Supplementary Information for “A systematic review of healthcare provider-targeted mobile applications for non-communicable diseases in low- and middle-income countries”

Supplementary Table 1. Search Strategies

| Date of search | Database          | Dates range | Search strategy                                                                                                                                 |
|----------------|-------------------|-------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| 07.10.2019     | Pubmed            | 2007-2019   | 2007:2019 [dp] (smartphone [mesh] OR smartphone [tiab] OR smart phone* [tiab] OR mobile phone* [tiab] OR mobile device* [tiab] OR cell phone* [tiab] OR tablet [mesh] OR tablet [tiab] OR tablets [tiab] OR "portable device" [tiab] OR ipad OR iphone* OR "android" OR iPhone Operating System) AND ("app" [tiab] OR "apps" [tiab] OR application [tiab] OR applications [tiab] OR mobile application* [tiab] OR software [tiab] OR tool [tiab]) AND (diagnosis [mesh] OR diagnose [tiab] OR diagnosed [tiab] OR diagnosis [tiab] OR diagnosis [tiab] OR diagnoses [tiab] OR diagnostic [tiab] OR diagnostics [tiab] OR screening [mesh] OR screening [tiab] OR screen [tiab] OR screened [tiab] OR screens [tiab] OR monitor [tiab] OR monitors [tiab] OR monitoring [tiab] OR monitored [tiab]) Timespan: 2007-2019. |
| 07.10.2019     | Web of Science    | 2007-2019   | (smartphone [mesh] OR smartphone OR smart phone* OR mobile device* OR mobile phone* OR mobile device* OR cell phone* OR tablet [mesh] OR tablet OR tablets OR ipad OR iphone* OR "android" OR iPhone Operating System) AND TOPIC: ("app" OR "apps" OR application OR applications OR mobile application* OR software OR tool) AND TOPIC: (diagnosis [mesh] OR diagnose OR diagnosed OR diagnosis OR diagnoses OR diagnostic OR diagnostics OR screening [mesh] OR screening OR screen OR screened OR screens OR monitor [mesh] OR monitor OR monitors OR monitoring OR monitored) Timespan: 2007-2019. |
| 30.09.2019     | Cochrane Central  | 2007-2019   | ((smartphone OR smart phone* OR mobile phone* OR mobile device* OR cell phone* OR tablet OR tablets OR iphone or iPhones OR "android" OR iPhone Operating System OR ipad):ti,ab,kw AND ("app" OR "apps" OR application OR applications OR mobile application* OR software OR tool):ti,ab,kw AND ((diagnose OR diagnosed OR diagnosis OR diagnoses OR diagnostic OR diagnostics OR screening OR screen OR screened OR screens OR monitor OR monitors OR monitoring OR monitored)):ti,ab,kw |
## Supplementary Table 2. Themes and Categories

| THEMES       | SUBTHEMES                | CATEGORIES                        | DEFINITIONS OR SUBCATEGORIES                                                                 |
|--------------|---------------------------|-----------------------------------|---------------------------------------------------------------------------------------------|
| **Epidemiology** | Medical Specialties       | Cardiology                        | Medical specialty concerned with the study of the heart, its physiology, and its functions. |
|              |                           | Ophthalmology and Otorhinolaryngology | A surgical specialty concerned with the structure and function of the eye and the medical and surgical treatment of its defects and diseases. / A surgical specialty concerned with the study and treatment of disorders of the ear, nose, and throat. |
|              |                           | Neurology                         | A medical specialty concerned with the study of the structures, functions, and diseases of the nervous system. |
|              | General Medicine          |                                   |                                                                                             |
|              | Maternal and Child Healthcare |                                   | The medical specialties concerned with the physiology and disorders primarily of the female genital tract, as well as female endocrinology and reproductive physiology, and maintaining health and providing medical care to children from birth to adolescence. |
|              | Dermatology                |                                   | A medical specialty concerned with the skin, its structure, functions, diseases, and treatment. |
|              | Endocrinology              |                                   | A subspecialty of internal medicine concerned with the metabolism, physiology, and disorders of the endocrine system. |
|              | Hematology                 |                                   | A subspecialty of internal medicine concerned with morphology, physiology, and pathology of the blood and blood-forming tissue/ the dynamics of blood flow. |
|              | Oncology                   |                                   | A subspecialty of internal medicine concerned with the study of neoplasms.                    |
|              | Psychiatry                 |                                   | The medical science that deals with the origin, diagnosis, prevention, and treatment of mental disorders. |
|              | Orthopedics and Traumatology |                                   | A specialty which utilizes medical, surgical, and physical methods to treat and correct deformities, diseases, and injuries to the skeletal system, its articulations, and associated structures. |
|              | Pulmonary Medicine         |                                   | A subspecialty of internal medicine concerned with the study of the respiratory system. It is especially concerned with diagnosis and treatment of diseases and defects of the lungs and bronchial tree. |
|              | Nutrition and Sports Medicine |                                   | The field of medicine concerned with physical fitness and the diagnosis and treatment of injuries sustained in exercise and sports activities, as well as nutrition processes during exercise and athletic performance, nutritional requirements of athletes and the relationship between nutritional status and nutrition disorders in athletes. |
|              | Surgery and Anesthesiology |                                   | Involves various branches of surgical practice limited to specialized areas in the human anatomy, alongside the study of anesthetics and anesthesia. |
|              | Rheumatology               |                                   | A subspecialty of internal medicine concerned with the study of inflammatory or degenerative processes and metabolic derangement of connective tissue structures which pertain to a variety of musculoskeletal disorders, such as arthritis. |
|              | Allergology and Immunology |                                   | A medical specialty concerned with the hypersensitivity of the individual to foreign substances and protection from the resultant infection or disorder. |
|              | Nephrology and Urology     |                                   | Subspecialties concerned with the anatomy, physiology, and pathology of the kidney and concerned with the study, diagnosis, and treatment of diseases of the urinary tract in both sexes, and the genital tract in the male. |
| **Technology** | Type of Mobile Device*     | Armband/Smartwatch                 | Wearable computers in the forms of a watch or a band usually wrist worn.                      |
|              | Smartphones                |                                   | A cell phone that includes additional software functions (such as email or an Internet browser) |
|              | Mobile Phones              |                                   | A portable, usually cordless, telephone for use in a cellular system                           |
|              | Tablets                    |                                   | A mobile computing device that has a flat, rectangular form like that of a magazine or pad of paper, that is usually controlled by means of a touch screen, and that is typically used for accessing the Internet, watching videos, playing games, reading electronic books, etc. |
|              | iPod Devices               |                                   | A small electronic device for playing and storing digital audio and video files, proprietary of Apple Inc. |
| Operating System | iPhone Operating System | Mobile operating system created and developed by Apple Inc. exclusively for its hardware. |
|------------------|-------------------------|------------------------------------------------------------------------------------------|
| Operating System | Android | Mobile operating system based on a modified version of the Linux kernel and other open-source software, designed primarily for touchscreen mobile devices such as smartphones and tablets. |
| Operating System | Windows | A group of several proprietary graphical operating system families, all of which are developed and marketed by Microsoft and targeted to different devices, ranging from Personal Computers to Mobile Phones. |
| Operating System | Blackberry | A proprietary mobile operating system developed by Canadian company BlackBerry Limited for its BlackBerry line of smartphone handheld devices. |
| Operating System | MultiPhone Operating System | Applicable to technologies that work on multiple operating systems. |
| Operating System | Others | Includes HTML5, MIDet Implementation of JM2E using NetBeans 5.5, Symbian, Tiny OS Platform. |
| Use of Accessories | Yes/No | Use or not of accessories additional to the mobile technology to achieve its purpose (i.e., electrodes, cellphone attachments, small screens, blood pressure cuffs, additional light sources, straps or bands, lenses, headphones). |
| Cost | Ranges of $ | 0-20 USD, 21-100 USD, >100 USD, or Not specified or not costing assigned yet. Some costs in different currencies were converted to USD dollars using Google at April 2021 rates of conversion. |

**METHODOLOGY**

| Author Affiliation | North America | Canada, USA |
|--------------------|---------------|-------------|
| Author Affiliation | South America | Brazil, Colombia |
| Author Affiliation | Europe | Austria, Belgium, Denmark, England, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Lithuania, Netherlands, Poland, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom |
| Author Affiliation | Africa | Cameroon, Madagascar, Nigeria, Rwanda, South Africa, Uganda, Zambia |
| Author Affiliation | Asia | Bangladesh, Bhutan, China, Hong Kong, India, Indonesia, Iran, Israel, Japan, Nepal, Republic of Korea, Singapore, South Korea, Taiwan, United Arab Emirates |
| Author Affiliation | Oceania | Australia, New Zealand |
| Author Affiliation | Multinational | Including several countries in the same study, either as collaborators or as study settings. |

| Year of Publication | Year Ranges | 2006-2008, 2009-2011, 2012-2014, 2015-2017, 2018-2020 |
| Study Design | Randomized Clinical Trials | A study design that randomly assigns participants into an experimental group or a control group. As the study is conducted, the only expected difference between the control and experimental groups in a randomized controlled trial (RCT) is the outcome variable being studied. |
|-------------|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|             | Observational Cohort      | Studies where researchers observe the effect of the studied technology without trying to change who is or isn’t exposed to it.                                                                                         |
|             | Studies/Case Control       | Studies where researchers observe the effect of the studied technology without trying to change who is or isn’t exposed to it.                                                                                         |
|             | Case Series/Case Reports   | A detailed report of the implementation of a technology in the diagnosis, monitoring or screening of an individual patient. A case series is group of case reports involving patients that were assisted in the diagnostic process by the same technology. |
|             | Diagnostic Accuracy Study  | A study that provides evidence on how well a technology correctly identifies or rules out disease and informs subsequent decisions about treatment for clinicians, their patients, and healthcare providers. |
|             | Qualitative                | Studies that collected and analyzed non-numerical data (e.g., text, video, or audio) to understand concepts, opinions, or experiences.                                                                            |
|             | Technical Description/Testing | A technical description describes a technology in terms of its function, organization, parts and details, without using a study design framework to do so.                                                      |

Sources: NCBI Mesh Medical Specialties¹, “Research Design: Qualitative, Quantitative, and Mixed Methods Approaches” Book².

