

Prevention of cardiovascular disease through “Cardio50” screening: one-year outcomes

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ABSTRACT

Cardiovascular diseases include a series of pathologies affecting the heart and blood vessels, including myocardial infarction, ischemic stroke and arterial hypertension. They represent one of the main causes of death both globally and in Italy and can be prevented through the adoption of a healthy lifestyle, including a balanced diet and regular physical exercise. The aim of the Cardio50 cardiovascular screening project is to reduce the mortality and morbidity associated with cardiovascular events through the early identification of at-risk subjects. It also promotes targeted interventions, including lifestyle changes, in order to prevent the onset of these pathologies, which are provided by trained healthcare workers in the Prevention Department. In 2024, the Local Health Authority ULSS 1 Dolomiti, which provides health- and social care in the Belluno province, screened the 1974 birth cohort, including subjects of both sexes, that reside in the province. A total of 1,746 residents (949 women and 797 men) participated in the cardiovascular screening (64.8% of the eligible population). In total, 78.3% of the participants benefited from targeted interventions, which promoted reductions in the risk factors covered by the screening; they were also sent to a general practitioner for care or were directed to specific paths for changing or improving their individual lifestyles. Furthermore, the data collected were compared with those of the PASSI surveillance (Progress of Authorities for Healthcare in Italy), which, in most cases, showed consistency with the results obtained from our local investigation.

INTRODUCTION

Cardiovascular diseases are one of the main causes of mortality globally, together with neoplastic diseases, which frequently share lifestyle risk factors, such as hypertension, diabetes, hypercholesterolemia and obesity. The World Health Organization (WHO) estimates that in 2019, globally, 17.9 million people died from cardiovascular diseases, equal to 32% of all deaths [1]. In Europe in 2021, 1.71 million deaths occurred due to diseases affecting the circulatory system, accounting for 32.4% of all deaths [2]. In Italy, according to the most recent ISTAT data (2022), these diseases represented 30.8% of all deaths [3]. In the Veneto region in 2023, there were a recorded 15,485 deaths (30.7%) due to diseases of the circulatory system, with a higher incidence among women (8,500) than among men (6,985). In the year 2023, in the territory of the Local Health Authority ULSS1 Dolomiti (ULSS 1 Dolomiti), the province of Belluno, there were 794 deaths due to diseases of the cardiovascular system, accounting for 32.1% of all deaths [4].

Recent scientific evidence has consolidated the importance of promoting and implementing preventive interventions aimed at delaying or preventing the onset of cardiovascular diseases through the adoption of healthy lifestyles. These interventions include promoting proper nutrition and regular physi-

cal activity, eliminating cigarette smoking, reducing alcohol consumption, and improving the quality of sleep, as well as adequate stress management [5]. In particular, it is widely known that:

- A balanced diet contributes to the prevention of various pathologies, such as obesity and overweight, arterial hypertension, cardiovascular diseases, metabolic diseases, type 2 diabetes and some forms of cancer;
- Practicing physical activity regularly is a determining factor in improving the quality of life by contributing to reductions in blood pressure and glycemic and cholesterol levels, as well as playing a fundamental role in the prevention of cardiovascular diseases [6];
- Exposure to smoking, even in passively, correlates with serious cardiovascular and respiratory diseases, including coronary heart disease and lung cancer [7];
- Alcohol consumption is associated with liver cirrhosis and steatosis, alcoholic hepatitis, neoplasms and cardiovascular diseases, among other diseases [8].

Numerous studies have highlighted how prevention not only contributes to improving patients' health, but also leads to significant savings in public spending [9-11], supporting the adoption of cardiovascular screening.

The WHO has implemented strategies aimed at con-



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taining and reducing the impact of chronic non-communicable diseases by 25% by 2025, mainly through reductions in the main determinants of these diseases, such as alcohol consumption, physical inactivity, tobacco smoking and hypertension [12].

An analysis of the local setting in Italy, conducted using recent data collected at the provincial level and processed through the PASSI surveillance system (Progress of Authorities for Healthcare in Italy) for the period of 2018-2023, highlighted that the majority of the Belluno population aged between 45 and 55 does not smoke (56%) or has stopped smoking (23.5%). Currently, 20.5% are smokers, and smoking is more common among men than among women (23% vs. 18%).

