

Tele-ECG consulting and outcomes on primary care patients in a low-to-middle income population: The first experience from Makassar Telemedicine Program, Indonesia

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Abstract

Background: Telemedicine has been a popular tool to overcome the lack access to healthcare facilities, primarily in underprivileged populations. We aimed to describe and assess the implementation of tele-electrocardiography (ECG) program in primary care settings in Indonesia, and subsequently examine the short- and mid-term outcomes of patients those received tele-ECG consultation.

Methods: A total of 505 ECG recordings from thirty primary care centers were transmitted to Makassar Cardiac Center, Indonesia from January to July 2017. We prospectively collected data by sending a detailed questionnaire to general practitioners (GPs). Follow-up was performed at 30 days and at the end of follow-up on October 2018.

Results: Of 505 recordings, all (100%) ECGs were qualified for analysis, and about a half showed normal findings. Ischemia presented in 15.6%, arrhythmia in 23.6%, and abnormalities compatible with structural changes in 5.1%. The mean age of participants was 53.3 ± 13.6 years, and 40.2% were male. Most (73.9%) of these primary care patients turned up with a manifested CVD symptom with at least one risk factor. More men had an ischemic ECG compare to women ($p < 0.01$), while aged > 55 years was associated with ischemic or arrhythmic ECG ($p < 0.05$). Factors significantly associated with a normal ECG were younger age, female gender, lower blood pressure and heart rate, and no history of previous cardiovascular disease (CVD) or medication. More patients with an abnormal ECG had a history of hypertension, known diabetes, and were current smokers ($p < 0.05$). Majority (95%) of GPs were satisfied with each tele-ECG consultation, and 58.6% used tele-ECG for an expert opinion. Over the total follow-up (14 ± 6.6 months), seven (1.4%) patients died and 96 (19.0%) were hospitalized for CVD. Of 88 patients for whom hospital admission was advised, 72 (81.8%) were immediately referred within 48 hours following the tele-ECG consultation.

Conclusions: Tele-ECG can be implemented in Indonesian primary care settings with limited resources and may assist the GPs for immediate triage, results in higher rate of early hospitalization for indicated patients.

Background

To date, telemedicine has been a popular tool in overcoming geographical barriers and increasing access to healthcare services. This particularly benefits the rural and underserved populations in low- and middle-income countries – groups that traditionally suffer from lack of access to healthcare.(1) World Health Organization has defined telemedicine as delivery of healthcare services, where distance is a critical factor, using information and communication technologies for the exchange of valid information for the diagnosis, treatment, and prevention of disease, for research and for evaluation.(1)

Indonesia is the worlds' largest archipelago and the most populated nation in South-East Asia; it consists of 17 508 islands and has a population of more than 260 million people.(2) More than half of the Indonesian population live in Java, with the rest distributed unevenly across ~ 6000 islands.(2, 3) Of this population, $> 10\%$ live in poverty.(4) Cardiovascular disease (CVD) is the leading cause of death in this lower middle-income country, responsible for ~ 37% of total deaths.(4) Premature deaths from coronary artery disease (CAD), stroke, and diabetes are significantly higher in Indonesia compared with neighboring countries.(4) In 2016, the latest analyses of the Global Burden of Disease reported that these diseases are also the top three causes of disability-adjusted life-years (DALYs) in Indonesia.(2) Despite the high burden of CVD in this nation, in 2016 only 1.5 cardiologists per 1 000 000 population were available, (4) and in 2013 there were ~ 30 cardiac centers (half located in Java) to serve > 2.6 million prevalent cases of CAD.(5, 6)

In view of the shortage of cardiologists and evident demand for expertise in cardiovascular care, Makassar Cardiac Center initiated the first telemedicine project in Eastern Indonesia – transferring the electrocardiography (ECG) recordings from primary care facilities to a center of expertise at Hasanuddin University Hospital. This project entailed decision support for general practitioners (GPs) in primary care when confronted with patients with symptoms or risk factors for CVD. Although the implementation of telemedicine program has been started in Indonesia since 2012, reporting on the performance and outcomes of the program remains less explored.

We aimed to study in detail the implementation of a tele-ECG program in a South-East Asian population with low resources, and to assess the patients' outcomes in relation to decision-making assisted by tele-ECG consulting. To this end, we conducted a population-based cohort study in patients with CVD symptoms and/or risk factors at primary care centers in Makassar, Indonesia.

Methods

In the initiation of this telemedicine program, Makassar Cardiac Center in collaboration with the local government of Makassar City provided one digital ECG machine for each primary care center in 2015. Distribution of all primary care centers in the city of Makassar is depicted in **Figure 1**.

Study population

Between January and July 2017, the 12-lead ECG recordings from thirty primary care centers (known as Pusat Kesehatan Masyarakat or Puskesmas) were transmitted to Hasanuddin University Hospital. We prospectively collected data from patient medical records and interview by sending a questionnaire to primary care GPs. We included a total of 505 patients in our study population as described in the flowchart (**Figure 2**).

Patients were eligible for ECG assessment if they presented at Puskesmas with a manifested cardiovascular symptom and/or risk factor. Patients with other diseases or healthy subjects were also eligible as long as they were willing to have an ECG examination as a check-up. If the GPs considered urgent referral or admission necessary, the patient was referred directly to the secondary/tertiary hospital without any delay, and therefore this group of patients was excluded from the tele-ECG consulting.

Data collection and measurement

A detailed questionnaire was designed to obtain data on socio-demographic and clinical profiles (i.e. symptom, onset, prior disease, prior medication, anthropometric status, vital signs, and cardiovascular risk factors: hypertension, diabetes mellitus, current smoking, and family history of CVD), management and medications after tele-ECG, and GP's reasons and satisfaction with tele-ECG consulting.