¹An algorithm for the classification of study designs to assess diagnostic, prognostic, and predictive test accuracy in systematic reviews³

1. Medicine - MeSH - NCBI [Internet]. [cited 2021 May 13]. Available from: https://www.ncbi.nlm.nih.gov/mesh/?term=medical+specialties
2. Creswell JW. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. SAGE Publications; 2009. 297 p.
3. Mathes T, Pieper D. An algorithm for the classification of study designs to assess diagnostic, prognostic, and predictive test accuracy in systematic reviews. Systematic Reviews. 2019 Sep 3;8(1):226.
## Supplementary Table 3. Studies that include 10 most common diseases in database (n=121)

| Diseases | Title | Authors | Disease RF | Clinical Domain | Aim | Type of Intervention | Mobile | Operating System | Study Population | Methods | Stage of Development | Cost | Year | Author Affiliation |
|----------|-------|---------|------------|----------------|-----|----------------------|--------|-------------------|-----------------|---------|---------------------|------|------|---------------------|
| Arrhythmia s (N=40) | Pit-a-Pat: A Smart Electrocardiogram System for Detecting Arrhythmia. | Jayeun Park, Kuyeon Lee, Kyungtae Kang | Arrhythmia | Cardiology | Monitoring | Mobile application | Smartphone | Android | MIT-BIH Arrhythmia database | Technical Testing | Developed | Not specified | 2015 | South Korea |
| | Diagnostic Performance of a Smart Device With Photoplethysmograph y Technology for Atrial Fibrillation Detection: Pilot Study (Pro-mAFA II Registry). | Fan, Y. et al. | Atrial Fibrillation | Cardiology | Diagnosis | Smartphone application | Smartphones (HUAWEI Mate 9, HUAWEI Honor TX), smart bands (HUAWEI Band 2) | Android | Consecutive inpatients were recruited from the Chinese People’s Liberation Army General Hospital (Beijing, China) from March 15 to April 1, 2018 | Pretest/Posttests | Developed | Not specified | 2019 | China |
| | Atrial Fibrillation Detection via Accelerometer and Gyroscope of a Smartphone | Lahdenoja, O. et al. | Atrial Fibrillation | Cardiology | Diagnosis | Smartphone application | Sony X-peria Z-series, Samsung Galaxy S5 | Android | AFib patients and healthy controls | Experimental | Developed | Not specified | 2016 | Finland |
| | Real-time ECG monitoring and arrhythmia detection using Android-based mobile devices. | Gradl, S. et al. | Atrial Fibrillation | Cardiology | Monitoring | Mobile application | Smartphone - Samsung GT-I9000, Samsung GT-N7000, HTC Wildfire S A510e | Android | MIT-BIH Arrhythmia and the MIT-BIH Supraventricular databases. | Experimental | Prototype | Not specified | 2014 | Germany |
| | Smartphone electrographic monitoring for atrial fibrillation in acute ischemic stroke and transient ischemic attack | Tu, H. et al | Paroxysmal atrial fibrillation | Cardiology | Monitoring | Smartphone application | iPhone | Android and iPhone Operating System | Patients with ischemic stroke or transient ischemic attack (TIA) without known AF, Age>18 years | Experimental | Proof of principle | Not specified | 2017 | Multinational |
| | Contact-Free Screening of Atrial Fibrillation by a Smartphone Using Facial Pulsatile Photoplethysmograph ic Signals | Bryan P Yan, et al | Atrial fibrillation | Cardiology | Screening | Smartphone app | Smartphone | iPhone Operating System | Sample of 217 subjects | Experimental | Developed | Not specified | 2018 | United States |
| | Diagnostic Accuracy of a Novel Mobile Phone Application for the Detection and Monitoring of Atrial Fibrillation | Guy Rosen | Atrial fibrillation | Cardiology | Screening | Smartphone application | Smartphone | iPhone Operating System | Patients with atrial fibrillation | Experimental | Developed | Not specified | 2018 | United States |
| | Atrial fibrillation screening in pharmacies using an iPhone ECG: a qualitative review of implementation | Nicole Lawres, Ines Krass, Lis Neubeck et al | Atrial fibrillation | Cardiology | Screening | Smartphone application | Smartphone | iPhone Operating System | Pharmacists that had been present during a previous study called SEARCH AF, from 10 pharmacies in Sydney, Australia | Experimental | Available | Not specified | 2015 | Australia |
| | Passive Detection of Atrial Fibrillation Using a Commercially Available Smartwatch | Tyson, G.H. et al. | Atrial fibrillation | Cardiology | Diagnosis | Mobile application | Apple watches | iPhone Operating System | Health eHeart Study participants with an Apple Watch | Experimental | Developed | Not specified | 2018 | United States |
| | Self-monitoring for atrial fibrillation recurrence in the discharge period post-cardiac surgery using an iPhone electrocardiogram | Lawres, N. et al. | Atrial fibrillation | Cardiology | Monitoring | Smartphone-based wireless single-lead ECG (SL-ECG) | Smartphone | iPhone Operating System | Patients with POAF following cardiac surgery | Observational | Developed | Not specified | 2016 | Australia |
| iPhone ECG application for community screening to detect silent atrial fibrillation: a novel technology to prevent stroke | Lau, J. et al. | Atrial fibrillation | Cardiology | Screening | Smartphone application | iPhone Operating System | Learning set and validation set of patients | Pretest/Posttest | Developed | Not specified | 2013 | Australi a |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Feasibility and cost-effectiveness of stroke prevention through community screening for atrial fibrillation using iPhone ECG in pharmacies: The SEARCH-AF study | Lawres, N. et al. | Atrial fibrillation | Cardiology | Screening | Smartphone application | iPhone Operating System | Pharmacy customers aged ≥65 years | Observational | Developed | Not specified | 2014 | Multinational |
| Screening for atrial fibrillation in 13,122 Hong Kong citizens with smartphone electrocardiogram | Chan, N. & Choy, C. | Atrial fibrillation | Cardiology | Screening | Smartphone-based wireless single-lead ECG (SL-ECG) | iPhone Operating System | Hong Kong citizens | Experimental | Developed | Not specified | 2016 | China |
| Diagnostic Accuracy of a Novel Mobile Phone Application for the Detection and Monitoring of Atrial Fibrillation | Rozen, G. et al. | Atrial fibrillation | Cardiology | Diagnosis/ Monitoring | Smartphone application | iPhone Operating System | Patients | Experimental | Developed | Not specified | 2018 | Multinational |
| Can smartphone wireless ECGs be used to accurately assess ECG intervals in pediatrics? A comparison of mobile health monitoring to standard 12-lead ECG. | Gropler, M. et al. | Arrhythmia | Cardiology | Monitoring | Wireless mobile health (mHealth) device | iPhone Operating System | Pediatric outpatients age <18 years presenting for cardiology clinic visits. 3 groups based on age: 0–5 years, 6–10 years, and 11–18 years. | Experimental | Developed | Not specified | 2018 | United States |
| A Smartphone Application to Diagnose the Mechanism of Pediatric Supraventricular Tachycardia | Fredman, D., Liberman, L., Silver, E. | Pediatric Supraventricular tachycardia | Cardiology | Diagnosis | Smartphone application | iPhone Operating System | Pediatric patients undergoing an ablation for SVT | Experimental | Developed | Not specified | 2015 | United States |
| A single center randomized, controlled trial investigating the efficacy of a mHealth ECG technology intervention to improve the detection of atrial fibrillation: the iHEART study protocol | Hickey, K.T. et al. | Atrial fibrillation | Cardiology | Diagnosis | Smartphone application | iPhone Operating System | Participants with a recent history of atrial fibrillation | Experimental | Developed | Not specified | 2016 | United States |
| Smart detection of atrial fibrillation | Krivoshe, L. et al. | Atrial fibrillation | Cardiology | Screening | Smartphone application | iPhone Operating System | Consecutive in-and outpatient at the University Hospital Basel | Experimental | Developed | Not specified | 2016 | Multinational |
| Detection of atrial fibrillation with a smartphone camera: first prospective, international, two-centre, clinical validation study (DETECT AF PRO) | Brasier, N. et al. | Atrial fibrillation | Cardiology | Diagnosis | Smartphone camera-based application | iPhone Operating System | In-house patients with presumed AF and matched controls SR | Experimental | Developed | Not specified | 2018 | Multinational |
| Mobile Phone-Based Use of the Photoplethysmograph y Technique to Detect Atrial Fibrillation in Primary Care: Diagnostic Accuracy Study of the FibrCheck App | Proesmans, T. et al. | Atrial fibrillation | Cardiology | Screening | Mobile phone application | iPhone Operating System | Patients aged 65 years and above, with or without a known history of AF, were recruited from 17 primary care facilities. Patients with an active pacemaker | Pretest/Posttest | Developed | Not specified | 2018 | Belgium |