The analysis also found that 35% of Belluno residents between the ages of 45 and 55 can be classified as alcohol consumers at higher risk because (i) they consume a lot of alcohol, (ii) they drink outside of meals, (iii) they are binge drinkers, or (iv) they are a combination of the three. Binge drinkers, that is, those who consume five or more alcoholic units (men) and four or more alcoholic units (women) on a single occasion, comprise 21% of the population. In general, based on PASSI data, in the territory of ULSS 1 Dolomiti, the percentage of subjects who consume alcohol is higher among men than among women. The same PASSI data show that, among the people between the ages of 45 and 55 in the Belluno area, 30% are overweight while 10% are obese, and excess weight is more common in men (47%) than in women (31%). In the period 2018-2023 in the ULSS 1 Dolomiti, 70% of adults between 45 and 55 years of age could be considered physically active because they reach the levels of physical activity recommended by the WHO, while 20% were considered partially active because they practice intense or moderate physical activity but do not reach the recommended levels, and 10% were completely sedentary. Men were more likely than women (92% vs. 88%) to (completely or partially) reach the recommended levels of physical activity.

The Regional Prevention Plan (PRP) 2020-2025, which continues the initiatives started in the previous PRP 2014-2019, provided support to the Local Health Authorities of the regional territory to initiate a cardiovascular screening campaign named "Cardio50". The purpose of the "Cardio50" campaign is to reduce the mortality and morbidity of cardiovascular events through the identification of at-risk subjects, particularly hypertensive, hyperglycemic and hypercholesterolemic individuals, and promotion of lifestyle changes in the identified population. The goal is to achieve 60% adherence to this screening program by the end of 2025 [13].

MATERIALS AND METHODS

The target population for the Cardio50 screening program is 50-51-year-old individuals of both sexes that reside in the ULSS 1 Dolomiti territory, in ac-

cordance with the regional protocol for cardiovascular prevention [14]. This age cohort was selected because it represents a particular moment in life, characterized by greater sensitivity and willingness to change habits in order to correct any lifestyles that are considered unhealthy. The subjects that were not eligible for enrollment in Cardio50 include subjects already affected by specific pathologies and/or clinical conditions, who are already covered by the National Health Service with targeted exemptions. After identifying the eligible participants, they were then invited to participate in cardiovascular screening through an invitation indicating the date, time and location of the proposed appointment. Participation in this screening program can therefore be defined on a voluntary basis. If they were unable to attend the screening appointment, they could reschedule by contacting the references listed in the invitation by telephone or e-mail. The refusal to participate in the screening could be communicated by the interested party either verbally or in writing. If the invited subject did not show up for the appointment, a new reminder invitation was sent three months after the first invitation. The healthcare workers (HCWs) involved in the cardiovascular screening were mainly nurses and health visitors, who were trained through specialized courses including motivational approach techniques and counseling techniques and strategies to encourage healthy behaviors among patients. This type of training is essential to ensure effective and personalized interventions.

At the beginning of each Cardio50 outpatient session, the HCW in charge of the Screening Service welcomed the invited person and provided a brief explanation of the purposes of the cardiovascular screening program. Subsequently, through personalized credentials, the HCW accessed the dedicated regional software, which is directly connected to the infrastructure containing the data in the regional health registry, and displayed the survey sheet of the enrolled subject, which contained the preloaded personal data. This data was confirmed at the start of the session as well as any documentation directly provided by the participant including blood tests carried out in the last six months, particularly total cholesterol and blood sugar results.

The HCW measured the participant's blood pressure using an OMRON M6 Comfort digital sphygmomanometer; if they had not performed a blood test in more than six months or could not provide the results, the HCW also performed a blood sugar measurement using a Medisense FreeStyle Optium Neo H glucometer and total cholesterol determination using a Roche Accutrend Plus device. In addition, anthropometric measurements were performed. The HCW explained the clinical significance of these values and the potential associated cardiovascular risks.

Through the standardized questionnaire in the software, the HCW collected information on various

aspects, including the following:

- General characteristics of the participant (personal data, etc.);
- Smoking habits, including whether they had a tobacco addiction; the use of heated tobacco cigarettes, IQOS or GLO; and characteristics of the smoker;
- Level of physical activity, categorized according to WHO recommendations;
- Consumption of fruit and vegetables, categorized based on the guidelines for a healthy diet;
- General eating habits, including the consumption of red meat and sausages, white meat and fish;
- Salt intake, categorized according to WHO recommendations;
- Alcohol consumption (amount consumed per unit of alcohol);
- Weight status (correlation between weight and height).

