual muscles or combine multiple groups for a more dynamic strength-training experience. In clinical settings, the A-Trainer offers a low-impact option for individuals recovering from upper-body injuries or those with limited mobility. Resistance training is essential in rehabilitation, aiding muscle reconditioning, joint function restoration, and cardiovascular health. The A-Trainer's adaptability makes it suitable for progressive

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Fig. 1. The A-Trainer.

rehabilitation programmes and therapeutic exercise interventions, providing a controlled and customisable approach to recovery. This unique combination of cardiovascular and resistance training distinguishes the A-Trainer as a versatile and efficient tool for enhancing overall fitness. It offers athletes and general users the flexibility to alternate their training programmes while optimising both endurance and strength development in a single session. This could be important as studies have found great benefits in low-impact high-intensity exercises that could increase individual adherence to a particular rehabilitation and exercise programme and subsequently improve quality of life [3,4].

Surface Electromyography (sEMG) is a valuable tool utilised in various settings, including clinical, therapeutic, and gym environments, for muscle testing and assessment [5,6]. In clinical and therapeutic settings, sEMG plays a crucial role in evaluating muscle function and identifying potential neuromuscular disorders or imbalances. In contrast to traditional electromyography, which involves inserting needles into muscles for electrical signal recording, sEMG sensors offer a non-invasive alternative [5,7]. Placed directly on the skin's surface, these sensors detect and measure electrical impulses generated during muscle contractions. By analysing the amplitude and frequency of these signals, sEMG technology provides valuable insights into muscle activity levels, recruitment patterns, and fatigue responses [6].

Cardiovascular exercise plays a vital role in overall health by enhancing heart and lung function, improving circulation, and boosting endurance [8]. However, while the physiological benefits of exercise are well-documented, the effectiveness of exercise machines, such as the A-Trainer, must be evaluated from a holistic perspective. Specifically, it is essential to measure cardiovascular responses during exercise, such as heart rate and calorie expenditure, to assess the machine's efficacy in improving cardiovascular fitness [9]. However, to fully understand the impact of the A-Trainer, quantitative data alone is insufficient.

Integrating qualitative research methods, particularly user interviews, is crucial in sports science and health studies. Qualitative insights provide a deeper understanding of user experiences, preferences, and perceived effectiveness of exercise equipment, which quantitative measures may not capture. According to current Public and Patient Involvement (PPI) guidelines from the NIHR [10], qualitative research is essential in ensuring that interventions meet the needs of users and are aligned with real-world application. By incorporating both objective physiological measures and subjective user feedback, the A-Trainer's evaluation becomes more comprehensive, enabling researchers to assess not only its physical effectiveness but also its user-centred benefits, such as comfort, ease of use, and motivational factors. This holistic approach ensures a well-rounded understanding of the A-Trainer's impact on long-term health improvements and user satisfaction [11].

This observational mixed-method study aims to evaluate the impact of the A-Trainer exercise machine on both cardiovascular health and muscle activation. By combining quantitative measurements with qualitative feedback, the study sought to capture a holistic view of the machine's effectiveness.

Methods

Study design

This was an investigator-initiated, single-center observational mixed-method study with full ethical approval granted by the Bournemouth University Research Ethics Committee (ref: 51,787) and prepared in accordance with STROBE guidelines for reporting observational studies [12,13].

Participants

Table 1 provides full eligibility criteria for the participants in the study. Participants were all recruited through publicising tools such as Twitter posts, and posters shared on the local leisure centres. Those interested in the study, initially contacted the lead researcher, were provided with an information sheet and to comply with Good Clinical Practice (GCP) guidelines [14], were given 48 h to consider participating. Participants granted their written informed consent before engaging in this study.

Study size and setting

Participants were recruited over a period of three weeks. The study was carried out at the Broad Street Gym in August 2023. In order to evaluate the impact of the A-Trainer on muscle activation, upon arrival at the centre, participants were fitted with sEMG sensors (Biometrics Ltd, UK) for 6 different upper extremity muscles, (Fig. 2), pectorals major left and right side [PML and PMR], trapezius [TR], medial deltoid [MD], biceps brachii [BB], and triceps brachii [TB] of the dominant extremity. To standardise the positioning of the sensors, a procedure was implemented wherein all muscles were initially located and subsequently marked. This ensured precision in sensor attachment (Fig. 2). Furthermore, each sensor was linked to a designated DataLog channel corresponding to a specific muscle for the entirety of the study. The TR and MD were considered as shoulder muscles, BB and TB as upper arm muscles, and PML and PMR as the chest muscles.