| Study Title                                                                 | Authors                          | Field                      | Technology       | Platform                      | Patients Excluded                                                                 | Study Design       | Status       | Year         | Country     |
|---------------------------------------------------------------------------|----------------------------------|----------------------------|------------------|-------------------------------|-----------------------------------------------------------------------------------|--------------------|--------------|--------------|-------------|
| Contact-free screening of atrial fibrillation by a smartphone using facial pulsatile photoplethysmograph ic signals | Yan, B. P. et al.                | Cardiology Screening      | Smartphone app   | iPhone Operating System       | Patients admitted to the cardiology ward of the hospital for clinical reasons     | Experimental       | Developed   | 2018         | Multinational |
| Diagnostic Performance of a Smartphone-Based Photoplethysmograph ic Application for Atrial Fibrillation Screening in a Primary Care Setting | Chan, P. et al.                 | Cardiology Screening      | Smartphone app   | iPhone Operating System       | Patients with hypertension, with diabetes mellitus, and/or aged ≥65 years         | Pretest/Posttest   | Developed   | 2016         | Hong Kong   |
| Performance and Usability of a Novel Smartphone Application for Atrial Fibrillation Detection in an Ambulatory Population Referred for Cardiac Monitoring | Sardana, M. et al.              | Cardiology Diagnosis      | Smartphone app   | iPhone Operating System       | Ambulatory patients, referred for cardiac event monitoring for cryptogenic stroke or suspected AF | Experimental       | Not specified | 2016         | United States |
| Smartwatch Algorithm for Automated Detection of Atrial Fibrillation        | Bumgarner, J. M. et al.          | Cardiology Diagnosis      | Apple smartwatch | iPhone Operating System       | Consecutive patients with a diagnosis of AF who presented for scheduled elective CV with or without a planned transesophageal echocardiogram | Experimental       | Prototype    | 2018         | United States |
| A novel application for the detection of an irregular pulse using an iPhone 4S in patients with atrial fibrillation | McMamus, D.D. et al.            | Cardiology Diagnosis      | Smartphone app   | iPhone Operating System       | Adults with persistent AFib                                                      | Experimental       | Prototype    | 2013         | United States |
| Atrial fibrillation detection using an iPhone 4S                            | Lee, J. et al.                  | Cardiology Diagnosis      | Smartphone app   | iPhone Operating System       | AF subjects undergoing electrical cardioversion                                  | Experimental       | Prototype    | 2013         | United States |
| Arrhythmia discrimination using a smartphone                               | Chong, J. W. et al.             | Cardiology Diagnosis      | Smartphone app   | iPhone Operating System       | Subjects with PVC and AC subjects as well as AF pre- and post-electrical cardioversion | Experimental       | Prototype    | 2013         | United States |
| PULSE-SMART: Pulse-Based Arrhythmia Discrimination Using a Novel Smartphone Application | DAVID D. McMANUS, JO WOON CHONG, APURV SONE | Arrhythmia Diagnosis    | Mobile app        | iPhone Operating System       | Patients with both benignant and malignant causes of irregular pulse               | Pretest/Posttest   | Validation   | 2016         | United States |
| The RITMIA+ Smartphone App for Automated Detection of Atrial Fibrillation: Accuracy in Consecutive Patients Undergoing Elective Electrical Cardioversion | Claudio Revesberi               | Cardiology Monitoring     | RITMIA App        | Smartphone                    | Patients with atrial fibrillation                                                | Observational      | Developed    | 2019         | Italy        |
| Study on Real-time Monitoring Technique for Cardiac Arrhythmia Based on Smartphone | Weng J, et al.                  | Cardiology Diagnosis/ Monitoring | Software for an ECG monitoring system on a smartphone platform | Smartphone                    | None                                                                              | Technical testing | Not specified | 2012         | China        |
| Novel Methods of Faster Cardiovascular Diagnosis in Wireless Telecardiology | Sufi, F. et al.                 | Cardiology Diagnosis/ Monitoring | Generic ECG compression algorithm suitable for Mobile phones | Midlet implementation of J2ME using | None                                                                              | Technical testing | Prototype    | 2009         | Australia    |
| Study Title                                                                                                   | Devices Used                                                                                      | Primary Outcomes                                                                 | Study Design                          | Funding                      | Year   | Country     |
|----------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|---------------------------------------|------------------------------|--------|-------------|
| Excellent Symptom Rhythm Correlation in Patients with Palpitations Using A Novel Smartphone Based Event Recorder | William George Newnham, Muzahir Hassan Tayebjee                                                  | Cardiology Diagnosis Mobile application Smartphone                                | Not specified                         | Patients with palpitations  | 2017    | United Kingdom |
| Continuous heart rate monitoring for automatic detection of atrial fibrillation with novel bio-sensing technology | Hochstad, A. et al.                                                                                | Cardiology Diagnosis PPG Wrist-watch sensor Custom-made wearable photo-plethysmograph [PPG] wrist-watch sensor | Not specified                         | Patients undergoing elective cardioversion of AF | 2018    | Israel      |
| Smart watches for heart rate assessment in atrial arrhythmias                                                | Kosky, A.N. et al.                                                                                | Cardiology Monitoring Smartwatch software FitBit (FB), Apple Watch (AW)            | Not specified                         | Hospitalized patients        | 2018    | Australia   |
| Detection of premature ventricular contractions using the RR-interval signal: a simple algorithm for mobile devices | Cuesta, P. et al.                                                                                 | Cardiology Diagnosis Algorithm for mobile devices Mobile devices                  | Not specified                         | Free application             | 2014    | Spain       |
| Assessing the accuracy of an automated atrial fibrillation detection algorithm using smartphone technology: The iREAD Study | William, A.D. et al.                                                                              | Cardiology Diagnosis Smartphone-coupled monitor Smartwatch coupled monitor          | Not specified                         | Consecutive patients with AF admitted for antiarrhythmic drug initiation | 2018    | United States |
| Diagnostic utility of smartphone ECG technology in the initial investigation of palpitations                  | Dimarco, A.D. et al.                                                                              | Cardiology Diagnosis Smartphone application Smartphones                            | Not specified                         | Subjects of legal age        | 2019    | United Kingdom |
| Trial design of the WATCH AF trial - SmartWATCHes for detection of atrial fibrillation                        | Deener, M. et al.                                                                                 | Cardiology Diagnosis Smartwatch software Smartwatch couple (Samsung) and a wristband (Wavelet health) | Not specified                         | Experimental                 | 2017    | Germany     |
| Automated Real-Time Atrial Fibrillation Detection on a Wearable Wireless Sensor Platform                     | Francisco Rincan                                                                                  | Cardiology Monitoring Wearable device Wearable wireless sensor                      | Not specified                         | Technical testing             | 2012    | Multinational          |