This information was used to inform the overall assessment of the individual’s cardiovascular risk. The average duration of each session was 20 minutes. The flow chart for the “Cardio50” program is shown in Figure 1.

The data collected through the questionnaire were

processed by software that assigned the participants to different risk classes:

- Class A: Subjects with normal anthropometric and laboratory parameters and blood pressure, and have a healthy lifestyle. These individuals did not require further follow-up.
- Class B1: Subjects with normal laboratory parameters and blood pressure, but who have at least one of the following behavioral risk factors:
 - » Consumption of up to 3 portions of fruits and vegetables per day;
 - » BMI between 25 and 27;
 - » Abdominal circumference between 80 and 88 cm for women and 94 and 102 cm for men.
 - » Similar to class A, these subjects also did not require further intervention.
- Class B2: Subjects with normal laboratory parameters and blood pressure, but had at least one of the following behavioral risk factors:
 - » Smoking habit;
 - » Light or no physical activity (less than 150 minutes of moderate activity per week);
 - » Consumption of 2 or fewer portions of vegetables and fruits per day;
 - » Consumption of at least 3 units of alcohol per day for males and at least 2 units for females;

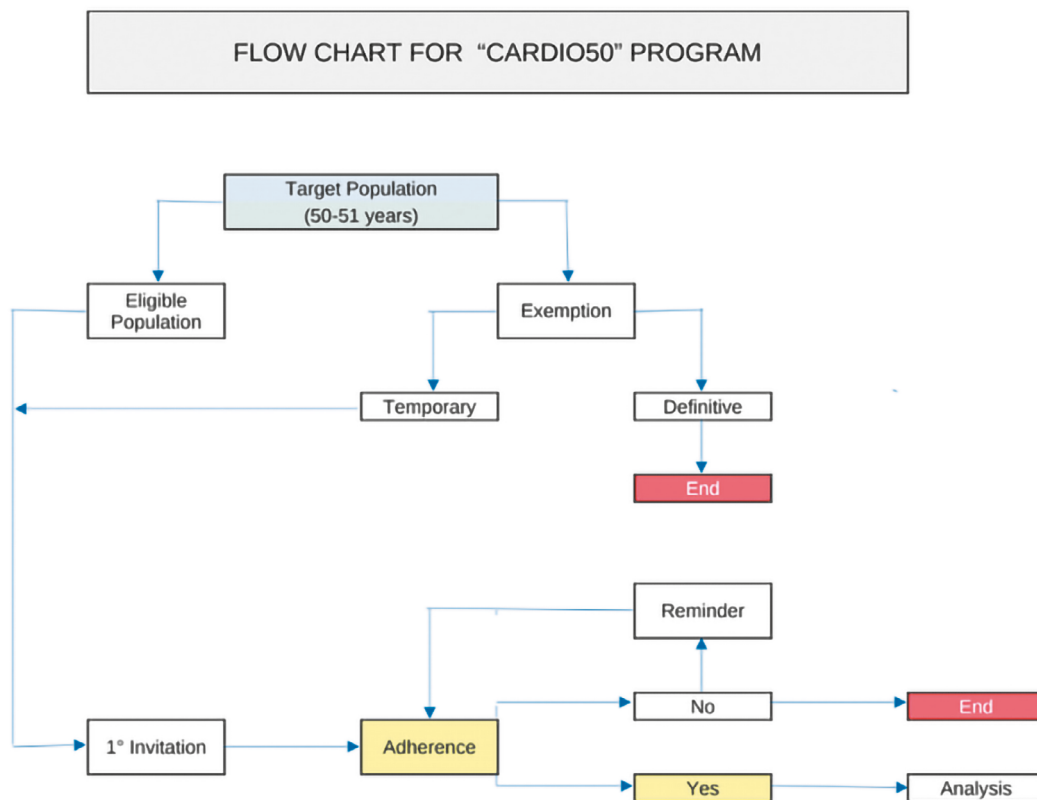


Figure 1: Flow chart for “Cardio50” program.



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- » BMI \geq 27;
- » Abdominal circumference greater than 88 cm in women and 102 cm in men.