Vital sign measurements (i.e. blood pressure, heart rate, respiration rate, and axillary temperature), anthropometrics, standard physical examination, and ECG assessment were performed in all participants. Body weight, height, and waist circumference were measured manually. No laboratory tests (e.g. fasting plasma glucose, lipid profiles, and creatinine) were performed, as these tests are generally not available at primary care level in Makassar.

ECG examination was performed by the trained primary care nurses using an automated ECG machine, BTL-08 SD ECG (BTL Industries Ltd, Hertfordshire, UK). The ECG files were sent through the internet to the analysis service center at Hasanuddin University Hospital, and saved in the hospital database. Two cardiologists reviewed and analyzed all the ECG recordings. Implementation of tele-ECG consulting in primary care center and illustration of ECG in Makassar Medical System are described in **Figure S1**.

Definitions and classification

A CVD symptom was defined as mild-to-moderate chest pain (angina), shortness of breath (dyspnea), palpitations, heartburn (epigastric pain), lightheadedness (dizziness) or headache, and syncope. Hypertension, diabetes mellitus, current smoking, family history of CVD, and obesity were categorized as the risk factors.

We classified the participants based on their ECG findings into normal and abnormal ECG. We used a hierarchical manner to determine the classification of the ECG patterns. The order of the categorization was ischemia, arrhythmia, structural change, and others, respectively. Management after tele-ECG were classified as: referral to the hospital, outpatient with no medications, and outpatient with cardiovascular medications for primary or secondary prevention.

ECG assessment and referral

The ECGs sent to the service center were analyzed every day, and a diagnosis and advice were sent back to the GPs. The advice for referral was based on the ECG finding and the severity of the symptoms presented. Patients were referred if they had a marked CVD symptom and the ECG showed an abnormal finding. Criteria for referral were patients with angina and ischemic ECG; patients with dyspnea and ischemic or structural-related ECG; and patients with palpitations, syncope or other symptoms with arrhythmic ECG. Where criteria were met or if there was doubt about the ECG, the advice was to refer the patient to a hospital with cardiovascular care facilities. GPs made the final decision on the urgency of the referral based on their own assessment. Once referred, the patient came under the responsibility of the cardiologists for diagnostic work-up and treatment.

Follow-up and outcomes of the study population

After ECG assessment, we followed the patients and measured the adverse outcomes (i.e. cardiovascular death and hospitalization) at 30 days and at the end of the study period, up to 30 October 2018. Primary care nurses, cadres, and research assistants performed the follow-up by obtaining data from the primary care medical records, through telephone calls, or home visits. None of the participants were lost to follow-up.

Statistical analysis

For continuous variables, means \pm standard deviations (SD) were calculated, while categorical variables were expressed as a proportion (percentage). Median (Q1-Q3) was used for the skewed data. Differences in continuous variables were estimated using the t-test for independent samples or Mann-Whitney U test. Proportions were compared using Pearson's Chi-square or Fisher's Exact tests. Baseline and clinical profiles, CVD symptoms and risk factors, management in primary care, and GP's reason and satisfaction on tele-ECG were presented in accordance with the ECG conclusion (normal vs. abnormal ECG). The rates of cardiovascular death and hospitalization at 30 days and >30 days until the end of follow-up were compared in the referral (abnormal ECG) vs. non-referral (normal and abnormal ECG) groups. A two-tailed p-value <0.05 was considered statistically significant. Data management and statistical computation were performed with IBM SPSS Ver. 23 for Mac.

Results

From January to July 2017, a total of 505 ECG recordings were received in the analysis center of the telemedicine program, at Hasanuddin University Hospital. All ECG recordings qualified for analysis. Of all participants, the mean age of participants was 53.3 ± 13.6 years, and 203 (40.2%) were male. We classified 253 (50.1%) of participants to normal, and 252 (49.9%) to abnormal ECG groups.

In **Table 1**, we present the baseline and clinical profiles of the study population according to ECG classification. Patients with a normal ECG were significantly younger, the majority were female, they had lower systolic and diastolic blood pressure and a lower heart rate; fewer had previously taken CVD and cardiovascular medications compared with those with an abnormal ECG. The majority (82.0%) of participants were of low and middle socio-economic status. More men than women were prone to have an ischemic ECG ($p < 0.01$), while older age (> 55 years) was associated with an ischemic or arrhythmic pattern ($p < 0.05$) (see **Figure 3**).

CVD symptoms and risk factors of the primary care patients are shown in **Table 2**. More female patients with chest pain had a normal ECG ($p = 0.01$). A longer (≥ 15 minutes) duration of angina ($p = 0.045$) and marked dyspnea ($p = 0.001$) was associated with an abnormal ECG. More patients with abnormal ECG had a history of hypertension, known diabetes, and were current smokers ($p < 0.05$). Half of the participants (254, 50.3%) had hypertension, and 171 (67.3%) were on medication. Of all participants, 42.4% were obese.

Profile of the participants and advice for referral according to ECG findings are described in **Table 3**. Overall, 79 (15.6%) patients were categorized as having ischemia, 119 (23.6%) as having arrhythmia, and 26 (5.1%) had structural changes. The majority of participants (73.9%) presented to primary care center with a manifested CVD symptom and at least one risk factor; 95 (18.8%) presented with symptoms only; 24 (4.8%) were asymptomatic with at least one risk factor; and 13 (2.6%) had neither CVD symptom nor risk factor, but purposely had an ECG assessment as part of a general check-up. The majority (79.5%) of patients who were advised for referral showed an ischemic ECG (**Figure 3**).

