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REVIEW

# A Systematic Review of Internet-Based Remote Patient Monitoring Systems for Chronic Disease Management in Asian

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**Background:** Chronic diseases are an increase global health concern driven by aging populations and lifestyle changes. In Asia, rapid demographic shifts and diverse healthcare systems pose unique challenges for chronic disease management. Internet-based remote monitoring systems offer innovative solutions for early detection and timely intervention, but their effectiveness within the varied Asian context requires thorough evaluation.

**Purpose:** This systematic review aimed to evaluate the effectiveness of internet-based remote monitoring systems in managing outcomes among patients with chronic diseases.

**Methods:** A systematic literature search was conducted across major electronic databases, including PubMed, Scopus, Taylor and Francis, and EBSCOhost, employing a combination of relevant search terms. The keywords used were "remote monitoring OR telemonitoring OR internet-based monitoring AND chronic disease OR chronic illness AND patient outcome OR health outcome OR clinical outcome". The inclusion criteria are defined using the PICO framework. The data were analyzed descriptively and qualitatively using thematic analysis.

**Results:** Following rigorous screening and quality appraisal, 16 studies met the inclusion criteria. These studies employed diverse remote monitoring modalities, encompassing automated remote monitoring systems, patient-reported monitoring, and personalized telecommunication-based approaches. The evidence demonstrates that internet-based remote monitoring systems significantly enhance chronic disease management across various Asian contexts.

**Conclusion:** Internet-based remote patient monitoring constitutes a pivotal advancement in chronic disease management. It facilitates timely emergency responses, reduces healthcare utilization, and optimizes clinical outcomes within Asian healthcare settings. Future efforts should focus on synergizing automated data acquisition, patient self-reporting, and personalized communication to overcome challenges related to sustained behavioral change and quality-of-life improvements.

**Keywords:** remote monitoring, internet-based monitoring, chronic diseases, emergency response, systematic review

## Introduction

Chronic diseases have become increasing global health challenge due to aging populations and changing lifestyles.[1] In Asia, chronic diseases, also known as non-communicable diseases (NCDs), are a major public health issue and contribute significantly to the disease burden in the region.[2] These diseases, including cardiovascular diseases, cancer, chronic respiratory diseases, and diabetes, are leading causes of death and disability.[3] According to a report by the WHO, NCDs account for a substantial proportion of deaths in the Southeast Asia region, ranging from 34% to 79%.[2] These conditions increase the incidence of morbidity and demand rapid and appropriate intervention in emergencies.[1,4,5] This situation demands innovation in the care system that can respond rapidly to prevent more severe complications.[6] Advances in technology have the potential to help patients with long-term conditions manage their health at home, making the provision of remote healthcare more accessible and efficient.[7]



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Patients with chronic diseases often experience medical emergencies. Early detection of changes in health conditions is key in managing chronic diseases.[8] In this context, internet-based systems help detect early warning signs of health deterioration, allowing faster emergency responses and reducing risks of severe complications or death.[9,10] Therefore, internet-based remote monitoring systems have emerged as an essential tool in managing chronic diseases, offering the potential for improvements in patient care.[7,11,12] This system is essential when patients experience emergency conditions, where timely intervention can significantly impact patient care outcomes.[13]

Previous studies have reported that remote monitoring systems have shown effectiveness in managing chronic diseases by reducing rehospitalization rates and mortality, especially in patients with heart failure and chronic obstructive pulmonary disease.[13–15] In addition, the study also found that remote monitoring system effectively reduce rehospitalizations and mortality. Mobile phone-based monitoring focuses more on tracking health data and sending notifications or reminders, while video-based systems facilitate direct communication and consultations between patients and healthcare providers.[13,16] However, the effectiveness of mobile phone-based monitoring and video conferencing still requires further investigation and more evidence is needed on newer tools like mobile apps and video consultations.[13,16] In addition, remote monitoring has shown comparable or even better results than traditional in-person care in terms of effectiveness, safety, and patient satisfaction.[11]

