Available online at www.sciencerepository.org

Science Repository

Research Article

# Telecardiology Screening in Athletes: A Feasibility e-Health Study

*Savvato Karavasileiadou[1,2*], Dimitrios Papadopoulos[3], Evangelia Kouidi[1], Nikolaos Koutlianos[1] and Asterios Deligiannis[1]*

[1]*Sports Medicine Laboratory, Aristotle University of Thessaloniki, Greece*

[2]*Department of Community Health Nursing, Princess Nourah Bint Abdulrahman University, Nursing College, Riyadh, Kingdom of Saudi Arabia*

[3]*University of Macedonia, Greece*

ARTICLE INFO

*Article history:*
Received: 5 January, 2021
Accepted: 23 January, 2021
Published: 4 February, 2021

Keywords:
*Cardiovascular screening*
*athletes*
*telemedicine*
*cost-benefit*
*Monte Carlo*
*sustainability*

ABSTRACT

The objective of this study was to enhance the accessibility of athletes to cardiovascular pre-participation screening services and to improve their well-being in a region by means of assessing the feasibility and sustainability of a telemedicine project. The project was undertaken by a non-profit institution. A feasibility analysis was performed based upon the scenario of transferring a medical team to the athlete's location. A sample of 506 athletes preceded the analysis to gather information about the process of pre-participation screening. The cost analysis included the capital, operational, maintenance and administrative costs, while monetized benefits included transportation and opportunity cost savings. The net present value and the ratio of benefits to costs were used to measure the performance of the investment project. A Monte Carlo simulation was conducted with demand and variable cost to represent the main sources of uncertainty. The uncertainty assessment revealed that the probability of having positive or negative net assets is evenly distributed and that small changes in the variable cost lead to high changes in net assets. The analysis showed a benefit-cost ratio above unity and a positive net present value. Investing in a telemedicine intervention project of pre-participation screening to athletes is socially desirable. Financial sustainability can be improved by controlling-monitoring specific variable costs.



## Introduction

In recent years, the issues of sudden cardiac death (SCD) and sudden cardiac arrest (SCA) in athletes have been of particular concern to the sports and medical community. Heart problems that can lead to sudden death are 2.5 times more in athletes than in non-athletes [1]. The implementation of a pre-participation cardiovascular screening on athletes can substantially reduce the risk of SCD and SCA [2-4]. Pre-participation screening (PPS) based on an electrocardiogram (ECG) can be undertaken with telemedicine support [2]. In particular, transtelephonic ECG monitoring from sports fields is feasible using both landline and mobile telephony. Thus, there is a potential to evaluate the screening findings in a direct and reliable manner, as well as to monitor a large number of athletes in remote areas without having a cardiology specialist on-site.

The positive externalities of telemedicine interventions are well documented, particularly when used to deliver health services to distant communities [5-8]. Previous reviews of economic evaluation studies highlighted the lack of cost-benefit analysis with a long-time interval and, as a result, raised concerns about the sustainability of telemedicine projects [5, 6, 8, 9]. In addition, many telemedicine programmes around the world have failed due to their inadequate long-term financial sustainability making them less attractive to public subsidies [5]. According to W.H.O., the proper time horizon to assess the cost-effectiveness of a health intervention is 10 years [10]. Obviously, a longer time horizon entails greater uncertainty which needs to be assessed. Akiyama & Yoo pinpointed the deficiency of the economic evaluation studies of not incorporating a probabilistic analysis such as Monte Carlo simulation to assess the uncertainty embedded in a telemedicine project [5].

*Correspondence to: Dr. Savvato Karavasileiadou, Assistant Professor, Sports Medicine Laboratory, Aristotle University of Thessaloniki, Greece, Department of Community Health Nursing, Nursing College, Princess Nourah Bint Abdulrahman University Riyadh, Kingdom of Saudi Arabia; Tel: 0966559945667; E-mail: skaravas@phed.auth.gr*


http://dx.doi.org/10.31487/j.JICOA.2021.01.09

There is no clear evidence from the economic evaluation studies that the utilization of telemedicine can lead to cost savings for both patients and health care providers and also be beneficial to society [5, 6, 11]. It is more likely that cost advantages and societal benefits may occur when the medical staff and the patients involved, avoid transportation and traveling expenses due to telemedicine intervention [6]. However, when a telemedicine project involves medical services like PPS and ECG which require the presence of specialized medical personnel, a question arises of whether these advantages and benefits still exist?