Table 4 presents the GPs reasons, satisfaction, and management after tele-ECG consultation. The majority of the GPs carried out a consultation through tele-ECG for an expert opinion (58.6%) and because of the manifested or moderate CVD symptoms (38.0%). Overall, 154 (30.5%) patients were observed in Puskesmas for a primary or secondary prevention with adequate medications; while 88 (34.9%) of patients with abnormal ECG were referred to the hospital. Most (95%) of the GPs were satisfied with each tele-ECG consultation.

Over the entire follow-up (14 ± 6.6 months), seven (1.4%) patients died and 96 (19.0%) were admitted to hospital for CVD. **Table 5** compares the adverse outcomes between abnormal vs. normal ECG groups. There was a significant difference between the abnormal and normal ECG groups, in terms of early CVD hospitalization ($p < 0.001$). In group with abnormal ECG, 88 (34.9%) patients were advised for hospital admission, and of those, 72 (81.8%) were sent immediately to the hospital within 48 hours following tele-ECG consultation. Over the 30 days, there were no significant differences between patients with abnormal and normal ECG in terms of mid-term cardiovascular death (2.0% vs. 0.4%, $p = 0.122$) and hospitalization (3.2% vs. 2.8, $p = 0.800$).

Discussion

This recent study shows that tele-ECG consulting was helpful to support primary care GPs in a low-to-middle income Indonesian population for making a quick pre-hospital triage. Of 505 ECG screenings transmitted to the analysis center, all recordings were qualified for analysis. Within 30 days, tele-ECG consulting resulted in a higher rate of early hospitalization. Overall, 88 (17.4%) participants were advised for hospital admission based on their evident symptom and abnormal ECG. Of these, 72 (81.8%) were getting CVD hospitalization within 48 hours following the consultation. Over the 30 days, we found no significant differences between the normal and abnormal ECG groups regarding the mid-term cardiovascular death and hospitalization.

From our analyses, we found that patients with normal ECG were predominantly female, younger, showed better clinical profiles, and had fewer CVD risk factors when compared with those with an abnormal ECG. Men were significantly more prone to have an ischemic ECG than women; while older age (≥ 55 years) was susceptible to have

an ischemic or arrhythmic ECG compared with younger age. In this study, the majority (80%) of our referral patients presented with moderate chest pain and suspected with an ischemic heart disease.

Half of the participants in this study suffered from hypertension; 22% were unaware of this and 33% were untreated. The National Survey 2013 reported that 62% of hypertension cases in the Indonesian general population were undiagnosed.(6) A previous review also reported that > 50% of the study participants with hypertension in Indonesia were unaware and untreated.(4) Our study population, the primary care patients with a manifested CVD symptom and/or risk factor, may explain the lower number of unaware and untreated cases. However, these numbers are still higher compared with the 16% unaware and 7% untreated hypertension cases in stroke patients recently studied in China.(7, 8) Another report states that overtreatment appears to be detected in 0.1% population in Indonesia, i.e. where medication is privately consumed without diagnosis at healthcare facilities.(6)

A large proportion of the population in Indonesia is estimated to have undiagnosed diabetes and often diabetes is first detected only when secondary complications are presented.(4) Nevertheless, currently, the standard screening and detection for diabetes mellitus and dyslipidemia (i.e. fasting plasma glucose and lipid profiles) are usually unavailable at primary care services in this country. In our study, ~ 9% of participants had known diabetes. We inferred that considering the moderate-to-high risk profile there must be more undetected or undiagnosed diabetes cases in this study population. Standard screening for CVD risk factors should be always available and affordable at primary care level.

From the present study, we observed more female patients presented with chest pain, yet showed a normal ECG. There is abundant evidence to indicate that women are more likely to present with chest pain – they often have recurrent symptoms and re-admissions – compared to men.(9) However, CAD occurs more frequently in men.(9) Another study also indicated that women scored the intensity of their chest pain significantly higher than men.(10) Non-CAD-related angina is commonly associated with persistent chest pain, causing poor function and quality of life, and re-admission.(9) Therefore, in women with a normal ECG, it should be kept in mind that if the symptom is moderate and recurs, the angina should be not underestimated. Microvascular dysfunction, coronary artery spasm, coronary artery dissection, and myocardial bridging are the most common causes of chest pain in women who present at the Emergency Department.(9) These underlying patho-mechanisms may be undetectable on a one-time point resting ECG assessment. Women are more vulnerable to longer admission to hospital, slower diagnosis, and inadequate treatment.(11) Previous studies have suggested that coronary angiography is used less often in women, largely because their risk is underestimated.(11) Women describe an atypical clinical feature of chest pain, which significantly differs with men. Often, women complain of concomitant atypical symptoms (e.g. heartburn to epigastric pain, unusual fatigue, dizziness, feeling of doom, and generalized weakness),(9) and make the indication for CVD even more difficult to establish.

Symptomatic patients with normal ECG findings are often reassured by their diagnosis and favorable prognosis, but receive no specific prevention management, although they have an increased risk for CVD events. Despite the moderate-to-high risk profiles, ~ 52% of our study population received no medications, while ~ 31% received adequate medications and planned for long-term primary or secondary prevention.