One of the main advantages of internet-based remote monitoring systems is their potential to reduce the incidence of hospitalization and optimize the use of medical resources.[17] With the ability to detect and respond early, this system can reduce the number of patients requiring emergency hospitalization.[6,10,17] This leads to lower costs and better quality of life by ensuring more consistent care. In addition, this system allows for more efficient coordination between various healthcare providers.[17]

Despite its many advantages, implementing remote monitoring systems is still faces several technical and operational challenges. Issues such as interoperability between devices, reliability of internet connections, and real-time data analysis capabilities must be addressed.[18,19] In the context of remote patient monitoring, interoperability ensures that data from different monitoring devices (such as blood pressure cuffs, glucose monitors, or wearable health trackers) can be integrated into one system for easy access and analysis by healthcare providers.[18,19] Developing technologies appropriate to clinical needs and adapting to different care environments requires a mature strategy. Therefore, further research is needed to optimize the use of this technology in everyday health practice.

The rapid demographic transition and increasing burden of chronic diseases in Asia make this region a critical focus for evaluating remote monitoring interventions. Asian countries face unique challenges, including diverse healthcare infrastructures, varying levels of technology access, and differing cultural attitudes towards digital health. Moreover, many Asian populations are experiencing accelerated aging and urbanization, which compound the prevalence of chronic diseases and strain healthcare systems. Despite promising evidence globally, remote monitoring technologies' contextual effectiveness, feasibility, and acceptability within Asian settings remain underexplored. Existing reviews have predominantly focused on Western and high-income countries,[6,20,21] with limited or no emphasis on the specific experiences and challenges Asian countries face. This highlights a significant gap in the literature and underscores the need for region-specific evidence to inform policy and practice in Asia.

# Materials and Methods

## Study Design

This review employed a systematic review design and followed the guidelines of the Cochrane Handbook for Systematic Reviews of Interventions and the Preferred Reporting Item for Systematic Reviews and Meta-analysis (PRISMA).[22,23] This systematic review has been registered in the International Prospective Register of Systematic Reviews (PROSPERO) with the registration ID CRD420251059366.

## Eligibility Criteria

This literature review used PRISMA to find the efficacy of internet-based remote monitoring systems for emergency response in chronic disease care.[22] Research questions and eligibility criteria were defined using the PICO framework (Population, Intervention, Comparison, Outcome).

P (Population): Adult patients with chronic diseases
I (Intervention): Remote monitoring or telemonitoring
C (Comparison): Standard care or usual care
O (Outcome): Emergency response, readmission, quality of life, etc

In this review, articles without full-text access, not published in English, and classified as secondary research were excluded from the analysis. The inclusion criteria consisted of full-text accessible articles published in English and original research discussing the efficacy of internet-based remote monitoring systems in chronic disease care. Additionally, this review did not limit the year of publication in the selection of literature to ensure broader coverage of the development of internet-based remote monitoring systems for emergency response. This approach enables the analysis of long-term trends, identification of early innovations, and comparison of the effectiveness of both old and new methods in enhancing learning outcomes.

## Data Collection and Analysis

### Search Strategy

Two authors (E.E and K.I) conducted a systematic literature search through four primary databases: EBSCOhost, Pubmed, Scopus, and Taylor and Francis. The keywords used were "remote monitoring OR telemonitoring OR internet-based monitoring AND chronic disease OR chronic illness AND patient outcome OR health outcome OR clinical outcome". Each keyword is verified using MeSH (Medical Subject Headings), and synonyms are applied to capture all relevant articles. In addition, the author uses Boolean operators such as "AND" and "OR" to filter or expand search results based on various word variations. Each database may have specific search features. Therefore, search terms will be adjusted to the relevant syntax and thesaurus.