For subjects classified as B2, a follow-up was planned after at least 6 months.

- Class C: Subjects with laboratory parameters and blood pressure outside the norm, accompanied by the presence of at least one of the following risk factors:
 - » Systolic blood pressure \geq 140 mmHg and/or diastolic blood pressure \geq 90 mmHg;
 - » Blood glucose \geq 110 mg/dl randomly or when fasting, or postprandial blood glucose \geq 140 mg/dl;
 - » Cholesterol \geq 240 mg/dl.
 - » These subjects were not called back for further checks, but they were sent to their general practitioner (GP) for management.
- Class C1: Subjects who presented laboratory parameters and blood pressure outside the norm, but did not show behavioral risk factors. These individuals were not called for further checks, but were encouraged to consult their GP.
- Class D: Subjects who were ineligible because they were undergoing pharmacological therapy or suffer from specific pathologies. If a subject with any of the exclusion criteria attended an appointment, they were excluded after the cardiovascular screening session.

Based on the risk class assigned to the screened subject, the software automatically generated a report that the HCW delivered to the assessed subject. Depending on the results of the screening visit, the HCW conducted a motivational counseling intervention aimed at enhancing the participant's empowerment and proposing the most appropriate treatment and change paths. In particular, for participants suffering from nicotine addiction, the operator provided detailed instructions regarding access to a clinic dedicated to aiding in smoking cessation. Overweight and/or obese subjects were directed to a nutritional clinic for an in-depth dietary-nutrition assessment. In addition, an additional service was offered that allows participants to receive advice and/or information from a dietician on nutrition, intolerances and do-it-yourself diets, in order to correct poor eating habits. For the participants with a completely sedentary lifestyle, the HCW, after explaining the risks associated with an inactive lifestyle, proposed accessing services aimed at promoting physical activity and a healthy lifestyle. The ULSS1 Dolomiti actively supports the population in this direction through initiatives such as "1 Km per day", "Walking Groups" and the use of certified "Health Gyms". For subjects affected by alcohol addiction who wished to receive support and assistance in stopping alcohol consumption, the HCW provided instructions for contacting the Addiction Service.

Any follow-up sessions assessed whether the subjects

achieved the objectives set during the first screening appointment. The follow-up was carried out after six months by sending a new invitation, and during this visit, new questionnaires were filled out that allowed the subject's file to be updated. If no significant changes emerged from the follow-up, the HCW investigated any difficulties encountered by the patient and proposed new strategies or personalized interventions to promote improvement. This approach allows the intervention to be adapted to the specific needs of the subject and increases the chances of success in the cardiovascular prevention process. At the initial screening, which was also the first time that the participant accessed the Cardio50 clinic of the Prevention of Non-communicable Diseases Screening Programs and Health Promotion Service, tacit informed consent for the use and processing of personal data was requested, including for purposes related to this prospective observational study. The investigation was performed in accordance with the World Medical Association Declaration of Helsinki and did not include any experiments involving human or human biological samples or identifiable human data. The study protocol was approved by the ULSS 1 Dolomiti (approval No. 2609_2023).

RESULTS

In 2024, the Prevention Department of the ULSS1 Dolomiti invited subjects born in 1974 to join the Cardio50 screening program for the first time, which resulted in a total of 2,694 potential participants. A total of 1,746 participants (64.8%) joined, of which 949 were women and 797 were men. For the first round of invitations, 235 outpatient sessions were scheduled, 51 sessions were scheduled through reminders and 35 six-month follow-up sessions were scheduled; the session locations were uniformly distributed across the territory.

Based on the outpatient visits (Table 1), 9.4% of the subjects were classified into class A, while 51.4% were classified into classes B1 and B2. A significant portion (26.9%) of the subjects was classified into classes C and C1 and the remaining 12.3% was classified into class D.

Table 1. Risk classes.

Risk Class	Number of Subjects	%
Class A	165	9,4%
Class B1	204	11,7%
Class B2	693	39,7%
Class C	379	21,7%
Class C1	90	5,2%
Class D	215	12,3%
Total	1.746	100,00%



The analysis of the questionnaires provided a detailed overview of the lifestyles and behaviors related to the main risk factors associated with circulatory system diseases.

Table 2. Smoking status.