After sensor placement, participants completed 3 min of upper-body dynamic warm-up and then completed a series of Maximum Voluntary Isometric Contractions (MVICs). During MVIC testing, participants were instructed to maximally contract the target muscles for 3 s, performing the excecise in the exact positioning as the A-Trainer movement. Each muscle was maximally contracted 3 times separated by 15 s of rest. Sixty seconds of rest was given between each different muscle. After concluding the MVICs test, the A-Trainer was adjusted to level 99 (maximum resistance). Subsequently, each participant was instructed to engage in a one-minute exercise session. In order to standardise participant positioning, a dedicated member of the research team

Table 1
Eligibility criteria.

Inclusion Criteria	Able-bodied volunteers Safely ambulatory without assistive devices Age 18 and over Must be able to give written informed consent
Exclusion Criteria	• Neurological or musculoskeletal conditions that the investigator deem affect independent exercise • A cognitive function that prevents participants from understanding the study • Medical conditions that might be jeopardised by exercise

Fig. 2. The A-Trainer positioning and the sEMG placement on upper extremity muscles. a) Trapezius [TR] and medial deltoid [MD]; b) biceps brachii [BB]; c) Pectorals major left and right side [PML and PMR]; and d) triceps brachii [TB].

supervised the process. Participants were guided to sit on the A-Trainer seat, maintaining their back against the seat, while their hips and knees formed a 90-degree angle. Additionally, their feet were positioned flat on the ground, and their elbows extended while grasping the handles of the A-Trainer.

The cardiovascular measurements were recorded using a MyZone heart monitor (MYZONE MZ-3, Douglas, Isle of Man), a wearable device designed to accurately track heart rate and calorie expenditure [15]. This data provided insights into the intensity of the cardiovascular workout and the overall effectiveness of the machine in elevating heart rate and promoting cardiovascular health [16].

Each participant wore a new MyZone device strapped to their chest, which was calibrated according to individual age, weight, and height. Participants maintained a position with their feet flat on the ground and their elbows extended while grasping the handles of the A-Trainer. The A-Trainer was set to level zero, and each participant performed three five-minute exercise sessions on the machine.

Resistance levels and power calculations

As reported by the manufacturer, at Level 99 (maximum resistance), a voltage of 17.6 V is recorded. Using the voltage measured at this level, the electrical power (Pe) was calculated with the formula: $Pe \frac{V^2}{R}$, where V represents the voltage and R is the resistance. Therefore, the calculated electrical power (W) was 28.7 W. To understand the mechanical power output, calculations were made for efficiencies of 40 % and 75 %, representing different potential system efficiency scenarios. At 40 % efficiency, the mechanical power output was 71.7 W, while at 75 % efficiency, it was 38.2 W.

Interviews

Following the excercise completion, in order to qualitatively explore the effectivness of the A-Trainer, all participants were invited for a semi-structured interview. The use of a semi-structure interview is proven to be an effective method to 1) collect qualitative, open-ended data; 2) explore participant thoughts, feelings, and beliefs about a particular topic; and 3) delve deeply into participant's challenges and experiences [17]. A topic guide (see Appendix A) was designed to cover key areas relevant to the study's objectives while allowing flexibility for participants to express their thoughts freely. Participant feedback was analysed using thematic analysis [18,19]. The six phases of the thematic analysis [18], 1) familiarisation with the data, 2) generating codes, 3) searching for themes, 4) reviewing themes, 5) defining, and 6) naming themes, were followed. The recording was anonymised and transcribed discussions were read through several times by the lead researcher to become familiar with the data and were organised using Microsoft Excel Version 2408. Codes were thereafter created, and similar codes were organised into potential themes. To ensure reliability and validity, the identified themes were reviewed and refined through discussions with co-researcher, allowing for the incorporation of alternative perspectives and ensuring the robustness of the findings. The sessions took around 25 to 35 min and were conducted in June 2024.