The purpose of the present paper is to evaluate the economic feasibility and long-term sustainability of a telemedicine project with the objective to address its social costs and benefits to a community. To our knowledge, this study would be the first to address with a long-term perspective, the social contribution and the economic viability of a telemedicine project with regard to a remote ECG based screening in athletes while allowing for uncertainty in key factors of the appraisal process. In addition, this is the first study where costs and benefits of a PPS using telecardiology are estimated by allowing the transfer of health care providers to sports fields.

## Materials and Methods

### I Facts and Assumptions

In the present study, the telemedicine project is undertaken by Sports Medicine Lab. of Aristotle University of Thessaloniki and is addressing athletes registered in sports clubs in the province of Thessaloniki, a location in north-central Greece [12]. The province has a population of just over 1.1 million of which 800 thousand live in urban areas. Given the lack of telemedicine units in the rural area of the province and the absence of the required telecommunication facilities in most of its sports clubs and training centers, then the only option left for the athletes to receive an ECG was to travel to the city at their own expense. In filling this gap, the University decided to build a team of specialists with the intention to travel to the athletes' settings to provide and support the ECG services.

Prior to the investment appraisal and in order to observe the effects of the telemedicine intervention and evaluate costs, a pre-participation screening was conducted on 506 male amateur soccer players of different ages and from 23 different sports clubs in the province. Some athletes preferred to be examined in the laboratory medical office and others in their field facilities. It was found that almost 87% of them would choose to undergo a pre-participation screening in the sports clubs at their own settlements. It should be acknowledged that currently, only a few hospitals are located in the center of the city and some private clinics provide PPS services. If the athlete opts to travel to the city, then he/she has to pay, apart from the travel costs, an admission fee of 5€ at a hospital or 30€ at a private clinic. These elements gathered together constituted the major motivational force behind the decision to build a team of specialists with the intention to travel to the athletes' settings to provide and support ECG services.

Types of economic evaluation methods predominantly include cost-benefit analysis (CBA), cost-effectiveness (CEA), cost-utility analysis (CUA) and cost-minimization analysis (CMA) [8, 13, 14]. CBA has been widely used as a decision-making tool in a variety of disciplines including healthcare and is considered a paradigm for the economic evaluation of health care services [15-18]. An economic feasibility study is identical to the cost-benefit analysis of an investment decision in which the monetized benefits accrued from the implementation of the project are compared with the associated economic costs [19, 20].

A profound economic evaluation relies on a set of sensible facts and assumptions relevant to the components of the project. The present feasibility study was built upon the following assumptions:

i. The university operates as a non-profit organization (tax-exempt status).
ii. The time horizon of the investment appraisal was set at 10 years.
iii. The quality of the outcome of the ECG service provided by the institution does not differ from that of the alternative healthcare provider.
iv. The athletes or the leaders of the sports clubs have a good knowledge of the prevailing ECG price in the public and private healthcare sector.
v. The demand for the first year was expected to be 2088 athletes.
vi. The organization has the capacity to perform 40 ECGs per day.
vii. Initial costs of medical consumables cover 2,500 ECG tests.
viii. A purchase of a van vehicle will take place in the 0 year of the investment.
ix. Donations, grants and subsidies were not considered in the analysis.
x. The property to be used belongs to the University of Thessaloniki.

The value of demand in the first year was based on the number of sports clubs in the province as well as on the approximations derived from the previously conducted ECG project. Estimations of future demand assisted from projected values presented in external sources [21]. Over the decade, the number of athletes to be examined is estimated to grow on average by 18.9% ranging from a high of 30% and 35% in the first two years to 5% in the last two years. It is expected that promotional efforts in the first three years will raise awareness and attract more athletes. Saturation and probably competition are expected to result in a slow shift of demand in late years. Prior to the CBA, 5-year projected non-profit financial statements were developed to determine the net assets and the additional working capital requirements. A start-up loan of 127,100 € was borrowed to finance operating expenses. The financial statements are available upon request from the authors.