Smoking Status	Number of Subjects	%
Smokers	370	21,1%
Former Smokers	312	17,9%
Never Smoked	1064	61%
Total	1.746	100,00%

Table 3. Fruit and vegetables consumption.

Fruit And Vegetable Consumption	Number of Subjects	%
Daily	1661	95,1%
Weekly	79	4,6%
Monthly	6	0,3%
Total	1.746	100,00%

Table 4. Physical activity levels

Physical Activity Level	Number of Subjects	%
Active	1442	82,6%
Insufficient	304	17,4%
Total	1.746	100,00%

Table 5. Body mass index categories

BMI Category	Number of Subjects	%
Overweight	651	37,3%
Obese	279	16%
Normal Weight	816	46,7%
Total	1.746	100,00%

A total of 255 participants (14.6%) had a blood pressure higher than 140/90 mmHg, while 75 participants (4.3%) had high blood glucose values, with no significant differences between men and women. Finally, 203 participants (11.6%) had total cholesterol levels ≥ 240 mg/dl, with similar distributions between the sexes.

DISCUSSION

Only 9.4% of the study population was classified into risk class A; this low percentage value indicates that we need to better understand the habits of the Belluno people in terms of their lifestyles, many

aspects of which are modifiable to reduce the risk of cardiovascular diseases.

With regard to physical activity, 82.6% of the participants reported that they lead an active lifestyle, with a significantly higher proportion of women than men (47.3% of men vs. 52.7% of women). In addition, 37.3% of the participants had a body mass index between 25 and 30, classifying them as overweight, while 16% were obese (BMI >30), with an equal distribution between men and women. Comparing this data with the results of the survey through the PASSI system, there was an increase of 6% in the obese population and 7.3% in the overweight population, despite a high percentage of participants reporting engaging in physical activity. With regard to dietary lifestyles, 95.2% of the participants consume fruit and vegetables on a daily basis; among these, over 47% reported consuming five portions per day. Salt consumption was mainly between the low (51.3%) and medium (43.4%) levels.

With regard to alcohol consumption, 17.8% of the interviewees reported daily intake of alcoholic beverages, with 8.5% exceeding the quantities recommended by the WHO. Furthermore, 48.1% reported weekly alcohol consumption, of which, 7.2% exceed the recommended guidelines; 18.1% of the interviewees consume alcohol occasionally, while 16% claimed that they do not consume any alcoholic substance. However, this data appears to be discordant with the PASSI surveys in which, in a cohort of a similar age (45-55 years), 35% of the interviewees were found to consume higher amounts of alcohol. In addition, 61% of the participants reported that they had never smoked, while 21.1% identified themselves as smokers. The prevalence of smokers was higher among males (56.7%). These data are similar to the results of the surveys carried out through the PASSI system, where 20.5% of the surveyed population were smokers while 9.9% reported being exposed to second-hand smoke on a daily basis.

All the participants with abnormal clinical parameters were referred to their GP for management, as required by the protocol. For those who had risk factors related to unhealthy lifestyles, the HCW outlined the available interventions: outpatient services for smoking cessation, nutritional clinics, and specific programs aimed at increasing physical activity, such as structured paths and health gyms. The overall analysis found that 78.3% of the participants required targeted interventions to improve their risk factors. These preliminary findings in the first year of this non-oncological screening program implemented at a local level identified a significant number of subjects as at-risk subjects.

To the best of our knowledge, this is the first report describing the outcomes of a cardiovascular screening program performed at a local level in the Veneto region. There is some preliminary data from the Friuli-Venezia Giulia Region for the year 2018 [15]. However, this study can only be considered a pre-





liminary investigation given the breadth of the data available for the population of a provincial territory. Evaluating the trends over time and comparing them with those of neighboring provinces or with other territories with similar geomorphological and social characteristics could provide useful information.

CONCLUSIONS

In industrialized social contexts, which are often characterized by unhealthy lifestyles and a prevalence of bad habits, a progressive increase in chronic degenerative diseases has been observed. The most effective strategy to counteract this trend is educating and informing the population about the nature of these diseases, the associated risks and the methods of prevention.

Companies, institutions and health systems have studied and implemented numerous prevention strategies aimed at raising awareness on the importance of adopting a healthy and conscious lifestyle

to improve longevity, also understood as “years of healthy life”.