| Atrial Fibrillation Detection Using a Novel Cardiac Ambulatory Monitor Based on Photo-Plethysmography at the Wrist | Bonomi, A.G. et al.                                                                               | Cardiology Diagnosis/ Monitoring Wrist-wearable device                             | Not specified                         | AF patients undergoing electrical cardioversion (ECV) and AF patients that were prescribed for 24 hours ECG Holter in outpatient settings (HOL) | 2018    | Netherlands |
| Parkinson’s disease and essential tremor classification on mobile device                                     | Alan Michael Woods et al                                                                         | Neurology Diagnosis/ Screening App on smartphone Smartphone Android                  | Fourteen participants diagnosed with PD and eighteen participants with ET undertook our study | Technical testing             | 2014    | New Zealand  |
| Study Title                                                                 | Authors                                                                 | Type                                                   | Participants                                                                 | Setting                                                                 | Outcome                                                                 | Year | Country  |
|---------------------------------------------------------------------------|-------------------------------------------------------------------------|-------------|----------------------------------------------------------------------------|------------------------------------------------------------------------|------------------------------------------------------------------------|------|----------|
| Wireless tremor through a Parkinson’s disease                             | Fraiwan, L. et al.                                                      | Experimental| PD patients and healthy controls                                          | Developed                                                              | Not specified                                                          | 2016 | United Arab Emirates |
| Predicting motor, cognitive & functional impairment in Parkinson’s        | Christine Lo, Siddibarth Arora, Fahad Baig et al.                       | Experimental| Participants being ascribed a probability of Parkinson’s of at least 90% by trained researchers at their latest clinic assessment | Developed                                                              | Not specified                                                          | 2019 | United Kingdom |
| A Smartphone Application for Automated Decision Support in Cognitive Task Based Evaluation of Central Nervous System Motor Disorders. | Lauritatis, A. et al.                                                  | Technical   | Individuals with PD diagnosed clinically by a movement disorder specialist and control participants | Developed                                                              | Free on Google Play Store                                               | 2019 | Lithuania |
| Detecting and monitoring the symptoms of Parkinson’s disease using smartphones: A pilot study | Aorea, S. et al.                                                        | Pilot       | 24 people diagnosed with Parkinson’s and 27 healthy controls              | Developed                                                              | Pilot study                                                            | 2015 | Multinational |
| A Mobile Cloud-Based Parkinson’s Disease Assessment System for Home-Based Monitoring | Pan, D. et al.                                                         | Prototype   | PD Patients                                                                | Developed                                                              | Not specified                                                          | 2015 | United States |
| Parkinson’s Disease Classification of mPower Walking Activity Participants | Benjamin Pittman                                                       | Developed   | Volunteers                                                                | Developed                                                              | Not specified                                                          | 2018 | United States |
| A Smartphone-Based Tool for Assessing Parkinsonian Hand Tremor             | Kostikis, N. et al.                                                    | Developed   | PD patients and age-matched healthy volunteers                            | Developed                                                              | Not specified                                                          | 2015 | Greece    |
| Validating an iPhone Operating System-based rhythmic auditory cuing evaluation (iRACE) for Parkinson’s disease | Zhu, S. et al.                                                         | Experimental| PD Patients                                                                | Developed                                                              | Not specified                                                          | 2014 | Singapore |
| A validated smartphone-based assessment of gait and gait variability in Parkinson’s disease | Ellis, R.J. et al.                                                     | Developed   | PD patients and healthy controls                                          | Developed                                                              | Not specified                                                          | 2015 | Singapore |
| Parkinson’s Disease Classification of mPower Walking Activity Participants | Pittman, R. et al.                                                    | Developed   | Parkinson’s disease                                                       | Developed                                                              | Not specified                                                          | 2018 | United States |
| Implementation of an iPhone for characterizing Parkinson’s disease tremor through a wireless device | Robert LeMoyne et al.                                                 | Experimental| One Parkinson disease diagnosed patient and a control individual          | Experimental                                                            | Not specified                                                          | 2010 | United States |
| Retinal Diseases (N=14) | Singh, S. and Xu, W. | Parkinson’s Disease | Neurology | Diagnosis | Smartphone application | iPhone Operating System | Unique participants | Experimental | Developed | Not specified | 2019 | United States |
|------------------------|---------------------|---------------------|-----------|----------------|------------------------|------------------------|-------------------|--------------|----------|---------------|------|----------------|
| Computed spiral analysis using the iPad | Sisti, J. A. et al. | Movement Disorders (essential tremor, Parkinson’s Disease, dystonia, etc.) | Neurology | Monitoring | CSA Ipad Application | Tablet | iPhone Operating System | Healthy controls and patients with moving disorders | Experimental | Developed | Not specified | 2016 | United States |
| Non-Contact Human Gait Identification through IR-UWB Edge Based Monitoring Sensor | Soumya Prakash Rana | Parkinson’s Disease | Neurology | Monitoring | UWB pulsed radar | UWB P410 radar module | Not specified | Test subjects | Technical testing | Developed | Not specified | 2019 | England |
| Parkinson’s disease and essential tremor classification on mobile device | Wood, A. M. et al. | Parkinson’s Disease | Neurology | Diagnosis | Smartphone application | Smartphone | Not specified | Participants diagnosed with PD and with ET | Experimental | Prototype | Not specified | 2014 | New Zealand |
| An intelligent mobile based decision support system for retinal disease diagnosis | Bourouis, A. et al. | Retinal disease | Ophthalmology | Diagnosis | Smartphone based intelligent system | Smartphone | Android | Test images | Experimental | Developed | Not specified | 2014 | Multinational |
| Decision Support Systems for Detection of Diabetic Retinopathy Using Smartphones | Prasanna, P. et al. | Diabetic Retinopathy | Ophthalmology | Screening | Smartphone application | Smartphone | Android | None | Technical testing | Developed | Not specified | 2013 | United States |
| Enduring eye care with smartphones aiding real time diagnosis. | Sudhakar, M. S. & Bhoopathy Ragan K. | Retinal pathologies | Ophthalmology | Diagnosis | Add-on for smartphones | Smartphone | Android | None | Technical testing | Developed | Not specified | 2014 | India |
| Wide-field smartphone fundus video camera based on miniaturized indirect ophthalmoscopy | Tosak, D. D et al | Retinal disease | Ophthalmology | Screening | Smartphone application | Smartphone | Android | Subjects without eye diseases | Technical testing | Proof of principle | Not specified | 2018 | Multinational |