In this study, we focused on a qualitative interpretation of the tele-ECG performance, quantified the patient profiles and management, and conducted an in-depth case analysis of all deaths and hospitalizations observed at the first 30 days and > 30 days after tele-ECG advice. Based on patient risk profile and clinical history, we obtained a reasonable picture regarding the quality of care and the impact of the tele-ECG consulting. In non-referral group with abnormal ECG, six (3.7%) patients had been hospitalized for CVD within 30 days, three (1.8%) patients died and 6 (3.7%) were admitted to hospital after 30 days. While in the normal ECG group, two (0.8%) patients died due to uncontrolled diabetes and heart

failure, while 7 (2.8%) were admitted to hospital due to CVD during the follow-up period. This indicates that the criteria for referral should be revised, and patients with recurrent and marked cardiovascular symptoms should be treated with caution despite a normal ECG presentation.

At mid-term follow-up, there were no significant differences between the referral and non-referral groups pertaining the cardiovascular death and hospitalization. We can assume that: (1) the low rate of cardiovascular mortality in abnormal ECG group indicated that early hospitalization based on tele-ECG advice had a favorable impact; (2) the higher rate of CVD hospitalization in normal ECG group indicated that those patients could have undetectable and uncontrolled cardiovascular risk factors, particularly because standard screening for diabetes and dyslipidemia is generally not available in primary care centers in Indonesia; and (3) the lower rate of mid-term CVD hospitalization implied well-controlled or prevention of CVD risk factors in the referral group.

A prior study in western population showed that mortality rates in patients with acute myocardial infarction (AMI) were not statistically different between those screened with pre-hospital tele-ECG compared with the controls, both at 30 days and 6 months.(12) However, in higher risk AMI patients, pre-hospital tele-ECG triage has been associated with a lower 6-month mortality.(12) In our study, we did not use a control group to compare the performance of pre-hospital tele-ECG since we used the general population in primary care settings as our study population.

While low- and middle-income countries are more likely to consider resources barriers such as high costs, underdeveloped infrastructure, and lack of technical expertise to tackle telemedicine, high-income countries are more likely to consider legal issues surrounding patient privacy and confidentiality, competing health priorities, and perceived lack of demand to be barriers in telemedicine implementation.(1) However, the success of the Makassar Telemedicine Program has shown that implementation of telemedicine (i.e. tele-ECG) in a low resource setting is feasible and beneficial in the context of patients' detection and selection for referral.

A previous study has suggested that tele-ECG is a practice and cost-effective tool for diagnosis and monitoring of CVD, and thus improves accessibility and quality of care in a rural low-to-middle income population in India.(13) Singh et al. reported the patient satisfaction was ~ 95%,(13) while in our study we accounted the similar 95% for GPs satisfaction in primary care facilities. Another study concluded that pre-hospital tele-ECG is highly appreciated and utilized by the emergency department staff with 86% indicated excellence for the satisfaction rate.(14) In developed countries, both pre- and in-hospital tele-ECG triage significantly shorten door-to-balloon time in patients with acute myocardial infarction and result in higher rates of timely primary percutaneous coronary intervention (PCI) (< 90 minutes), compared to the control group.(12, 15, 16) Tele-ECG has been relevantly proved to reduce unnecessary hospitalization and wrong diagnosis in the case of suspected acute CVD.(14)

To our knowledge, the present study is among the first to explore the implementation of telemedicine programs in South-East Asia, and couples the program performance to patient outcomes. During follow-up, we had to cope with the unorganized and incomplete patient data at primary care centers (Puskesmas). Follow-up would be far easier if all Puskesmas kept standardized and reliable medical records. In the future, primary care records should be available in the form of an electronic database to ease the integration and communication with the hospitals. Secondly, patient and doctor engagement and long-term planning for primary or secondary prevention should be managed better. Each patient should have one permanent record for all check-ups and consultations. Thirdly, patients who are eligible and willing to participate in a research study should provide a copy of an official ID card (e.g. residence permit or kartu tanda penduduk; or driver's license or surat ijin mengemudi), to ensure that follow-up and data acquisition from hospital or primary care centers could be performed efficiently.

During the entire follow-up (14 ± 6.6 months), seven (1.4%) patients died and 96 (19.0%) were hospitalized for CVD. However, due to poor medical records in Puskesmas in Indonesia, particularly in Makassar, there is no primary care database available. Therefore, any comparison in terms of cardiovascular mortality or hospitalization is not possible. This study has other potential limitations. Firstly, before this tele-ECG program, the ECG assessment had not been existed in most of primary care centers in Makassar, and hence comparison regarding the waiting time, performance, or other evaluation tasks before and after the implementation of tele-ECG is also unfeasible.

Secondly, we made an assumption that there were undiagnosed and undetected patients with diabetes in our study population, meaning that we might have underestimated the rate of CVD risk factors. The CVD risk profiles could be even worse than we observed. However, this limitation is unlikely to have biased our main results. We suggest that the Indonesian Government should be more serious about combating CVD risk factor burden in this country.

Considering that atherosclerotic CVD and diabetes are the leading causes of mortality and morbidity in Indonesia, detection and screening of diabetes and dyslipidemia should be available and affordable at primary care level. (2, 4) Thirdly, The effectiveness of the tele-ECG program can only be estimated, as data collection did not allow for reliable calculation of false-negative and false-positive ratios. Lastly, one has to be aware of the fact that healthcare resources are limited and therefore funding of this study to monitor the effectiveness of the tele-ECG program is also limited. Consequently, robust quantitative data collection and analysis can only be performed in limited manner.

Conclusions

In conclusion, in a less-developed country, tele-ECG is feasible and affordable to assist primary care GPs for a quick triage in recognizing a life-threatening CVD, based on an expert advice. The use of tele-ECG in this resource-limited setting indicates a higher rate of early hospitalization for indicated patients.