Data analysis

Electromyography muscle activity raw data during the MVIC and exercise performance trials from all 6 muscles were filtered with a band-pass filter (20–250 Hz). These were then rectified before calculating the mean amplitude of the muscle activity. The EMG-dependent variables which included mean muscle activity (mean EMG), and MVIC for all 6 upper extremity muscles were measured during each individual trial.

The heart rate, recorded continuously by the MyZone device throughout each exercise session. Heart rate data were collected at regular intervals (e.g., every 30 s) to capture dynamic changes in response to the exercise intensity. Effort levels, represented as a percentage of the participant's maximum heart rate, were analysed to assess adherence to the prescribed exercise intensity (61–69 %). This analysis included calculating the mean, and range of effort levels across the three repetitions for each participant.

Statistical methods

All data were analysed using IBM SPSS Statistics version 26 (SPSS Inc., Chicago, IL, USA). Data are expressed as the mean and standard deviation. Non-parametric analysis was used as the sample size was small, and therefore not normally distributed. A repeated-measured ANOVA (Friedman 2-way by rank) was used to compare the data for pre to post-workout using the A-Trainer. A *P* value lower than 0.05 was considered statistically significant for all analysis.

Results

Fifteen adults (12 males, 3 females, average age 41.7 ± 16.5 years old, average BMI 25.8 ± 5.4 kg/m^2) were recruited to take part in this study.

Table 2 presents a summary of sEMG muscle activity, encompassing mean values, standard deviations, and P-values for evaluations of relative muscle groups. There was a significant difference in sEMG muscle activity between the isometric pre-workout and post-A-Trainer workout strength assessments for all muscle groups, indicating a substantial alteration in muscular engagement.

Table 3 presents a desriptive summary of MyZone cardiovascular calories burnt in a five minute excercise, encompassing mean values, standard deviations, for each participants.

Qualitative analysis

The codes and themes relating to the A-Trainer, are illustrated in Fig. 3.

Effectiveness

Participants found the exercise machine effective for cardio workouts at level zero, with smooth movement and no strain on the body. Additionally, all participants agreed that increasing the level of resistance resulted in significantly harder movement. Consequently, they unanimously felt that the machine is excellent for muscle building.

> “I believe it is great for cardiovascular exercise. It has a significant effect on blood circulation, and you can adjust the levels of resistance to make it more challenging. It provides a substantial pump in your muscles, and you really feel the strength when you get off it, making you feel like you’ve had a hard workout.”

> “The strength training aspect is definitely good. The ability to use different settings and adjust the resistance can really help push your heart rate when needed, which is great for intense cardio and upper body strength training.”

Comfort

Participants highlighted the ergonomic benefits of the exercise machine. Emphasis was placed on the comfort and support provided by the seating and backrest, which help maintain correct posture during use. This feature ensures that users can push down without straining their bodies, contributing to a more effective and comfortable workout. Others pointed out the machine’s flexibility, particularly for taller users with longer arms, allowing them to adjust and reposition their hands. This adaptability caters to a wider range of body types and preferences, enhancing the overall user experience by providing customised comfort and support.

> “Seating is very comfortable, and the backrest helps maintain your correct positioning while pushing down.”

Table 2
sEMG muscle activity. EMG = electromyography; BB = biceps brachii; TB = triceps brachii; TR = trapezius; MD = medial deltoid; MVIC = maximal voluntary isometric contraction. Mean +/- SD for mean EMG, and MVIC for muscles with significant differences for evaluation between MVIC and post A-Trainer workout (P).

Muscle	Mean EMG (μV)		p
	A-Trainer	MVIC	
PML	327.9 ± 266.4	89.6 ± 181.9	0.003
PMR	371.2 ± 48.2	100.5 ± 41.8	0.005
BB	280.3 ± 85.3	98.4 ± 89.9	0.013
TB	310.5 ± 121.3	79.7 ± 177.1	<0.0004
TR	147.8 ± 269.9	53.2 ± 138.3	0.021
MD	160.3 ± 124.1	71.2 ± 51.0	0.047

> “I think there’s a sort of flexibility in that if you are a bit taller and have longer arms, you can adjust and move the position of your hands.