| Smartphone-Based Accurate Analysis of Retinal Vasculature towards Point-of-Care Diagnostics | Xiuya Xu et al | Diabetic retinopathy, various diseases | Ophthalmology | Diagnosis | Android app | Smartphone | Android | 40 funduscopic from a data base and 10 healthy patients | Experimental | Developed | Not specified | 2016 | China |
| Retinal imaging with smartphone. | Ademola Popoola, D., Olatunji, V. | Retinal diseases | Ophthalmology | Diagnosis | Smartphone camera for retinal imaging | Smartphone | Blackberry | Patients aged between 15 months and 61 years with various diagnosis. | Experimental | Tested in clinical practice | Not specified | 2017 | Nigeria |
| Automatic diabetic retinopathy diagnosis using adjustable ophthalmoscope and multi-scale line operator | Qu, M. et al. | Diabetic retinopathy | Ophthalmology | Diagnosis/Screening | Smartphone ophthalmoscop e | Smartphone | iPhone Operating System | Patients after pupil dilation | Prototype | In development | Not specified | 2017 | China |
| MII RetCam assisted smartphone-based fundus imaging for retinopathy of prematurity | Lekha, T. et al. | Retinopathy of prematurity | Ophthalmology | Diagnosis/ Monitoring | Smartphone add-on | Smartphone | iPhone Operating System | All the preterm babies subjected to MSFI as part of ROP screening from September 2017 to November 2018 | Observational | Developed | MII RetCam device costs USD 380. | 2019 | India |
| Mobile phones for retinopathy of prematurity screening in Lagos, Nigeria, sub-Saharan Africa | Tunji S. Oluweye, Adefunke Rotimi-Samu el, Adetunji Adenekan | Retinopathy of prematurity | Ophthalmology | Screening | Mobile application | Smartphone | iPhone Operating System | Preterm infants with birthweight of less than 1.5 kg or gestational age of less than 32 weeks | Technical testing | Available in App Store | Not specified | 2016 | Nigeria |
| Hearing loss (N=13) | Smartphone Hearing Screening for School Children | Mohamed-Assmail, Faheem, De Wet, Eikelboom, Myburgh, Hall, James | Hearing loss | Otochinoiarynology | Screening | Mobile application | Smartphone | Android | School-age children from grade 1 to 3 with an average age of 8 years (±1 SD; range 5 to 12 years) were recruited from five public government schools in underserved regions of the Gauteng Province, South Africa. | Pretest/Posttest | Available | Not specified | 2015 | South Africa |
|---------------------|-------------------------------------------------|-----------------------|-------------|---------------------|----------|-------------------|-----------|---------|--------------------------|----------------|----------|------------------|-------|------------------|
| Hearing Tests Based on Biologically Calibrated Mobile Devices: Comparison With Pure-Tone Audiometry. | Marcin Masalski, MD, PhD; Tomasz Gryalsański, PhD (Eng); Tomasz Krecicki, PhD, MD | Hearing loss | Otochinoiarynology | Monitoring | Mobile application | Smartphone | Android | Patients of Otolaryngology Clinic | Pretest/Posttest | Available | Free | 2018 | Poland |
| Smartphone-Based Hearing Screening at Primary Health Care Clinics | Christine Louw, De Wet, Swaepoel, Eikelboom, et al. | Hearing loss | Otochinoiarynology | Screening | Mobile application | Smartphone | Android | Patients from two Primary Health Care Centers in Tshwane Province, South Africa. | Experimental | Available | Free | 2016 | South Africa |
| Extended High-Frequency Smartphone Audiometry: Validity and Reliability. | Bornman, M. et al. | Age-related hearing loss, noise-induced hearing loss (NIHL) and ototoxicity | Otochinoiarynology | Screening | Smartphone application | Samsung Galaxy Trend Neo | Android | Participants were recruited from adults attending the Audiology Department at Dr. George Mukhari Hospital, GaRankuwa, South Africa and from the University of Pretoria. | Experimental | Developed | Not specified | 2019 | Multinational |
| Community-based hearing screening for young children using an mHealth service-delivery model | Hussein, S. et al. | Hearing loss | Otochinoiarynology | Screening | Smartphone-based hearing screening program | Smartphone | Android | Children (3-6 years old) | Experimental | Developed | Not specified | 2018 | South Africa |
| Evaluation of the Hearing Test Pro Application as a Screening Tool for Hearing Loss Assessment. | Arena, Shaiba Kayode | Hearing loss | Otorhinolaryngology | Screening | Smartphone app as screening tool for hearing loss | Smartphone | Android | Adult android-phone users | Pretest/Postest | Available | Not specified | 2018 | Nigeria |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tablet-Based Hearing Screening Test | Alessandra G. Samelli | Hearing loss | Otorhinolaryngology | Screening | Tablet-based software | Apple Ipad and Dell Notebook PC | iPhone Operating System | Patients with diverse types of hearing loss | Observational | Developed | Not specified | 2017 | Brazil |
| Implementation of uHear™ – an iPhone Operating System-based application to screen for hearing loss - in older patients with cancer undergoing a comprehensive geriatric assessment | Michelle Lycka , Tom Roterbergh , Evi Martens et al | Presbycusis | Otorhinolaryngology | Screening | Mobile application | iPod, iPhone, iPad | iPhone Operating System | Older patients with cancer at the radiotherapy and oncology departments of the General Hospital Groeninge (Kortrijk, Belgium) from December 2014 till June 2015 | Pretest/Postest | Available | Not specified | 2016 | Belgium |
| Application-Based Hearing Screening in the Elderly Population | Leonid Livshitz, Reem Ghanayim, Carmi Krans et al | Presbycusis | Otorhinolaryngology | Screening | Mobile application | Tablet | iPhone Operating System | Patients 65 years of age or older hospitalized for any reason in an internal medicine department | Experimental | Available | Free | 2017 | United States |
| Initial assessment of hearing loss using a mobile application for audiological evaluation | Derin, S. et al | Hearing loss | Otorhinolaryngology | Diagnosis | Mobile application | Smartphone | iPhone Operating System | Patients with hearing loss | Pretest/Postest | Developed | Not specified | 2016 | Turkey |
| Smartphone-based audiometric test for screening hearing loss in the elderly | Abu-Ghanem, S. et al. | Hearing loss | Otorhinolaryngology | Screening | Smartphone app as screening tool for hearing loss | Smartphone - iPhone and Tablet - iPod, iPad | iPhone Operating System | Subjects aged 84.4 ± 6.73 years (mean ± SD) were recruited. | Pretest/Postest | Available | Free | 2015 | Israel |
| Hearing loss in the developing world: evaluating the iPhone mobile device as a screening tool. | Peer, S. & Fagan, J. | Hearing Loss (High risk: Presbycusis, HIV and TB Therapy, Chemotherapy) | Otorhinolaryngology | Screening | Smartphone application | Smartphone | iPhone Operating System | Participants recruited from the Otolaryngology Clinic, Groote Schuur Hospital, Cape Town, South Africa. | Pretest/Postest | Developed | Free | 2014 | South Africa |
| Hearing tests are just child’s play: the sound scout’s’ game for children entering school. | Dillon, H. et al. | Hearing loss | Otorhinolaryngology | Screening | Tablet-based hearing test | Tablet | iPhone Operating System or Android | Children (n=213) and adults (n=20) screened to have hearing thresholds of 20dB or better. | Experimental | Developed | Not specified | 2018 | United Kingdom |
| Melanoma and other skin lesion detection using smart handheld devices. | Gouridakis et al | Melanoma | Dermatology | Diagnosis | Mobile application | Smartphone | iPhone Operating System | None | Technical testing | Not specified | Not specified | 2014 | Spain |
| Cell phone usefulness to improve the skin cancer screening: preliminary results and critical analysis of mobile app development | Goulaert, C.E. et al. | Skin Cancer | Dermatology | Screening | Smartphone application | Smartphone | Android | Individuals monitored by routine skin cancer screening by the Cancer Prevention Department at Barretos Cancer Hospital during 2016. | Pretest/Postest | Developed | Not specified | 2019 | Brazil |
| Early melanoma diagnosis with mobile imaging | Do, T.-T. et al | Melanoma | Dermatology | Diagnosis | Smartphone application | Smartphone (Samsung Galaxy S4) | Android | NA | Technical testing | Prototype | Not specified | 2014 | Singapore |
| Skin Cancer Diagnostics with an All-Inclusive Smartphone Application | Kulwa, U. et al | Skin Cancer | Dermatology | Diagnosis | Smartphone application | Smartphone (Samsung S6) | Android | Images with Synthetic Minority Over-sampling Technique (SMOTE) and without SMOTE | Experimental | Prototype | Not specified | 2019 | United Kingdom |
| Mobile teledermoscopy. | Borve, Alexander | Skin cancer | Dermatology | Screening | Mobile app and customised dermoscope | Smartphone | iPhone Operating System | Patients with one or more suspicious skin | Experimental | Not specified | Not specified | 2013 | Sweden |