Declarations

Ethics approval and consent to participate

Written, signed, and dated informed consent was obtained from all participants. The Ethics Committee and Institutional Review Board of the Faculty of Medicine, University of Hasanuddin, Makassar approved the protocol of this study (Letter Number 180/ H4.8.4.5.31/ PP36-KOMETIK/ 2017).

Consent for publication

The primary care nurse and patient provided written consent for publication for the Supplementary material (Figure S1).

Availability of data and materials

All data generated or analysed during this study are included in this published article or uploaded as supplementary materials. No additional data are available. Dataset available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

IM is the principal investigator of this Tele-ECG program (Makassar Telemedicine Project). AQ, CU, and BM conceived the idea of the study and were responsible for the design of the study. AQ and IM were responsible for the data collection and follow-up. AQ was responsible for data analysis and drafting the first manuscript. CU, BM, and JH provided input into the data analysis and interpretation. The manuscript was then circulated repeatedly to CU, BM, JH, and IM for critical revision. All authors approved the final version of the manuscript.

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Abbreviations

- ECG: Electrocardiography
- GPs: General practitioners
- CVD: Cardiovascular disease
- CAD: Coronary artery disease
- DALYs: Disability-adjusted life-years
- Puskesmas: Pusat kesehatan masyarakat
- SD: Standard deviation
- AMI: Acute myocardial infarction
- PCI: Percutaneous coronary intervention

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Tables

Table 1. Baseline and clinical characteristics of the participants according to ECG findings

Variables	Normal ECG (n = 253)	Abnormal ECG (n = 252)	Total (n= 505)	p-value
Age (years)	50.7 ± 14.1	56.0 ± 12.6	53.3 ± 13.6	<0.001
Male sex	85 (33.6)	118 (46.8)	203 (40.2)	0.002
Systolic BP (mmHg)	124.7 ± 15.6	136.2 ± 22.2	130.4 ± 20.0	<0.001
Diastolic BP (mmHg)	79.5 ± 8.2	82.5 ± 9.4	81.0 ± 8.9	<0.001
Heart rate (bpm)	77.9 ± 9.5	83.5 ± 16.9	80.7 ± 14.0	<0.001
BMI (kg/m ²) ^a	24.2 (21.8-26.7)	24.1 (21.4-27.2)	24.2 (21.6-26.9)	0.788
Low-to-middle SES	213 (84.2)	201 (79.8)	414 (82.0)	0.196
Previous Diseases:				
Cardiovascular disease ^b	2 (0.8)	8 (3.2)	10 (2.0)	<0.001
COPD ^b	5 (2.0)	2 (0.8)	7 (1.4)	0.055
Previous Medications:				
Anti-hypertension	61 (24.1)	110 (43.7)	171 (33.9)	<0.001
Anti-diabetic	14 (5.5)	29 (11.5)	43 (8.5)	0.016
Anti-cholesterol	9 (3.6)	19 (7.5)	28 (5.5)	0.051
Anti-platelet	1 (0.4)	11 (4.4)	12 (2.4)	0.003
Anti-arrhythmia ^b	0 (0.0)	2 (0.8)	2 (0.4)	0.249

Values are n (%) or means SD, unless otherwise stated. Comparison was performed using independent-samples t-test for continuous variables and Pearson Chi-square test for categorical variables.

^aValues are medians (Q1-Q3). Comparison was done using Mann-Whitney U test.

^bComparison was performed using Fisher's Exact test.

ECG = electrocardiogram; BP = blood pressure; bpm = beat per minute; BMI = body mass index; SES = socio-economic status; COPD = chronic obstructive pulmonary disease.

Table 2. CVD symptoms and risk factors of the cohort based on ECG recordings

Variables ^a	Normal ECG (n = 253)	Abnormal ECG (n = 252)	Total (n= 505)	p-value
CVD Symptoms:				
Chest pain	164 (64.8)	153 (60.7)	317 (62.8)	0.340
≥15 min.	17 (6.7)	30 (11.9)	47 (9.3)	0.045
Female sex	105 (64.0)	76 (49.7)	181 (57.1)	0.010
Heartburn	19 (7.5)	14 (5.6)	33 (6.5)	0.374
Dyspnea	27 (10.7)	54 (21.4)	81 (16.0)	0.001
Palpitation	24 (9.5)	38 (15.1)	62 (12.3)	0.055
Syncope ^b	0 (0.0)	1 (0.4)	1 (0.2)	0.499
Dizziness/headache	20 (7.9)	24 (9.5)	44 (8.7)	0.519
Recurrent symptoms	64 (25.3)	78 (31.0)	142 (28.1)	0.157
CVD Risk Factors:				
Hypertension	99 (39.1)	155 (61.5)	254 (50.3)	<0.001
Known diabetes	15 (5.9)	29 (11.5)	44 (8.7)	0.026
Current smoking	37 (14.6)	70 (27.8)	107 (21.2)	<0.001
Sticks/day	10 ± 7	12 ± 6	11 ± 6	0.147
Family CVD	15 (5.9)	12 (4.8)	27 (5.3)	0.067
Obese (BMI ≥25)	106 (41.9)	108 (42.9)	214 (42.4)	0.827

Values are n (%) or means SD, unless otherwise stated. Comparison was performed using independent-samples t-test for continuous variables and Pearson Chi-square test for categorical variables.

^aMore than one symptom and/or risk factor is possible.

^bComparison was performed using Fisher's Exact test.

ECG = electrocardiogram; CVD = cardiovascular disease; min. = minutes.