### Study Selection and Quality Appraisal

Two authors (E.E and K.I) independently selected studies that met the eligibility criteria. Using the Mendeley reference manager, the authors checked for duplication in the initial selection process. Then, check the title, abstract, and full text for relevance to the research topic and establish inclusion and exclusion criteria. Three authors (E.E., T.K., and N.F.) checked each text completely using the Joanna Briggs Institute (JBI) critical appraisal checklist in the final process.[24] Each statement offered four response options: Yes, No, Not Applicable, and Unclear. A "Yes" response was assigned a score of 1, while all other options received a score of 0. Following the evaluation, studies with a JBI score below 70% were excluded. Subsequently, the authors reviewed the selection outcomes to identify any discrepancies. Ultimately, all authors will discuss again to reach a unanimous agreement, with no conflicting opinions regarding the suitability of the included studies.

## Data Extraction and Analysis

The first author extracted the data and double-checked it with other authors in the form of an extraction table In this review, data extraction from the studies was analyzed using a table describing all the results related to the topic discussed. The information presented in the extraction table is related to the characteristics of the study and remote monitoring characteristics.

The data analysis process begins with the identification and presentation of data obtained in the form of tables based on the reviewed articles. After receiving the data, all authors analyze and explain each finding based on the extraction results. The analysis uses thematic analysis to identify key themes and patterns across the studies, complemented by a qualitative descriptive approach to provide rich, detailed descriptions of the findings. Finally, the authors recheck the included studies to ensure and minimize errors during extraction.

### Assessment of Risk of Bias in Included Studies

Three authors (E.E, K.I, and T.K) independently assessed the Risk of Bias (RoB) for RCT studies included in this review analysis using the Cochrane Risk of Bias (RoB) tool. RCT studies consist of five RoB domains, including (1) randomization process, (2) deviation from the intended intervention, (3) missing outcome data, (4) outcome measurement, and (5) selection of reported outcomes.[25] RoB is defined as "high", "low", or "some concern", or "no information" for each domain.

Rob assessment for the quasi-experimental and observational study design used the Cochrane Review of Nonrandomized Intervention Studies (ROBINS-I).[26] ROBINS-I consists of 7 domains: Bias due to confounding, bias in the selection of participants into the study, bias in classification of interventions, bias due to deviations from intended interventions, bias due to missing data, Bias in measurement of the outcome, and Bias in selection of the reported result. Discrepancies in the assessment results were then discussed, and review by the all authors determined the decision.

# Results

## Study Selection

In the identification phase, 8185 records were retrieved from major electronic databases, including PubMed (774), Scopus (5636), EBSCOhost (320), and Taylor & Francis (1455) (see Figure 1). An additional 4 records were identified through hand searching. After removing 970 duplicates, 7215 records remained for title and abstract screening. During this screening phase, 6940 records were excluded for not meeting the initial eligibility criteria.

At the eligibility assessment stage, a total of 275 full-text articles were assessed for eligibility. However, 194 reports were not retrieved so only 81 articles could be fully assessed. Of these 81 articles, 69 were excluded for the following reasons: inappropriate study design (n=21), inappropriate intervention (n=6), publication not in English (n=8), and study not conducted in Asia (n=34). Finally, 16 studies met all inclusion criteria. Of these, 12 articles were from database searches and 4 articles from manual searches.

## Critical Appraisal and Risk of Bias Results

Table 1 presents the quality assessment of the studies analyzed in this review. Both of the evaluated cohort studies demonstrated ambiguity regarding identifying and managing confounding factors. Nevertheless, outcome measurements