| Diabetes | (N=40) |
|-----------------|---------|
| **SkinScan©: A Portable Library for Melanoma Detection on Handheld Devices** | Wadhawan, T. et al | Melanoma | Dermatology | Screening | Smartphone application | Smartphone | iPhone Operating System | Not specified | Technical testing | Not specified | 2011 | United States |
| **Implementation of the 7-point checklist for melanoma detection on smart handheld devices** | Wadhawan, T. et al | Melanoma | Dermatology | Diagnosis | Smartphone application | Smartphone and iPad | iPhone Operating System | Not specified | Technical testing | Not specified | 2011 | United States |
| **SkinScan©: A portable library for melanoma detection on handheld devices** | Wadhawan, T. et al | Melanoma | Dermatology | Diagnosis | Smartphone application | iPhone 4, iPod, iPad and Android-based devices | iPhone Operating System | Artifacts free images | Experimental | Developed | Not specified | 2011 | United States |
| **Dermatologist-level classification of skin cancer with deep neural networks** | Esteva, A. et al | Skin cancer | Dermatology | Screening/ Diagnosis | Single convolutional neural network algorithms | Smartphone | Not specified | Clinical images including dermoscopy images | Pretest/Posttest | Developed | Not specified | 2017 | United States |
| **Mobile teledermatology for skin tumour screening: diagnostic accuracy of clinical and dermoscopic image tele-evaluation using cellular phones** | Kroemer, S. et al | Skin tumour | Dermatology | Screening | Telemedicine system | Nokia N73 | Not specified | Patients from the general outpatient clinic at the Department of Dermatology, Medical University of Graz, Graz, Austria | Experimental | Developed | Not specified | 2011 | Austria |
| **Melanoma Screening with Cellular Phones** | Massone, C. et al | Melanoma | Dermatology | Screening | Smartphone application | Sony Ericsson K750i | Not specified | Patients that attended the Pigmented Skin Lesions Clinic of the Department of Dermatology, Medical University of Graz during two routine working days. | Experimental | Proof of principle | Not specified | 2007 | Austria |
| **Interactive diary for diabetes: a useful and easy-to-use new telemedicine system to support the decision-making process in type 1 diabetes** | Rosi, M. et al | Diabetes | Endocrinology | Monitoring | Telemedicine system | Mobile phones | Not specified | Type 1 Diabetes patients | Experimental | Developed | Not more than 1.5 Euros | 2009 | Multinational |
| **Mobile communication using a mobile phone with a glucometer for glucose control in Type 2 patients with diabetes: as effective as an Internet-based glucose monitoring system** | Cho, J-H. et al | Diabetes | Endocrinology | Monitoring | Mobile phone | Mobile Health-care diabetes phone: LG-KP8400 | Not specified | Type 2 diabetes patients | Experimental | Developed | Not specified | 2009 | Republic of Korea |
| **Design of an mHealth app for the self-management of adolescent type 1 diabetes: a pilot study** | Cafazzo, J. A. et al | Diabetes | Endocrinology | Monitoring | Smartphone application | iPhone 4 or iPod Touch | iPhone Operating System | Adolescents with type 1 diabetes | Experimental | Pilot | Not specified | 2012 | Canada |
| **Diabetes self-management smartphone application for adults with type 1 diabetes: randomized controlled trial** | Kirwan, M. et al | Diabetes | Endocrinology | Monitoring | Smartphone application | Smartphone | iPhone Operating System | Adult patients with type 1 Diabetes | Experimental | Developed | Free application | 2013 | Australia |
| **Re-usable electrochemical glucose sensors** | Bandodkar, A. et al | Diabetes | Endocrinology | Monitoring | Smartphone-based reusable glucose meter | Smartphone | Android | NA | Technical testing | Prototype | Not specified | 2018 | United States |
| Study Title | Anemia (N=7) | Disease | Department | Measurement | Methodology | Technology | Device Details | Operating System | Cost | Reference Years | Country |
|-------------|-------------|---------|------------|-------------|-------------|-----------|---------------|-----------------|------|----------------|---------|
| Evaluation of a mobile phone telemonitoring system for glycemic control in patients with diabetes | Diabetes | Endocrinology | Monitoring | Mobile phone-based system | Motorola A-100 mobile phone | Android | Patients with complicated diabetes | Experimental | Not specified | 2009 | United Kingdom |
| Ultrabright Polymer-Dot Transducer Enabled Wireless Glucose Monitoring via a Smartphone | Diabetes | Endocrinology | Monitoring | Smartphone application | Smartphone- Huawei Mate 9 | Android | BalbC nude mice (Vital River Laboratories, Beijing, China). 8-week-old female mice | Experimental | In vitro and in vivo studies | Not specified | 2018 | China |
| Real time monitoring of glucose in whole blood by smartphone | Diabetes | Endocrinology | Monitoring | Combined thread-paper microfluidic device | Sony DSC-HX300 digital camera, a Samsung Galaxy S5 smartphone, a Samsung Galaxy Tab A tablet, and a Motorola Moto G4 Play smartphone | Android | None | Technical testing | Developed | Not specified | 2019 | Multinational |
| Smartphone based non-invasive salivary glucose biPhone Operating Systemensor | Diabetes | Endocrinology | Diagnosis/Screening | Smartphone application | Smartphone | Android | Subjects between age group 20-80 years at Outpatient Department of Indian Institute of Technology Delhi hospital, New Delhi | Experimental | Developed | Not specified | 2017 | India |
| Non-invasive blood glucose monitor based on spectroscopy using a smartphone | Diabetes | Endocrinology | Monitoring | Non-invasive blood glucose monitor | Smartphone | Android | Human subjects who drank Cola beverage of 50g sugar | Pretest/Posttest | Developed | Not specified | 2014 | United States |
| Cost-effective and rapid blood analysis on a cellphone | Anemia | Hematology | Diagnosis | Mobile application | Smartphone | Android | Anonymous human whole blood samples obtained from UCLA Blood and Platelet Center | Experimental | Developed | Not specified | 2013 | United States |
| 3D printed auto-mixing chip enables rapid smartphone diagnosis of anemia | Anemia | Hematology | Diagnosis | Smartphone application | Smartphone | Android | Patients and healthy donors aged 25-39 years and resident of the site zone | Experimental | In development | The overall cost per test is 50 cents. | 2016 | United States |
| Histogram analysis for smartphone-based rapid hematocrit determination | Anemia | Hematology | Diagnosis | Lab-on-a-chip platform including a disposable microfluidic device and a smartphone app | Smartphone | Android | Healthy adult blood donor | Technical testing | Developed | US $300 (includes smartphone cost) | 2017 | South Korea |
| Smartphone app for non-invasive detection of anemia using only patient-sourced photon | Anemia | Hematology | Screening | Mobile application | Smartphone | Android and iPhone Operating System | Patients with a variety of anemia diagnosis mixed with healthy subjects | Experimental | Developed | Not specified | 2018 | United States |
| Detection and quantification of subtle changes in red blood cell density using a cell phone | Anemia | Hematology | Diagnosis | Smartphone add-on | Smartphone | iPhone Operating System | Multiple donors | Technical testing | Developed | Approx. $45.75 (iPhone device parts) | 2016 | United States |
| Development and validation of a noncontact spectroscopic device for hemoglobin estimation at point-of-care | Anemia | Hematology | Screening | Software application running on a tablet computer | Tablet computer | Not specified | Patients of all ages, sex, and skin color | Pretest/Posttest | In development | Not specified | 2017 | India |
| Impairment | Validation of dynamic random dot stereotests in pediatric vision screening. | Amblyopia, Anisometropia, Convergent strabismus, and Hyperopia | Ophthalmology | Screening | Tablet-based visual acuity test | Tablet | Android | Children with diagnoses of amblyopia, anisometropia, convergent strabismus, and hyperopia, as well as healthy subjects | Pretest/Posttest | Not specified | 2019 | Hungary |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Visual Impairment (N=7) | Clinical Validation of a Smartphone-Based Adapter for Optic Disc Imaging in Kenya. | | Ophthalmology | Diagnosis | Smartphone application | Smartphone | Android | Adults 55 years and older | Pretest/Posttest | Prototype | Not specified | 2016 | United Kingdom |
| | Automated Measurement of Visual Acuity in Pediatric Ophthalmic Patients Using Principles of Game Design and Tablet Computers. | Visual impairment | Ophthalmology | Screening | Software application running on a tablet device | Tablet | Android | Patients from a pediatric ophthalmology outpatient clinic | Pretest/Posttest | Tested in clinical practice | Not specified | 2016 | United Kingdom |