Table 3. Patient profiles and advice for hospital admission based on ECG findings

Patient profiles	Normal ECG (n = 253)	Abnormal ECG ^a					Advice for hospital admission (n = 88)	p-value
		Ischemia (n = 79)	Arrhythmia (n = 119)	Structure (n = 26)	Others (n = 28)			
Symptom only	55 (21.7)	8 (10.1)	21 (17.6)	6 (23.1)	5	9 (10.2)	0.218	
Symptom (+) with 1 risk factor	119 (47.0)	21 (26.6)	57 (47.9)	8 (30.8)	11 (17.9)	27 (30.7)	0.010	
Symptom (+) with >1 risk factors	51 (20.2)	46 (58.2)	39 (32.8)	11 (42.3)	10 (39.3)	48 (54.5)	<0.001	
Risk factors only			1 (0.8)	1 (3.8)	10	3 (3.4)	0.115	
No symptom and no risk factors	18 (7.1)	3 (3.8)	1 (0.8)	0 (0.0)	1 (3.6)	1 (1.1)	0.322	
	10 (4.0)	1 (1.3)			1 (3.6)			

Values are n (%). Comparison was performed using Pearson Chi-square test.

^aCategorization based on dominated pattern presented on ECG.

ECG = electrocardiogram.

Table 4. GP's reason, management, and satisfaction on tele-ECG consulting

Variables	Normal ECG (n = 253)	Abnormal ECG (n = 252)	Total (n= 505)	p-value
GP's reason for tele-ECG:				
Manifested CVD symptoms	76 (30.0)	116 (46.0)	192	<0.001
Unable to interpret the ECG	2 (0.8)	12 (4.8)	(38.0)	0.007
Ask for an expert opinion	175 (69.2)	121 (48.0)	14 (2.8)	<0.001
Others ^a	0 (0.0)	3 (1.2)	296	0.124
Management after tele-ECG:				
Refer to hospital	0 (0.0)	88 (34.9)	3 (0.6)	<0.001
Outpatient without medications	183 (72.3)	80 (31.7)		<0.001
Outpatient with new or continued medications	70 (27.7)	84 (33.3)	88	0.167
Medications at primary care following tele-ECG consultation :				
Aspirin			263	
Clopidogrel ^a	2 (0.8)	49 (19.4)	(52.1)	<0.001
Beta blocker ^a	0 (0.0)	8 (3.2)	154	0.004
Calcium-channel blocker	0 (0.0)	8 (3.2)	(30.5)	0.004
ACE inhibitor	53 (20.9)	95 (37.7)		<0.001
Angiotensin receptor blocker	7 (2.8)	54 (21.4)		<0.001
Diuretic	4 (1.6)	10 (4.0)	51	0.102
Nitrate	0 (0.0)	17 (6.7)	(10.1)	<0.001
Lipid-lowering agents	13 (5.1)	47 (18.7)	8 (1.6)	<0.001
	8 (3.2)	39 (15.5)	8 (1.6)	<0.001
GP's satisfaction on tele-ECG:				
Yes	232 (91.7)	247 (98.0)	148	
			(29.3)	0.001
			61	
			(12.1)	
			14 (2.8)	
			17 (3.4)	

			60 (11.9) 47 (9.3)
			479 (94.9)

Values are n (%) or mean. Comparison was performed using Pearson Chi-square test.

^aComparison using Fisher's Exact test.

ECG = electrocardiogram; CVD = cardiovascular disease.

Table 5. Major adverse cardiovascular events (MACE) in normal and abnormal ECG groups

MACE	Abnormal ECG		Normal ECG	p-value ^a
	Referred (n = 88)	Not referred (n = 164)	Not referred (n = 253)	
≤ 30 days				
CVD death	0 (0.0)	0 (0.0)	1 (0.4)	1.000
CVD hospitalization	75 (85.2)	6 (3.7)	0 (0.0)	<0.001
Admission within 48 hours	72 (81.8)	5 (3.0)	0 (0.0)	<0.001
Total	75 (85.2)	6 (3.7)	1 (0.4)	<0.001
> 30 days				
CVD death	2 (2.3)	3 (1.8)	1 (0.4)	0.122
CVD hospitalization	2 (2.3)	6 (3.7)	7 (2.8)	0.800
Total	4 (4.5)	9 (5.5)	8 (3.2)	0.276

Values are n (%). Comparison was performed using Pearson Chi-square and Fisher's Exact test.

^aComparisons were done between abnormal vs. normal ECG groups.

ECG = electrocardiogram; CVD = cardiovascular disease; min. = minutes.