### II Societal Perspective

In the analysis, the benefits accrued to the athletes by receiving ECG services at their location are expressed as a sum of three terms. The first term is associated with savings by obviating travel costs which include the mileage reimbursement and the lost work time. The second term regards the price of ECG the athlete has to pay to an alternative health provider and the third term involves the cost savings to the system of avoiding hospital admission. The estimate of mileage reimbursement was based on the average time required to reach the center of the city and included the fuel cost (1.5€/litre), the fuel consumption (7.5€ per 100 km) and the car depreciation (wear-and-tear) which was set at 60% of the fuel cost. A geographical research was conducted to calculate distances between the city center and 31 small towns and villages across the province. The average travel distance was found to be 41.73 km with a mean travel time (one-way) of 41±13 minutes. The cost of travel (fuel usage plus depreciation) was estimated at 7.5 ± 3.3 €.

It is noteworthy to say that these figures are similar to the figures of 39.1 km and 7€ found in the previously made research study over 506 athletes. Lost work time takes into account that the driver escorts the athlete and spends time spent which is considered as equivalent to the hourly salary of an ambulance driver. Time is the summation of the travel time plus the average waiting time at the public health provider (PHP). Cost savings of not attending a hospital admission is considered equivalent to the resulting savings from not using public health resources. The aforesaid savings was estimated to be 10€ per ECG and was derived by taking into account the required time and the average monthly salary of the healthcare personnel involved in the process of delivering the ECG services.

## III Pricing Policy

A non-profit organization should balance the need to retain financial viability and service improvement with the need to serve as many as possible. The pricing strategy followed by the university is aimed at capturing the value the athlete places on ECG. An essential part of this perceived value is the commuting cost between the location of the alternative PHP and the origin of the athlete. Since commuting costs vary depending on distance, zone pricing was implemented by using the center of the city as a basing point. Specifically, the province was divided into four zones according to the distance from the center of the city and then prices were calculated for each zone. The other parts of the pricing construct include the price of the ECG at a public health provider and the lost work time of the driver accompanying the athlete. It is presumed that the higher the distance, the higher these costs and therefore, the higher the price the athlete or its club is willing to pay for an ECG.

Table 1 summarizes the three costs corresponding to the four zones. The sum of the costs is the price for the ECG that will compensate for the athlete's travel to visit a PHP. A small price increase will take place in the 4th and 8th year of the investment period in order to adjust to costs and safeguard solvency. This will be two euro for zone I and 1 euro for zone II and III. For the athletes traveling from the outer zone, there will be no increase in price over the entire investment period. The additional payment of two euro for the athletes coming from the inner-city zone is justified on the grounds that they have to travel a shorter distance in comparison to the rest of the athletes. Overall, the small price premium is considered not to outstrip the benefits bearing on the importance of averting waiting times, traveling discomfort and other delays.

**Table 1:** Zone pricing.

| | Zone I (Inner city) | Zone II (Suburbs) | Zone III (Beyond suburbs) | Zone IV (Province borders) |
|---|---|---|---|---|
| Mileage reimbursement | 3.2€ | 8.4€ | 13€ | 22.4€ |
| Loss work time | 2.0€ | 3.6€ | 5.5€ | 8€ |
| ECG cost at a PHP | 5€ | 5€ | 5€ | 5€ |
| Total cost | 10.1€ | 17€ | 23.5€ | 35.4€ |

So far, the actual price includes the athlete's clinical examination, the associative medical history and the ECG test. According to the findings of the study on a sample of 506 athleteς, 9% of them needed an echocardiogram and 1% had to undergo a cardiopulmonary testing exercise or pass through a holter monitoring session or a tilt testing. The price for these extra tests was set at 20 euros. A 10% of athletes were expected to receive a PPS at the university site. The population density of the province was used to define and allocate the athletes from the four zones. It was estimated that 56% of the athletes would come from within the city's borders, 14% from the surrounding suburbs, 18% from beyond the suburbs and 12% from the borders of the province. These percentages were used as weights to derive the number of athletes coming from the different zones. By taking into account the extra tests needed (e.g. tilt testing) the number of athletes, was multiplied by the price assigned to each zone so as to obtain revenues.