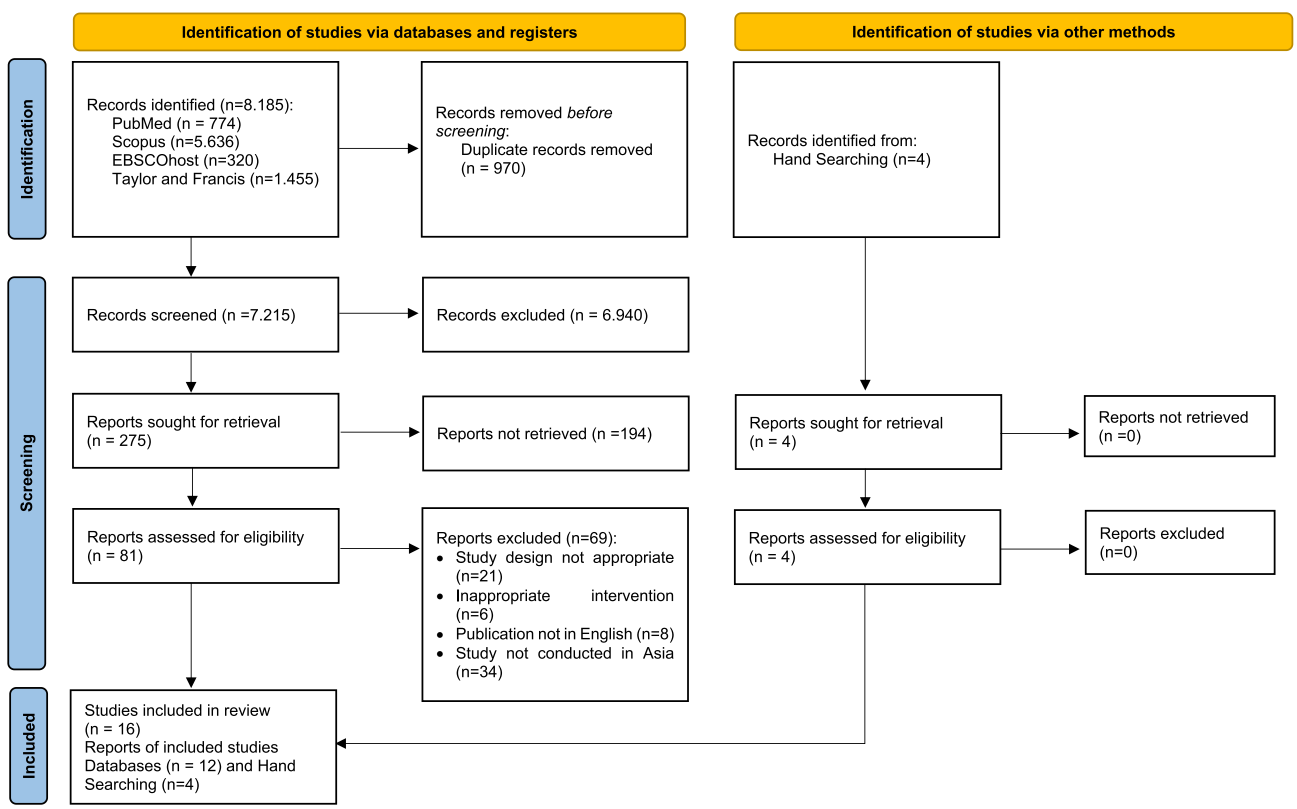


**Figure 1** PRISMA Flow Diagram. Adapted from Page MJ, McKenzie JE, Bossuyt PM et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*. 2021;372:n71. Creative Commons.[22]