Figures

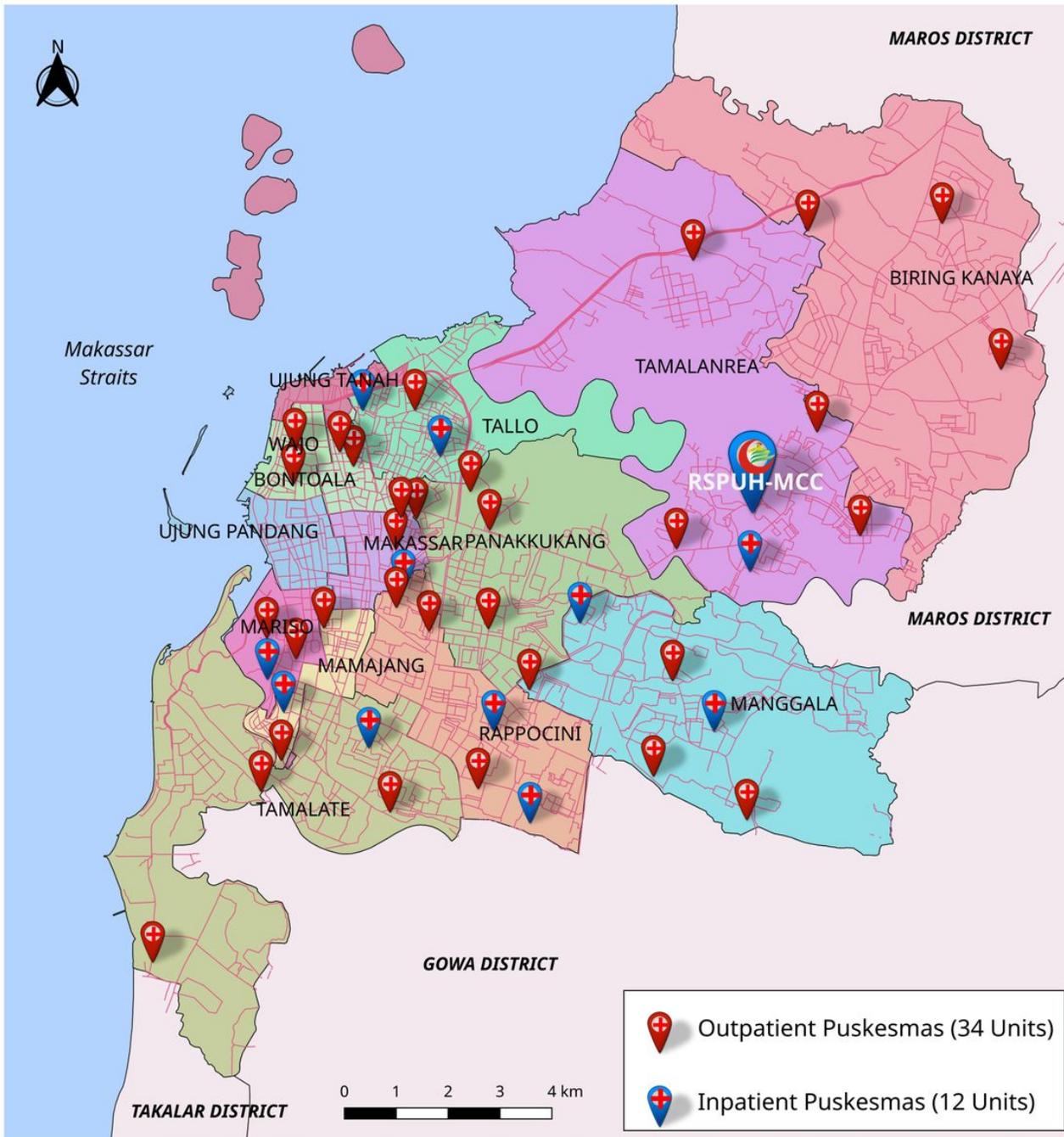


Figure 1

Primary care centers (Puskesmas) in Makassar City (199.3 km²). RSPUH = Rumah Sakit Pendidikan Universitas Hasanuddin (Hasanuddin University Hospital); MCC = Makassar Cardiac Center. Source: <https://tanahair.indonesia.go.id/portal-web/download/perwilayah> (freely usable).