Cardiovascular diseases are a global public health problem that must be addressed and effectively countered. In a first attempt to provide the best response to these critical goals, the “Cardio50” screening aims to intervene with at-risk individuals at an early stage and to provide detailed information on both modifiable and non-modifiable risk factors. This non-oncological screening program aims to promote, among other things, proper nutrition and the adoption of healthy lifestyles, with the intent of reducing the incidence of cardiovascular events. The role of HCWs and institutions in this context remains crucial: it is necessary to continue increasing the commitment to education and prevention activities and strengthening the strategies for promoting healthy behaviors in all age groups and in at-risk populations.

REFERENCES

1. World Health Organization. Cardiovascular diseases (CVDs). Available online: [https://www.who.int/en/news-room/fact-sheets/detail/cardiovascular-diseases-\(cvds\)](https://www.who.int/en/news-room/fact-sheets/detail/cardiovascular-diseases-(cvds)) (accessed on 2 May 2025).
2. EUROSTAT – Cardiovascular Diseases Statistics. Available online: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Cardiovascular_diseases_statistics (accessed on 2 May 2025).
3. Ministero della Salute – Malattie cardiovascolari. Available online: <https://www.salute.gov.it/new/it/tema/salute-della-donna/malattie-cardiovascolari> (accessed on 2 May 2025).
4. Servizio Epidemiologico Regionale – Regione del Veneto. Available online: <https://www.ser-veneto.it/it/aree-tematiche/mortalit/mortalit> (accessed on 2 May 2025).
5. Arnett, D, Blumenthal, R, Albert, M. et al. 2019 ACC/AHA Guideline on the Primary Prevention of Cardiovascular Disease: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *JACC*. 2019 Sep, 74 (10) e177–e232. doi.org/10.1016/j.jacc.2019.03.010
6. World Health Organization. European Regional Obesity Report 2022. Copenhagen: WHO Regional Office for Europe; 2022. Licence: CC BY-NC-SA 3.0 IGO.
7. World Health Organization. Tobacco. Available online: <https://www.who.int/en/news-room/fact-sheets/detail/tobacco> (accessed on 8 May 2025).
8. World Health Organization - Global status report on alcohol and health and treatment of substance use disorders. Available online: <https://www.who.int/publications/i/item/9789240096745> (accessed on 8 May 2025).
9. Jülicher P, Varounis C. Estimating the cost-effectiveness of screening a general population for cardiovascular risk with high-sensitivity troponin-I. *Eur Heart J Qual Care Clin Outcomes*. 2022 May 5;8(3):342-351. doi: 10.1093/ehjqco/qcab005.
10. Søgaard R, Diederichsen ACP, Rasmussen LM, Lambrechtsen J, Steffensen FH, Frost L, Egstrup K, Urbonaviciene G, Busk M, Lindholt JS. Cost effectiveness of population screening vs. no screening for cardiovascular disease: the Danish Cardiovascular Screening trial (DANCAVAS). *Eur Heart J*. 2022 Nov 1;43(41):4392-4402. doi: 10.1093/eurheartj/ehac488.
11. Win ZM, Mao W, Traill T, Kyaw ZL, Paing PY, Ogbuoi O, Yamey G. Cost-effectiveness and budget impact analysis of screening and preventive interventions for cardiovascular disease in Myanmar: an economic modelling study. *Lancet Reg Health Southeast Asia*. 2024 Apr 10;26:100394. doi: 10.1016/j.lansea.2024.100394.
12. Istituto Superiore di Sanità. Alcol. Available online: <https://www.epicentro.iss.it/alcol/aggiornamenti> (accessed on 12 May 2025).
13. Italian Ministry of Health. General Directorate of Health Prevention. National Prevention Plan 2020-2025.
14. Regione del Veneto. Vivo Bene Veneto. Piano Regionale della Prevenzione. Documento Tecnico Procedura Regionale per la Prevenzione Cardiovascolare “Cardio50”. PL11 - “Sistema integrato per il contrasto dei determinanti della cronicità” P.R.P. 2020-2025.
15. Bordin P, Picco F, Valent F, Mattiussi B, Vidotto L, Brianti G. Cardiovascular prevention in 50-year-old adults: an Italian intervention study. *J Cardiovasc Med (Hagerstown)*. 2018 Aug;19(8):422-429. doi: 10.2459/JCM.0000000000000682.



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