| | Performance of an iPad Application to Detect Moderate and Advanced Visual Field Loss in Nepal. | Visual field loss | Ophthalmology | Screening | Tablet application | Tablet | iPhone Operating System | Subjects: normal (NL), with glaucoma (GL) and with diabetic retinopathy (DR) at Tilganga Institute of Ophthalmology, Kathmandu, Nepal | Pretest/Posttest | Developed | Free | 2017 | Multinational |
| | Normative values for a tablet computer-based application to assess chromatic contrast sensitivity. | Color vision deficiencies (could relate to ocular conditions such as diabetic retinopathy, age-related macular degeneration and glaucoma) | Ophthalmology | Diagnosis | Tablet computer-based games | Tablet | iPhone Operating System | Healthy control participants with a VA of 6/6 or better, measured with a Bailey Lovie LogMAR VA chart | Pretest/Posttest | Developed | Not specified | 2017 | Australia |
| | Evaluation of a smartphone photoscreening app to detect refractive amblyopia risk factors in children aged 1-6 years. | Refractive amblyopia risk factors | Ophthalmology | Screening | Photoscreening tool | Smartphone | iPhone Operating System | Children aged 1-6 years | Pretest/Posttest | Food and Drug Administration on Approved device | Not specified | 2018 | United States |
| | The Efficacy of a Novel Mobile Phone Application for Goldmann Ptosis | Superior visual field obstruction | Ophthalmology | Screening | Mobile application | Smartphone | iPhone Operating System | Ophthalmology board certified and fellowship-trained oculoplastic | Technical testing | In development | Not specified | 2014 | United States |
### Supplementary Table 4. Studies with most advanced stage of development

| Title                                                                 | Authors                          | Name of the Technology | Disease RF                             | Clinical Domain | Aim                              | Type of Intervention | Mobile | OS              | Study Population                              | Methods                      | Evaluation Values | Stage of Development | Cost            | Year | Author Affiliation |
|----------------------------------------------------------------------|----------------------------------|-------------------------|----------------------------------------|-----------------|----------------------------------|----------------------|--------|-----------------|-----------------------------------------------|-----------------------------|---------------------|----------------------|-----------------|------|-------------------|
| A smartphone application to support recovery from alcoholism: a randomized clinical trial | Gustafson, D.H. et al.           | Addiction–Comprehensive Health Enhancement System (A-CHESS) | Alcoholism | Psychiatry | Monitoring | Smartphone application | Smartphone | Not specified | Patients who met the criteria for DSM-IV alcohol dependence when they entered residential treatment | Experimental                      | Variability measures | Developed | 8 months of A-CHESS cost about $597 per patient | 2014 | United States |
| The utility of hand-held mobile spirometers technology in a resource-constrained setting | Du Plessis, E. et al.            | Air-Smart Spirometer    | Chronic respiratory diseases           | Pneumology      | Screening | Smartphone application | Smartphone | Not specified | Consecutive patients and healthy volunteers | Experimental                      | Measures of diagnostic accuracy | Developed | Not specified | 2019 | South Africa |
| Screening for atrial fibrillation in 13 122 Hong Kong citizens with smartphone electrocardiogram | Chan, N. & Choy, C.              | AliveCor                | Atrial fibrillation                   | Cardiology      | Screening | Smartphone application | Smartphone-based | Smartphone | Hong Kong citizens | Experimental                      | Measures of diagnostic accuracy | Developed | Not specified | 2016 | China |
| SPEAR Trial: Smartphone Pediatric Electrocardiogram Trial            | Nguyen, H.H. et al.              | AliveCor                | ECG Monitoring                        | Cardiology      | Diagnosis | Smartphone application | iPhone Operating System | Not specified | Pediatric patients with age 18 years or younger, with paroxysmal arrhythmia | Pretest/Posttest                 | Not specified | Developed | Not specified | 2015 | United States |
| Diagnostic utility of smartphone ECG technology in the initial investigation of palpitations | Dimarco, A.D. et al.             | AliveCor                | Palpitations                          | Cardiology      | Diagnosis | Smartphone application | Smartphone | Not specified | Patients that experienced palpitations less than daily and had access to, and the ability to use, a smartphone | Experimental                      | Not specified | Developed | Not specified | 2019 | United Kingdom |
| Wireless Smartphone ECG Enables Large-Scale Screening in Diverse Populations. | Haberman, Z. et al.              | AliveCor                | ECG Monitoring                        | Cardiology      | Screening | Smartphone application | Smartphone and tablet | iPhone Operating System and Android | University of Southern California (USC) Division I Athletes, asymptomatic USC students and ambulatory USC cardiology clinic patients | Experimental                      | Measures of diagnostic accuracy | Developed | Not specified | 2015 | United States |
| Self-monitoring for atrial fibrillation recurrence in the discharge period post-cardiac surgery using an iPhone electrocardiogram | Lowres, N. et al.                | AliveCor Heart monitor | Atrial fibrillation                   | Cardiology      | Monitoring | Smartphone-based wireless single-lead ECG (SL-ECG) | Smartphone | iPhone Operating System | Patients with POAF following cardiac surgery | Observational                 | Not specified | Developed | Not specified | 2016 | Australia |

**Abbreviations:** ECG: Electrocardiogram. USA: United States of America
| Lowres, N. et al. | AliveCor Heart Monitor | Atrial fibrillation | Cardiology | Screening | Smartphone application | Smartphone | iPhone Operating System | Pharmacy customers aged ≥65 years | Observational | Measures of diagnostic accuracy | Developed | Not specified | 2014 | Multinational |
|--------|------------------------|---------------------|------------|----------|-----------------------|-----------|------------------------|--------------------------------|----------------|--------------------------|-----------|----------------|------|-----------------|
| Lau, J. et al. | AliveCor iPhone ECG | Atrial fibrillation | Cardiology | Screening | Smartphone application | Smartphone | iPhone Operating System | Learning set and validation set of patients | Pretest/Posttest | Measures of diagnostic accuracy and intra & interobserver values | Developed | Not specified | 2013 | Australia |
| Groppler, M. et al. | Alivecor Kardia Mobile (KM) | Arrhythmia | Cardiology | Monitoring | Wireless mobile health (mHealth) device | Smartphone | iPhone Operating System | Pediatric outpatients aged <18 years presenting for cardiology clinic visits. 3 groups based on age: 0-3 years, 6–10 years, and 11–18 years | Experimental | Measures of diagnostic accuracy | Developed | Not specified | 2018 | United States |
| Hickey, K.T. et al. | AliveCor® Mobile ECG | Atrial fibrillation | Cardiology | Diagnosis | Smartphone application | Smartphone | iPhone Operating System | Pediatric patients undergoing an ablation for SVT | Experimental | Not specified | Developed | Not specified | 2015 | United States |
| William George, Newhama, Murzahir Hassan Tayebjee | AliveCorEC G | Palpitations | Cardiology | Diagnosis | Mobile application | Smartphone | iPhone Operating System | Participants with a recent history of atrial fibrillation | Experimental | Not specified | Developed | Not specified | 2016 | United States |
| Muhlestein, J.B. et al. | AliveCor™ Heart Monitor | STEMI | Cardiology | Monitoring | Smartphone application | iPod Touch 5th Gen | iPhone Operating System | Patients for whom the hospital STEMI protocol was activated | Pre-Posttest | Not specified | Developed | Not specified | 2015 | Multinational |
| Mitchell, K. et al. | Azumio’s Instant Heart Rate | Pulse rate | Cardiology | Monitoring | Smartphone application | Smartphone | iPhone Operating System and Android | Individuals from the Texas Woman’s University School of Physical Therapy – Houston Campus* | Pre-Posttest | Not specified | Developed | Not specified | 2016 | United States |
| Cesaretti, M. et al. | BLIPS Ultra lens | Macrovesicular steatosis (MS) | Clinical Lab | Diagnosis | Smartphone with lens adaptor | Smartphone | iPhone Operating System | Liver donors aged > 18 y who underwent surgical liver biopsy | Experimental | Correlation values | Available | Ultra Blips Lens: 10 Euro Together with stage and light source: about 25 Euro | 2017 | France |