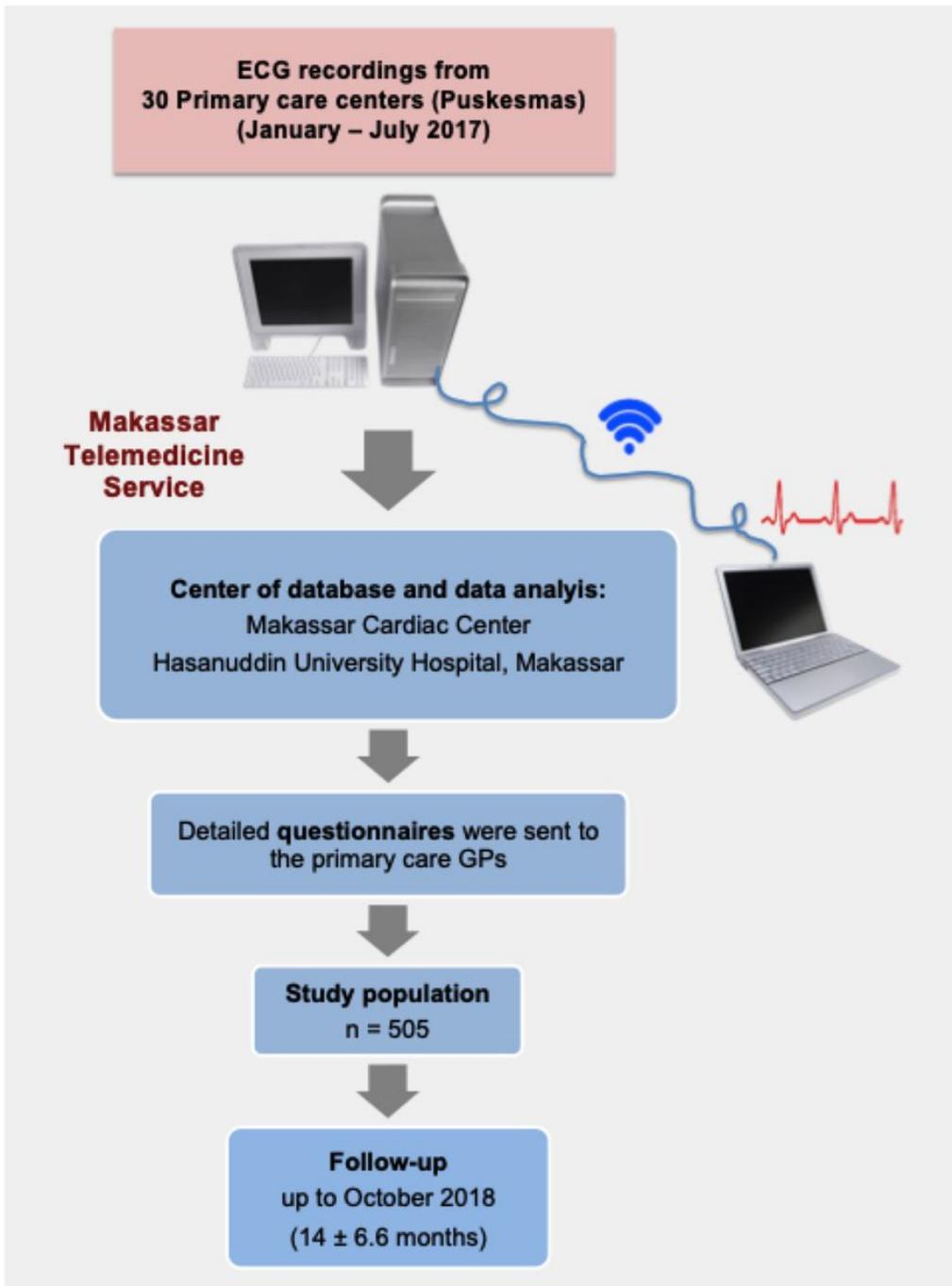


Figure 2

Flowchart of the study population ECG = electrocardiogram; Puskesmas = Pusat Kesehatan Masyarakat; GP = General Practitioner

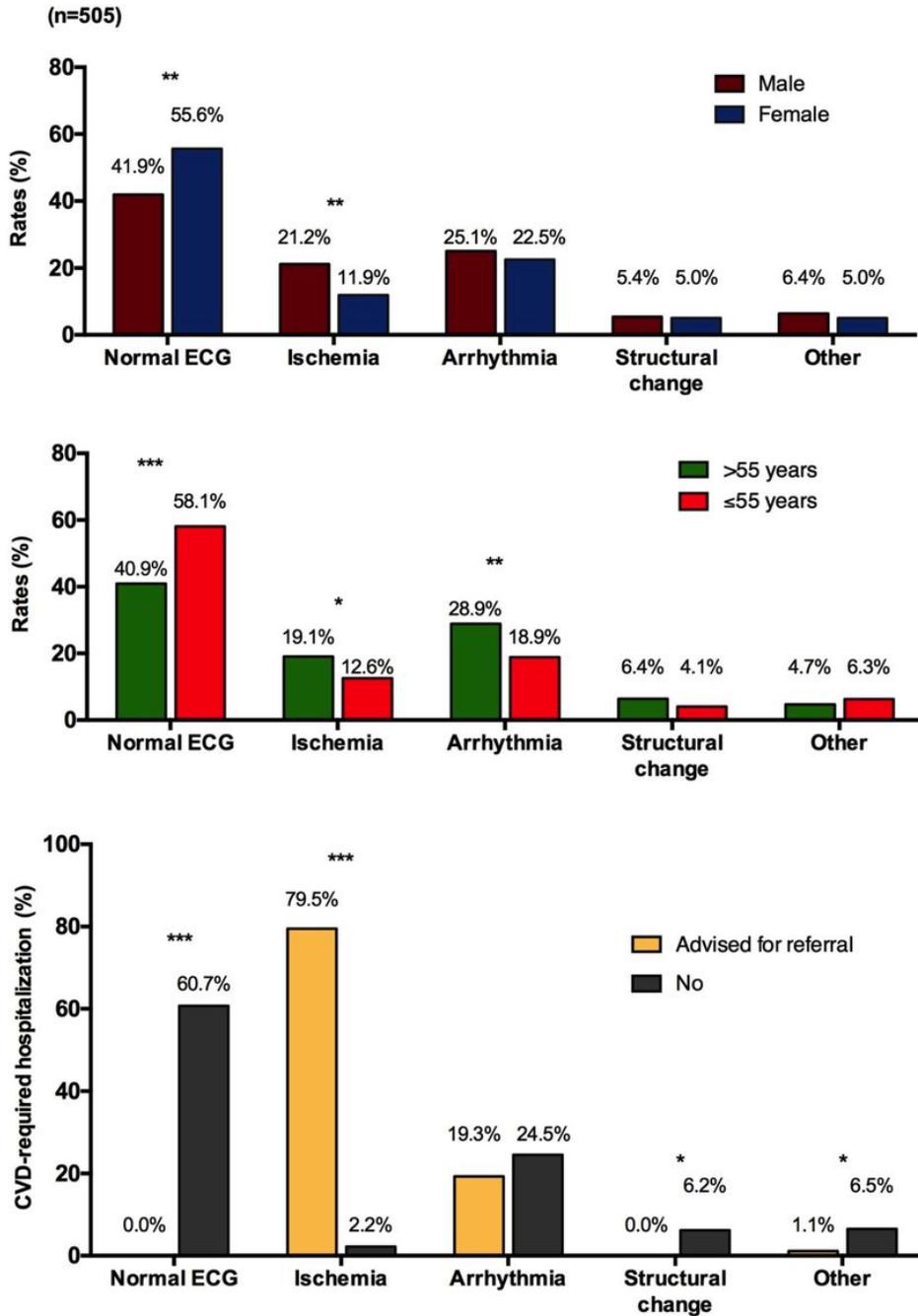


Figure 3

Distribution of ECG findings in the study population, according to age, gender, and advised for referral *p<0.05; **p<0.01; ***p<0.001

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [QuestionnaireandConsentFormteleECGPrimaryCare.pdf](#)
- [BMCFFig.S1b.png](#)
- [BMCFFig.S1a.png](#)