Muscle engagement

Participants agreed on the capability of engaging various muscle groups. However, they all emphasised the importance of technique and positioning when using the exercise machine, highlighting how these factors influence muscle engagement.

> "It’s about using the right technique. When I’ve been using it, my seating position and where I hold the apparatus determine which muscles are engaged. When I sit more upright, I’m engaging my abdominals more. When I sit lower, I feel it more in my triceps, back, and shoulders. Additionally, I feel it in my legs due to the grounding. Just like when you do a chest press and the force travels up through your legs, I still feel that on the machine."

> "I think it depends on how you hold the handles, as there are different ways to grip them when you press down. You’re working your abdominals, biceps, and triceps. And, of course, your abs. Definitely.”

User experience and accessibility

The analysis of the participants views on the user experience and acceptability, illustrated a balanced view of the machine’s usability and effectiveness, with some emphasising simplicity and ease of operation, and others detailing the learning curve and benefits observed through consistent use and correct technique. One female participant expressed admiration for the machine, emphasising its inclusivity for people of ’any age’. She highlighted its potential benefit for her husband, who has had a heart attack and needs to exercise cautiously. The machine’s features, such as its simplicity and clear feedback system (indicated by colours like green and blue), are praised for their user-friendliness and effectiveness in guiding workouts. Once set up correctly, the speaker finds the machine to be particularly advantageous, potentially ideal for her husband’s health needs.

> “I just think it’s really good because it’s suitable for any age. Anyone can do that. I just thought it was really, really good. Like my husband, I thought he’d be good on that because he’s kind of given up a bit, not entirely, but he’s had a heart attack. So he has to exercise carefully. He doesn’t do too much, you know, like this. So that would be ideal for him in my mind because he can see it. You know, like, I know you can get all these apps on your phones, and that was really clear when you put your phone there. Oh, it’s gone green. Stop. Breathe. It’s back to blue. Start again, which I think was great. Okay, once you know it’s set up, I think that’s really good.”

> “I think the machine is easy to use and it’s not tons of buttons, and its easy to reset.”

> “Yeah, it seemed fun. I had a positive experience. I think I’m not quite at a good level of fitness anyway. But when I sat on the machine, firstly, I struggled because it works different muscles in your body and puts you under a different type of stress. But I can see the benefits from it. Each time I used it, I felt like I was working out, getting used to it, and getting stronger. So I’ve seen a lot of benefit from adding it into my workouts; the machine is user-friendly overall. Yeah, I think you need someone to show you how to use it properly. That’s important because it’s not like a vending machine; you need the right technique on a machine like that. It’s very easy for a beginner to sit on it and start using it incorrectly. So I think it’s user-friendly as long as you have someone to guide you. But once you know how to use it then its very good.”

Table 3
Participant Characteristics, Predicted Calories Burned, and Effort Levels During Exercise Sessions.

Participant	Age (years)	Calories Burned				Effort (%)
		Repetition 1	Repetition 2	Repetition 3	Mean (SD)	Mean
P1	45	66	69	67	67.3 (1.5)	68
P2	68	48	51	50	49.7 (1.5)	63
P3	44	76	39	58	57.7 (18.5)	62
P4	65	54	53	54	53.7 (0.6)	61
P5	67	56	56	56	56.0 (0.0)	61
P6	18	58	70	64	64.0 (6.0)	67
P7	61	57	56	57	56.7 (0.6)	63
P8	34	57	56	57	56.7 (0.6)	63
P9	26	39	53	46	46.0 (7.0)	61
P10	27	51	49	50	50.0 (1.0)	61
P11	34	74	63	69	68.7 (5.5)	67
P12	37	57	74	66	65.7 (8.5)	67
P13	31	54	53	54	53.7 (0.6)	61
P14	26	57	54	56	55.7 (1.5)	61
P15	42	56	54	55	55.0 (1.0)	61