| Title                                                                 | Authors                        | Methodology | Participant Details                                                                 | Study Design       | Accuracy Measures                          | Setting      | Year   | Country    |
|---------------------------------------------------------------------|--------------------------------|-------------|-------------------------------------------------------------------------------------|--------------------|--------------------------------------------|-------------|--------|------------|
| Assessment of a smartphone app (Capstesia) for measuring pulse pressure variation: agreement between two methods: A Cross-sectional study | Poh, M.Z. et al.               | Smartphone  | Healthy adult volunteers                                                             | Experimental       | Measures of diagnostic accuracy            | Developed   | 2016   | United States |
| Validation of a Standalone Smartphone Application for Measuring Heart Rate Using Imaging Photoplethysmography | Chan, P. et al.                | Rhythm      | Patients with hypertension, with diabetes mellitus, and/or aged ≥65 years           | Pre-Posttest       | Measures of diagnostic accuracy            | Developed   | 2016   | Hong Kong |
| Diagnostic Performance of a Smartphone-Based Photoplethysmography e-Application for Atrial Fibrillation Screening in a Primary Care Setting | Bryan P. Yah, et al.           | Atrial fibrillation | Sample of 217 subjects                                                             | Experimental       | Measures of diagnostic accuracy and correlation values | Developed   | 2018   | Unites States |
| Diagnostic Accuracy of a Novel Mobile Phone Application for the Detection and Monitoring of Atrial Fibrillation | Rozen, G. et al.               | Atrial fibrillation | Healthy adult volunteers                                                             | Experimental       | Measures of diagnostic accuracy            | Developed   | 2018   | Multinational |
| Passive Detection of Atrial Fibrillation Using a Commercially Available Smartwatch | Tison, G.H. et al.             | Atrial fibrillation | Healthy adult volunteers, participants with an Apple Watch                           | Experimental       | Measures of diagnostic accuracy            | Developed   | 2018   | United States |
| Design and pilot results of a mobile phone weight-loss application for women starting a meal replacement programme | Brindal, E. et al.             | Weight loss | Overweight or obese adult women                                                      | Experimental       | Variability measures                       | Developed   | 2013   | Australia |
| Mobile microscopy as a screening tool for oral cancer in India: A pilot study | Skandarajah, A. et al.         | Oral cancer  | Patients attending the dental out-patient departments of the Mazumdar-Shaw Medical Center (MSMC), Bangalore and its collaborative partner the KLE Society’s Dental College (KLESDC), Bangalore. | Pre-Test            | Measures of diagnostic accuracy            | Developed   | 2017   | India |
| A Smartphone-Based Tool for Rapid, Portable, and Automated Wide Field Retinal Imaging. | Kim, T. et al.                 | Retinal diseases | Subjects from the University of Michigan Kellogg Eye Center Retina Clinic             | Experimental       | Measures of diagnostic accuracy            | Developed   | 2018   | United States |
| Reliability Analysis of a Smartphone-aided Measurement Method for the Cobb Angle of ScollPhone Operating Systems | Qiao, J. et al.                | Ophthalmology | Patients with posteroanterior radiographs of adolescent idiopathic scollPhone Operating Systems patients with thoracic scollPhone | Pre-Posttest       | Intra & interobserver values               | Developed   | 2011   | China |
| Clinical chemistry measurements with commercially available test slides on a smartphone platform: Colorimetric determination of glucose and urea | Yuanyuan Wu et al | ColorAssist | Diagnostics for urea and glucose | Clinical lab | Diagnosis | Smartphone application | Smartphone | iPhone Operating System | Operating Systemis | Canine whole blood samples were collected from five different dogs | Technical testing | Diverse measurements | Developed | Not specified | 2015 | United States |
| Hormonal Smartphone Diagnostics. | P. R. Mutia-Garcia, J. L. Martinez-Hurtado, A. Beckley, M. Schmidmuyr , and V. Seifert-Klaus | Colorimetric | Reproductive and metabolic disorders | Maternal and child health | Monitoring | Smartphone application | Smartphone | iPhone Operating System | None | Technical testing | None | Available | Not specified | 2018 | Multinational |
| Kidney Smartphone Diagnostics | P. R. Mutia-Garcia, J. L. Martinez-Hurtado | Colorimetric | Kidney damage | Nephrology | Monitoring | Mobile application | Smartphone | iPhone Operating System | None | Technical testing | None | Available | Not specified | 2018 | Australia |
| Reliability of a smartphone-based goniometer for knee joint goniometry | Ferritero, G et al. | DrGoniometer (DrG) | Knee joint goniometry | Orthopedics and Traumatology | Diagnosis | Smartphone application | Smartphone | iPhone Operating System | None | Technical testing | None | Developed | Not specified | 2013 | Italy |
| A Mobile Phone-Based Approach for Hearing Screening of School-Age Children. Cross-Sectional Validation Study. | Chu, Y. et al | Ear Scale App | Hearing status | Otoneurolaryngology | Screening | Smartphone application | Smartphone and Tablet | iPhone Operating System | School-age children | Observational | Measures of diagnostic accuracy | Developed | Free | 2019 | Taiwan |
| Initial assessment of hearing loss using a mobile application for audiological evaluation | Dorin, S. et al | Ear Trumpet app | Hearing loss | Otoneurolaryngology | Diagnosis | Mobile application | Smartphone | iPhone Operating System | Patients with hearing loss | Pre-Posttest | Not specified | Developed | Not specified | 2016 | Turkey |
| Automated audiometry using apple iPhone Operating System-based application technology. | Foudad, A., Bui, P., Djallilian, H | EarTrumpet | Audiology | Otoneurolaryngology | Diagnosis | Smartphone application | Smartphone, iPod and Tablet | iPhone Operating System | Subjects in the University of California, Irvine Medical Center neurotology clinic during their standard appointment for hearing evaluation | Experimental | Not specified | Developed | Not specified | 2013 | United States |
| Validity of the Elite HRV smartphone application for examining heart rate variability in a field-based setting | Perrotta, A.S. et al | Elite HRV | Heart rate | Cardiology | Monitoring | Smartphone application | Smartphone | Not specified | Recreational athletes | Pre-Posttest | Measures of diagnostic accuracy and variability measures | Developed | Not specified | 2017 | Canada |
| Utility of the EncephalApp Stroop Test for covert hepatic encephalopathy screening in Chinese cirrhotic patients. | Xin Zeng Et al | EncephalApp | Hepatic encephalopathy | Gastroenterology | Screening | Smartphone and tablet app | Smartphone and tablet | Not specified | Cirrhotic patients | Experimental | Measures of diagnostic accuracy | Developed | Not specified | 2019 | China |
| Validation of EncephalApp, Smartphone-Based Stroop Test, for the Diagnosis of Covert Hepatic Encephalopathy. | Bajaj, J. et al | EncephalApp | Covert hepatic encephalopathy | Neurology | Diagnosis | Smartphone-based strop test | Smartphone and iPad | iPhone Operating System | Patients with cirrhosis and controls | Experimental | Measures of diagnostic accuracy and intra & interobserver values | Developed | Not specified | 2015 | United States |
| Endoscope-i: an innovation in mobile endoscopic technology transforming the delivery of patient care in otolaryngology | N Mistry, C Coulson, A George | Endoscope-i | Patient care | Otoneurolaryngology | Diagnosis/Screening | Endoscopic Mobile Image System | Smartphone | iPhone Operating System | None | Technical testing | None | Developed | £ 999.00 (aprox) | 2017 | United Kingdom |
| Diabetes self-management smartphone application for adults | Kirwan, M. et al | Glucose Buddy | Diabetes | Endocrinology | Monitoring | Smartphone application | Smartphone | iPhone Operating System | Adult patients with type 1 diabetes | Experimental | Variability measures | Developed | Free | 2013 | Australia |
| Wojtczak, J., & Bonadonna, P. | Mobisante MobiUS system | Airway Anesthesiology | Diagnosis Smartphone-based application | Toshiba smartphone | Not specified | Healthy (body mass index <50) volunteers | Experimental | Variability measures | Developed | Not specified | 2013 | United States |