## IV Discount Rate and Performance Indicators

The discount rate reflects the cost of capital (opportunity cost) and is used to calculate the present value of the costs and benefits. The decision to set a suitable discount rate is important as discounting can influence the outcome of an investment project. The issue of choosing the correct social discount rate (SDR) has been the focus of much debate and controversy among economists [22]. The European Commission recommended an SDR of 3% to 5% depending on whether the country is a member of the cohesion group [21]. Also, the WHO suggested an SDR of 3% for both costs and health effects [10]. These rates, however, refer to investment projects undertaken by the government and the public sector, where monetary earnings are not of primary importance. Douglas proposed a discount rate that is equal to the inflation rate as the non-profit organization will have to replace its fixed assets at some point in time [23]. Olsen and Nicholls recommended that the return on risk-free assets (e.g. Treasury bond rate) can be used to discount social returns [24].

The present study applied a discount rate of 5.5% to reflect the borrowing costs. The reason for adopting a market-derived discount rate was the substantial cash flow requirements the institution needed to fund the project over the first few years of its life. To adjust for inflation, it was assumed that operating costs would increase on average by 1.5% and fuel costs by 3%. The financial metrics of Net Present Value (NPV) and the ratio of benefits to costs (BCR) were used to assess the performance of the investment. A positive or negative NPV will indicate the acceptance or the rejection of the project respectively. A BCR above unity means that the benefits outweigh the costs and therefore, the project adds to the welfare of the society.

## V Uncertainty Assessment

A Monte Carlo simulation was conducted to calculate the probability distribution of the net assets (earnings) based on a random generation of numbers related to variables that can have a significant impact on the net assets. The Monte Carlo technique uses random numbers and probability distributions instead of point values in order to assess the uncertainty and risk in decision making. It is utilized in a wide variety of applications including feasibility studies. As a first step, the technique requires the identification of the critical input variables (e.g. costs) which can deviate from their expected values and have a significant impact on the output (e.g. earnings). Prices and costs are identified as the most critical elements to the viability of the investment. However, prices are set with a non-profit mindset and in accordance with the potential benefits accrued to athletes due to the presence of the medical professional team at the athlete's location. Therefore, any increase in future prices will be solely a result of a rise in the costs associated with travel. On the costs side and over a ten-year revenue stream, some of the fixed costs can change, but this change will not jeopardize the entire project given the expected future increase in demand for ECG. Variable costs are not fixed and vary in proportion to the number of ECGs demanded. The breakdown of total variable costs by cost component was: consumbables-53%; travel cost of medical team-37%; general expenses -10%.

The second step proceeds with the building of a deterministic model that links the input and output variables. The model will then be converted into a probabilistic model by assigning, within a predefined range of values, a distribution for each input variable. Then, by taking into account, the relationships between the variables in the model, the probability distribution of the output variable can be determined. In the present CBA study, the objective was to predict the probabilities of positive net assets (earnings) based upon a range of values for the critical factors of the average variable cost, the price of the ECG and the number of athletes examined. The deterministic model used to generate a series of random numbers for the critical variable random data was the simple earnings equation that is the difference between revenues and costs. The model is described as:

Net asset = (ECG price x No of athletes examined) - (Fixed cost + Average Variable cost).

For the price of the ECG the range of discounted values was set from 18.10 to 18.80 and for the variable cost was set from 4.90€ to 5.06€. The number of athletes annually examined was allowed to range between 8,774 and 9,228. These interval values correspond to the estimated breakeven points for each year of the ten-year investment period. The fixed cost (121,250 €) is treated as a constant in the model. Random numbers were generated for each input variable using the uniform distribution at n=5000. The Monte Carlo simulation was performed in Microsoft Office Excel.

## Results

The results of the simulation process showed that the probability of having a loss is 51.1%. Figure 1 provides a visual representation of the uncertainty in net assets. The histogram is augmented with the cumulative distribution function. The distribution resembles a normal distribution with no extreme values. It appears that uncertainty is split almost evenly between earnings and losses. The two crossed red lines displayed were drawn to indicate that the probability for the organization to have earnings is 48.9%. This probability occurs when the average variable cost lies within the interval of 4.90€ and 5.06€. Among the four input variables included in the model, the average variable cost is considered as the most crucial one. The variable of demand for most of its part is exogenously determined and the variable of the price should be kept as low as possible given the non-profit character of the institution. The variable cost remains the only input that is made up of components that can be controlled. Table 2 Illustrates a range of average variable cost values and the respective probabilities for net assets to be greater than zero. It can be seen that while the average variable cost (AVC) increases in intervals of 5 cents, the probability of having positive net assets decrease at percentage levels which range between 10% and 30%.