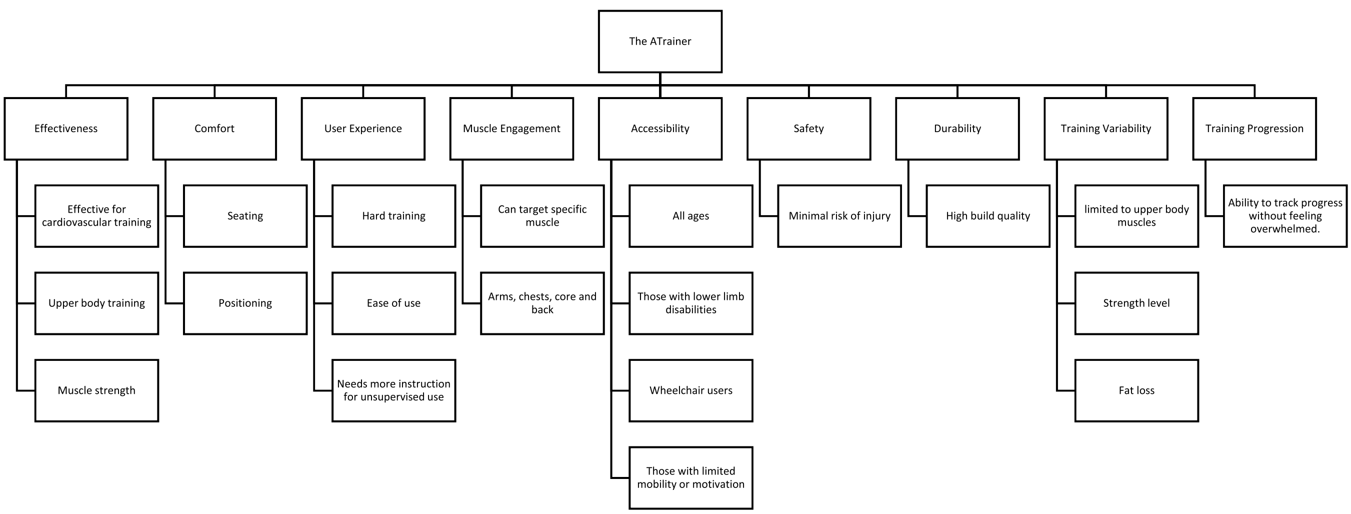

Fig. 3. The codes and themes related to the A-Trainer.

Safety and durability

The participants collectively agreed that the exercise machine is safe and well-built. They felt that the design minimises the risk of injury by being self-explanatory and excluding free weights.

"I felt secure using the machine. There's minimal risk of injury as the system is self-explanatory and doesn't involve free weights. By simply adjusting the resistance on the digital screen, I can increase the intensity of my workout."

"The exercise machine feels robust and sturdy. It remained stable throughout, whether I was using it at level zero or level 99."

Feedback on areas for improvement

Overall, participants did not suggest any improvements; they felt the machine was well-designed and provided a very useful exercise experience. However, two participants commented on additional features for enhancement. The first participant noted the absence of instructional guidance, especially regarding different positioning, despite well-designed handlebars. They suggested that clearer instructions could significantly improve user interaction with the machine. In contrast, the second participant expressed a desire for enhanced functionality by adding sensors to the handlebars. This feature could enable users to monitor their heart rate and workout intensity directly on the machine's monitor, offering real-time feedback and potentially increasing the machine's utility and appeal to users interested in detailed workout metrics.

"The handlebars are well-designed, but overall, the machine lacks any instructions attached to it. Guidance on different positioning could greatly enhance the user experience."

"I would have liked to see sensors on the handle bar so my heart rate and intensity can be displayed on the monitor"

Other comments

Participants also had an opportunity to share any further thoughts, whether positive or negative, about their exercise experiences or throughout the study that may not have been discussed earlier in the interview. An interesting point was raised regarding the usability of the machine, particularly for individuals with lower limb disabilities. The machine offers a cardiovascular strength workout while seated, challenging traditional workout methods. This highlights its potential to provide effective exercise opportunities in a comfortable seated position, which may appeal to wheelchair users or those who require seated workouts for various reasons.

"You know, to be honest, it's something I've never seen before in terms of any kind of exercise machine in a gym or anywhere else. I haven't seen anything like it at all. Any last comments? I think everybody should take a look at this machine because, like I said before, it's one of a kind. I highly recommend it for literally anyone who wants to work on not just muscle endurance, but also to get a solid blood pump and improve their cardiovascular system. Some people hate running, and I get it, I understand. But this machine really gets your heart going, even if we didn't talk about smashing your lungs. So, anyone who wants to get fit and may not be able to run should consider using this machine."

"No, I just think it's revolutionary in the sense that I've never had, like you said, a cardiovascular strength workout in a seated position like that."

Discussion

The aim of this observational study was to evaluate the impact of the A-Trainer exercise machine on both cardiovascular health and muscle activation. Though utilization of the sEMG sensors to monitor specific muscle groups, and also heart monitor to analyse calorie expenditure the effectiveness of a short exercise was assesed. Additionally, following the excercise completion, in order to qualitatively explore the effectivness of the A-Trainer, all participants were invited for a semi-structured interview.

Based on sEMG muscle activity results, a minute of intensive training with the A-Trainer activated all targeted upper body muscles. However, there are currently no directly comparable exercise machines, making it difficult to contextualise these findings against existing literature. While traditional resistance exercises such as the bent-over row, concentration curl, triceps kickbacks, and barbell chest press have been studied, their biomechanics and muscle activation patterns differ from the A-Trainer. Given these differences, direct comparisons are not feasible. The literature indicates that the average mean EMG values for an upright row exercise yield 253.12±138.33 μV for the TR muscle and 130.26±51.03 μV for the MD muscle [20]. Notably, the outcomes concerning the shoulder muscles (TR and MD) in this study align with previous findings, where the A-Trainer demonstrates a similar impact on these muscles as observed in a 45-minute training session following just a minute of intense training. Additionally, all other muscles such as BB, TB, PML, and PMR showed a higher average of muscle activity data here when compared to data from post-relevant exercises [21]. Future research should explore the A-Trainer's efficacy in different populations and training protocols to further establish its physiological benefits.

The study also investigated calorie expenditure using a heart rate monitor during physical exercise sessions. The findings revealed significant variation in calorie expenditure across the three repetitions, ranging from 52.7 to 68.3 calories, which reflects differences in individual metabolic rates and the intensity of effort during the exercise regimen [22]. For example, participant P1 consistently burned between 66 and 69 calories in the first two repetitions, with a predicted value of 67 for Repetition 3, resulting in a mean of 67.3 calories. In contrast, participant P9 exhibited a wider range, burning 39 calories in Repetition 1, 53 in Repetition 2, and a predicted 66 calories in Repetition 3, averaging 52.7 calories across the sessions. Understanding these individual variations in calorie expenditure is crucial for tailoring exercise regimens to achieve specific fitness goals. Participants such as P11, who consistently burned higher calories (68.3 on average), may benefit from targeted high-intensity workouts, while those with lower calorie burns, like P9, might require adjustments in exercise intensity or duration to achieve desired outcomes. These findings underscore the importance of personalised fitness approaches based on individual metabolic responses and effort levels [23]. Moreover, they highlight the capability of the A-Trainer and its suitability for use within diverse groups.

Another consideration when using the A-Trainer machine was the grip and positioning. It was ensured that all participants used the same grip and perform the exercise in the same position, as the effect on different muscles was evident if the grip or the positioning before the exercise testing was changed. The effect of fat grip and standard Olympic barbell grip has been reported elsewhere but the findings from this study are evident that regardless of grip size, the A-Trainer affects all upper muscles simultaneously while performing one exercise.

The A-Trainer exercise machine provides a solution to the contemporary issue of restricted time for workouts by delivering a high-intensity regimen in brief periods. This is particularly relevant in today's brisk lifestyle, where time frequently poses a barrier to exercise [24,25]. By tackling this concern, the A-Trainer aligns with the ongoing drive for physical activity. Significantly, it responds to the World Health Organization's call for augmented physical participation among adults, a factor acknowledged to diminish mortality rates and enhance overall quality of life [26].