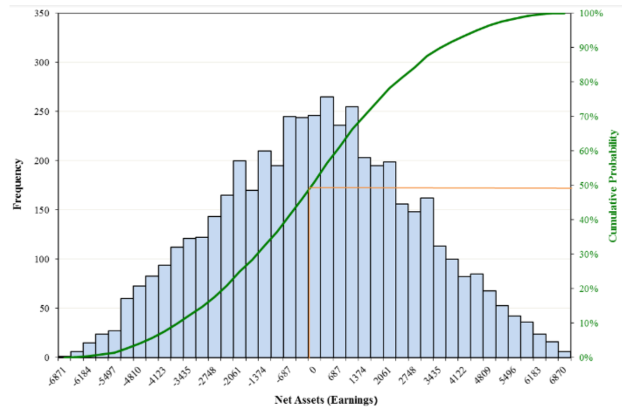


**Figure 1:** Monte Carlo Simulation.

**Table 2:** Probabilities of positive net assets according to average variable cost.

| AVC. (€) | Net Assets (€) | Pr (%) |
|---|---|---|
| **4.90** | 95 | 58.2 |
| **4.95** | 108 | 52.6 |
| **5.00** | 5 | 47.0 |
| **5.05** | 0.22 | 40.3 |
| **5.10** | 22 | 34.0 |
| **5.15** | 101 | 28.7 |
| **5.20** | 54 | 24.6 |
| **5.25** | 71 | 18.6 |
| **5.30** | 16 | 14 |
| **5.35** | 60 | 12 |
| **5.40** | 50 | 8.4 |

## Cost-Benefit Analysis

Table 3 presents the summary results of the cost-benefit analysis. The results show a positive social NPV (SNPV) and a BCR above 1 indicating that the net social gains that arise from investing in the project exceed the related costs. From a societal perspective, the investment in the project is considered acceptable and the institution should go ahead with it. However, the favourable measures of the two metrics do not ensure the financial sustainability of the investment. The appraisal process projected that in the future, the institution will not have the necessary liquidity to meet its obligations. As is shown in (Figure 2), the negative cash-flows cover a period of five years which calls for an effective response to balance the accumulated deficit. The dotted line represents the cumulative discounted net cash flows; it follows a negative path for seven years, signifying the poor financial standing of the institution.

**Table 3:** Summary of the results of the CBA.

| | |
|---|---|
| Start-up capital | 151,301€ |
| Start-up Cost | 41,573 € |
| Cumulative constant value of costs | 3,008,250 € |
| Cumulative constant value of benefits | 3,111,543 € |
| Present Value of Benefits | 2,839,505 € |
| Present Value of costs (with a loan) | 2,754,094 € |
| BCR (with loan) | 1.03 |

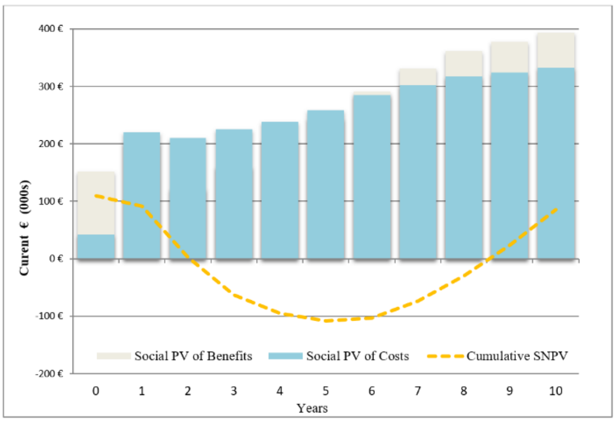


**Figure 2:** Discounted cash flows of benefits and costs.

The actions proposed to deal with the issue of cash flow shortfalls include: a) supplying the vehicle with a gas-consuming mechanism to cut fuel expenses by half, b) reducing the feeding expenses of the medical team during traveling by one third through an agreement with a catering company and c) raising the price of ECG for the inner city athletes by one euro to increase revenues. These actions reduced the deficit time span from five to four years and increased the value of BCR from 1.03 to 1.11. Financial imbalances may still exist on a yearly basis, but the institution does not need to raise more money to fund its operations. The available liquidity is sufficient to cover losses in the coming years. Figure 3 confirms the positive progress of the cumulative net discounted cash flows (cumulative SNPV) which reflect the financial capacity of the institution to operate the ECG services.

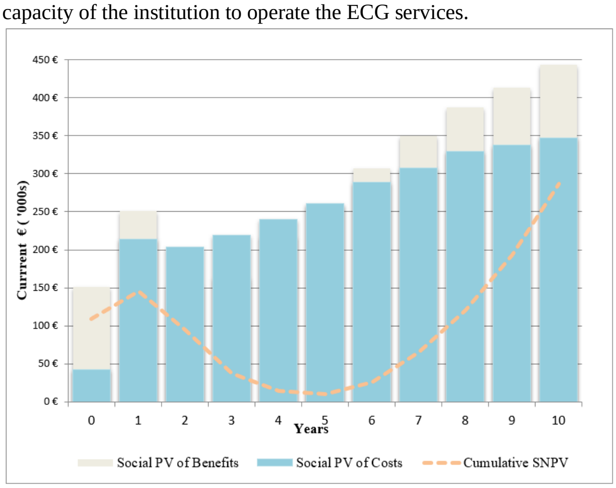


**Figure 3:** Discounted cash flows of benefits and costs after the variable cost reduction.

## Discussion

In this paper, an economic feasibility study, commonly called cost-benefit analysis, was performed on behalf of a non-profit institution. The aim was to appraise the economic viability and the social contribution to a community of a telecardiology intervention investment in order to support an ECG based pre-participation screen programme of athletes. In contrast to other studies, the present study takes a further step by evaluating the costs and benefits of an e-health telemedicine intervention over a long-time interval in order to provide information about the sustainability of a telemedicine project.

From a societal perspective, the setting of a zone pricing scheme that reflected distances and travel costs proved to be critical for the beneficial outcome of the analysis. With the use of the cost of funds as a discount rate, the results of the cost-benefit analysis revealed that for each euro spent on the resources of the telemedicine, project the return to the society will be higher by 3%. This social return is not a complete representation of the entire spectrum of benefits accrued to athletes and to the community. Benefits like increasing the access of athletes to the ECG services, averting them from travel by receiving an ECG in their environment comfortably and relieving them from the burden of wait times at the hospital were not possible to be quantified and not included in the analysis. All these benefits can make the PPS and ECG services more acceptable and encourage its provision through telemedicine to expand to other athletes participating in other competitive sports apart from football. As to the provider of the service, the results showed that the positive NPV did not warrant the financial viability of the project. For the project to become economically feasible, the institution needed to raise the price by a small amount for the inner-city athletes and turn its actions towards reducing specific variable costs. Even in that situation, the institution will still run losses for a time span of four years but these losses will be covered by the cash available due to the loan facility.

Alternatively, to a bank loan, the project could be financed via a government subsidy but at present, telemedicine services in urban areas are not covered by the national health insurance of Greece. Nevertheless, a government subsidy funding would have increased the BC ratio by five units and would have improved the liquidity position of the institution. Fundraising through donations was not considered since there was a price charged for the provision of the ECG services. It is possible that at some future time, the institution will be open to charities and monetary donations, with the objective to maximize its ECG services. As an example, donations could support the purchase of software to optimize athletes' appointment scheduling process. At present, the only plausible way to increase revenues significantly is to expand PPS services to high school and university athletes. Drezner and Khan suggested that all athletes 12 years of age and over should undergo a medical examination prior to their participation in sports [25].