The qualitative analysis of participant feedback provided valuable insights into various aspects of the exercise machine, covering effectiveness, comfort, muscle engagement, user experience, safety, durability, and suggestions for improvement. These findings shed light on both the strengths and potential areas for enhancement of the machine, offering implications for its application and further development. While participants generally expressed satisfaction with the machine's design and functionality, suggestions for improvement centred on enhancing user guidance and functionality. Clearer instructional guidance on optimal positioning and usage techniques was noted as beneficial, potentially improving user interaction and ensuring maximum benefit from workouts. Additionally, integrating sensors into handlebars to monitor heart rate and workout intensity in real-time was suggested to enhance functionality and appeal to users seeking detailed workout metrics.

From a coaching and physiotherapy perspective, the findings of this study offer valuable insights into the impact of the A-Trainer on cardiovascular health and muscle activation. For coaches, this information can inform the design of more targeted and effective training programmes, optimising both cardiovascular fitness and muscle engagement for different fitness levels. In physiotherapy, the study's results can guide the integration of the A-Trainer into rehabilitation protocols, particularly for patients who require gradual increases in cardiovascular exertion or specific muscle activation. Additionally, the qualitative feedback provided by participants highlights user experiences, preferences, and challenges, offering useful information for improving the accessibility and comfort of the A-Trainer. This combination of physiological data and user insights may be essential for tailoring exercise interventions to the needs of both athletes and rehabilitation patients.

Limitations of the study

The limitations in this study are mainly inherent to the study methodology. There was no formal power calculation; instead, the sample size of 15 participants was chosen based on the recommendation for a minimum number required to provide a reliable answer within a research trial [27]. Additionally, the study exclusively evaluated EMG activity at a single resistance level (Level 99). One limitation is the lack of precise knowledge regarding the exact magnitude of eccentric resistance at this level. However, since this parameter was consistently applied across all participants, it was deemed acceptable for analysis. Another important limitation is that EMG data were collected unilaterally for most muscles, except for the pectoralis major, which may have introduced variability due to potential muscle imbalances. Future research should incorporate bilateral EMG placement for all muscles to provide a more comprehensive assessment. Additionally, comparisons of EMG data with an isometric contraction specific to the targeted muscle would offer a more precise reference point, rather than relying solely on maximum voluntary isometric contraction without engaging in the corresponding movement. Furthermore, participant recruitment was not standardised based on baseline fitness levels, BMI, or muscle strength, potentially leading to variability in muscle activation and cardiovascular responses. Since sEMG measures relative muscle activation rather than absolute force output, differences in baseline strength could have influenced the findings. Future studies should consider stratifying participants based on fitness levels or normalising EMG data to account for these variations. Heart rate data were recorded at 30-second intervals, which may not have fully captured rapid fluctuations during the short exercise duration. A higher-frequency data collection approach could provide a more detailed understanding of cardiovascular responses. Additionally, exercises were performed in a fixed order rather than being randomised, which may have led to fatigue accumulation affecting muscle activation results. Although standardised rest periods were implemented, future studies should consider randomising exercise order or extending rest intervals to minimise potential fatigue effects. To build upon these findings, future research should examine EMG activity at varying resistance levels to assess the A-Trainer's adaptability across different fitness levels. Additionally, evaluating EMG responses during explosive movements or at elevated velocities would be valuable, as execution speed is a key factor in resistance training [28].

Conclusion

The objective of this mixed-method observational study was to assess the effectiveness of the A-Trainer exercise machine on both cardiovascular health and muscle activation. The findings indicated that just a minute of intense training with the A-Trainer could impact all the specified upper muscles investigated. The qualitative insights into the exercise machine underscore its effectiveness, comfort, and safety, while also highlighting opportunities for enhancement through improved user guidance and advanced functionalities. By addressing these aspects, developers can refine future iterations of the machine to better meet user needs and expectations, ultimately promoting healthier and more accessible exercise options for diverse populations. However, it's important to note that this study focused on EMG activity and heart monitoring during a single relative intensity. Future studies should consider evaluating the effectiveness of the A-Trainer across different levels of intensity and velocity to achieve a more comprehensive comprehension.

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None

Declaration of competing interest

The authors have no relevant financial or non-financial interests to disclose

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.ipemt.2025.100033.

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