However, any pattern of demand expansion can become temporal. The state may decide to create one or more telemedicine units away from the city and close to the sports fields in the province area. Then, the alternative costs for many athletes will decrease as a result of lower travel expenses which will induce the institution to lower its price in order to retain the level of demand and to balance the costs and benefits. In this case, the financial viability of the project will be contingent upon the size of the current demand. A change in demand is expected to have significant repercussions on operational expenses. Under the current scale of operation, the institution has a threshold demand response potential of 40 athletes per day which is just three athletes away from the number of athletes served at the end of the appraisal period [26]. Any scenario that will shift demand beyond this threshold potential will move the institution to different cost patterns due to mandatory changes in infrastructure and workload necessary to meet the new demand. The absence of this scenario in the analysis can be considered as a major study weakness which can affect the quality of the results.

Another weakness is that the future estimates of demand were based upon an approximation of a first-year demand and the value of which is not an outcome of a thorough survey. Deviations from actual demand can lead to an overestimation or underestimation of revenues, thus weakening the credibility of the results. There is a belief that the negative effects of any large potential discrepancies between evaluations of current and future demand were minimized to some extent through the process of Monte Carlo simulation, where demand was considered as an input variable.

A study limitation was also recognized when an approximation was used to evaluate the savings accrued to the health care system by avoiding hospital admissions. This specific limitation is attributed to the lack of official financial cost data for an ECG service in a public health provider. The major limitation of the study stems from the study itself. Economic evaluation studies of telemedicine are performed within a specific context which means that findings cannot be easily generalized [27, 28]. Results can differ according to the country, region or sub-region and according to the type of telemedicine application [29]. More importantly, the embedded costs differ from context to context rendering the generalizability of the findings disputable.

Still, the study is replicable in other geographic locations as well as for different forms of telemedicine. Some of the weakness may be unavoidable, but the study could be enriched by a survey on the present demand for telemedicine services and by including more input variables in the uncertainty assessment to further improve the investment decision making. The analysis can be expanded by incorporating an economic feasibility study from the private perspective and make comparisons with the not-for-profit study. A sensitivity analysis could be conducted to capture the scenario of moving to a higher scale of operations as a result of increased demand.

## Conclusion

Maximization of cardiac health outcomes can be enhanced through early diagnosis and equity of access to health care services. The present economic feasibility study revealed that a telecardiology intervention to support an ECG based PPS to athletes contributes to the well-being of a community. A pricing structure with a non-profit mindset hindered the long-term sustainability of the project. Accepting a small price premium and reducing specific variable costs, sustainability can be retained. Specific internal and external initiatives like monetary donations, charities and government subsidies can improve the sustainability and economic viability of the investment. The sustainability state of the investment is subjected to the growth of current demand which depends largely on the efficiency of marketing efforts and on the provision of supplementary services which can optimize the quality of telemedicine health care services.

## References


1. Higgins JP and Andino A (2013) Soccer and Sudden Cardiac Death in Young Competitive Athletes: A Review. *J Sports Med (Hindawi Publ Corp)* 2013: 967183. [Crossref]
2. Brunetti ND, Dellegrottaglie G, Di Giuseppe G, Lopriore C Loiacono T et al. (2014) Young Football Italian amateur players Remote electrocardiogram Screening with Telemedicine (YOU FIRST) study: Preliminary results. *Int J Cardiol* 176: 1257-1258. [Crossref]
3. Corrado D, Biffi A, Migliore F, Zorzi A, Rigato I et al. (2013) Primary Prevention of Sudden Death in Young Competitive Athletes by Preparticipation Screening. *Cardiac Electrophysiology Clinics* 5: 13-21.
4. Deligiannis P, Deligiannis A and Kouidi E (2011) Trends in e-Health Monitoring Implementation in Sports. *Sport- und Präventivmedizin* 41: 34-37.
5. Akiyama M and Yoo B-K (2016) A Systematic Review of the Economic Evaluation of Telemedicine in Japan. *J Prev Med Public Health* 49: 183-196. [Crossref]
6. Davalos ME, French MT, Burdick AE and Simmons SC (2009) Economic evaluation of telemedicine: Review of the literature and research guidelines for benefit–cost analysis. *Telemed J E Health* 15: 933-948. [Crossref]
7. Natafgi N, Shane DM, Ullrich F, MacKinney AC, Bell A et al. (2017) Using tele-emergency to avoid patient transfers in rural emergency departments: An assessment of costs and benefits. *J Telemed Telecare* 0:1-9. [Crossref]
8. World Health Organization (2016)/Pan American Health Organization. Framework for the Implementation of a Telemedicine Service. Washington, DC.
9. Snoswell C, Smith AC, Scuffham PA and Whitty A (2017) Economic evaluation strategies in telehealth: Obtaining a more holistic valuation of telehealth interventions. *Journal of Telemedicine and Telecare* 23: 792-796. [Crossref]
10. World Health Organization/Edejer TT, Baltussen R, Adam T Hutubessy R, Acharya A et al. (2003) Making choices in health: WHO guide to cost-effectiveness analysis.
11. Whitten PS, Mair FS, Haycox A, May CR, Williams TL et al. (2002) Systematic review of cost effectiveness studies of telemedicine interventions. *BMJ* 324: 1434-1437. [Crossref]
12. Harriss DJ, Macsween A and Atkinson G (2019) Ethical Standards in Sport and Exercise Science Research: 2020 Update. *Int J Sports Med* 40: 813-817. [Crossref]
13. Drummond M, Sculpher MJ, Claxton K, Stoddart GL and Torrance GW (2015) Methods for the economic evaluation of health care programmes. *Oxford University Press* 2015.
14. Tai Bilvick B-W, Bae YH and Le QA (2016) A Systematic Review of Health Economic Evaluation Studies Using the Patient's Perspective. *Value Health* 19: 903-908. [Crossref]
15. Corrado D, Cristina Basso C, Schiavon M, Antonio Pelliccia and Gaetano Thiene (2008) Pre-Participation Screening of Young Competitive Athletes for Prevention of Sudden Cardiac Death. *J Am Coll Cardiol* 52: 1981-1989. [Crossref]
16. Gabbett HT, Windt J and Gabbett TJ (2016) Cost-benefit analysis underlies training decisions in elite sport. *Br J Sports Med* 50: 1291-1292. [Crossref]

17. Robertson L, Skelly C and Phillips D (2019) Making Hard Choices in Local Public Health Spending With a Cost-Benefit Analysis Approach. *Front Public Health* 7: 147. [Crossref]
18. Reardon T (2005) Research Findings and Strategies for Assessing Telemedicine Costs. *Telemed J E Health* 11: 348-369. [Crossref]
19. Dennis A, Wixom BH and Roth RM (2014) System Analysis and Design. Wiley & Sons, Inc.
20. Schniederjans MJ, Hamaker JL and Schniederjans AM (2004) Information Technology Investment, Decision Making Methodology. World Scientific Publishing Co. Pte. Ltd.
21. European Commision (2014) Guide to Cost-Beneft Analysis of Investment Projects, Economic appraisal tool for Cohesion Policy 2014-2020, Regional and Urban policy.
22. Asian Development Bank, Economics and Research / Zhuang J, Liang Z, Lin T and Guzman FD (2007) Theory and Practice in the Choice of Social Discount Rate for Cost-Benefit Analysis: A Survey. ERD Working Paper.
23. Douglas AC (1984) Returns on Equity to Not-for-Profit Hospitals: Theory and Implementation. *Health Serv Res* 1984: 41-63. [Crossref]
24. Olsen S and Nicholls J (2005) A Framework for Approaches to SROI. San Francisco, CA: SVT Consulting.
25. Drezner JA and Khan K (2008) Sudden cardiac death in young athletes. *BMJ* 337: a309. [Crossref]
26. Karavasileiadou S, Papadopoulos D, Kouidi E, Koutlianos N, Deligiannis A (2021) An Economic Evaluation of Pre-Participation Screening (PPS) Project in Athletes from a Profit and non-Profit Perspectives. *Eur Sport Manage*.
27. Bergmo TS (2009) Can economic evaluation in telemedicine be trusted? A systematic review of the literature. *Cost Eff Resour Alloc* 7-18. [Crossref]
28. Bergmo TS (2012) Approaches to economic evaluation in telemedicine. *J Telemed Telecare* 18: 181-184.
29. Roine R, Ohinmaa A and Hailey D (2001) Assessing Telemedicine: a systematic review of the literature. *CMAJ* 165: 765-771. [Crossref]