**Table 1** Characteristics of Study

| Ref | Design | Country | Participants | Mean Age | Male (%) | Diagnosis | JBI |
|---|---|---|---|---|---|---|---|
| Amir et al, 2017[27] | Prospective, longitudinally-controlled study | Israel | 50 | 73.8 ± 10.3 | 62 | Acute decompensated heart failure | 81.8% |
| Chau et al, 2012[28] | RCT | Hong Kong | 40 | 73.50 ± 6.05) | 95.5 | Moderate to severe COPD | 77% |
| Chen et al, 2013[29] | Quasi-experimental | Taiwan | 141 | 70.8 (60.8–78.3) | 61 | Cardiovascular diseases | 100% |
| Cho et al, 2009[30] | RCT | South Korea | 69 | 45.2 ± 11.3 | 78.2 | Type 2 diabetes mellitus | 77% |
| Chow et al, 2019[31] | Non-randomized controlled study | Singapore | 205 | 57.9 ± 12.3 | 60.7 | Heart failure | 100% |
| Kim et al, 2008[32] | Quasi-experimental | South Korea | 34 | 45.5 ± 9.1 | 50 | Obese type 2 diabetes | 100% |
| Kim et al, 2019[33] | RCT | South Korea | 60 | 45.3 (9.5) | 85 | Obstructive sleep apnea (OSA) | 77% |
| Kotooka et al, 2018[34] | RCT | Japan | 181 | 67.1 ± 12.8 | 59.1 | Heart failure | 84.6% |
| Liew et al, 2009[35] | RCT | Malaysia | 931 | 57.73 | 39.5 | Chronic disease (DM, HT, Hyperlipidaemia) | 92.3% |
| Liu et al (2011)[36] | RCT | Taiwan | 89 | 50.4 ± 1.9 | 51.2 | Moderate-to-severe persistent asthma | 77% |
| Porath et al (2017)[37] | Quasi-experimental | Israel | 389 | 79.6+ 7.4 | 44.8 | Complex chronic conditions (DM, HT, TIA, HF, COPD, Dementia) | 100% |
| Shahid et al (2015)[38] | RCT | Pakistan | 440 | 48.95 ± 8.83 | 61.4 | Type-2 Diabetes Mellitus with HbA1c ≥ 8% | 77% |
| Shetty et al (2011)[39] | Pilot Study with Randomization | India | 144 | 50.5 ± 8.3 | NR | Type-2 Diabetes Mellitus | 77% |
| Shimoyama et al (2023)[40] | RCT | Japan | 31 | 72.5 ± 10.9 | 58.1 | Chronic respiratory failure with NPPV | 77% |
| Tian et al (2015)[41] | RCT | China and India | 2.086 | 59.7±11.7 | 34,6 | CHD, stroke, diabetes, hypertension | 84.6% |
| Tsang et al (2001)[42] | Prospective interventional crossover study | Hong Kong | 19 | 30 ± 8.0 | 68.4 | Diabetes mellitus | 81.8% |

**Abbreviations**: RCT, Randomized Controlled Trial; COPD, Chronic Obstructive Pulmonary Disease; DM, Diabetes Mellitus; HT, Hypertension; TIA, Transient Ischemic Attack; HF, Heart Failure; OSA, Obstructive Sleep Apnea; CHD, Coronary Heart Disease.


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were conducted with high validity and reliability, supported by adequate and complete follow-up periods and appropriate statistical analyses, resulting in an overall score of 81.8%.

In randomized controlled trials (RCTs), most studies applied proper randomization and adequately concealed treatment allocation with comparable groups at baseline. However, several studies showed participant, provider, and outcome assessor blinding limitations, which could introduce bias. Despite these limitations, outcome measurements were consistent and reliable, with complete follow-up data and appropriate statistical analysis, yielding quality scores ranging from 77% to 92.3%. For quasi-experimental studies, all evaluated research demonstrated a clear understanding of causal relationships, comparability between participant groups, the presence of control groups, repeated outcome measurements before and after the intervention, and completeness and reliability of follow-up data. All studies also employed appropriate statistical analyses, resulting in a perfect quality score of 100%.

Risk of bias assessment for cohort and quasi-experimental studies showed a low risk of bias in most domains, except for confounding bias, which was rated as moderate across all studies (see Figure 2). The overall risk of bias was generally low in RCTs, although some concerns were noted regarding deviations from intended interventions. Overall, the studies demonstrated good methodological quality, though particular attention should be given to potential confounding bias and intervention implementation to ensure the validity of the findings.

## Characteristics of Studies

Geographically, the study was conducted in various countries in Asia and beyond, including Israel, Hong Kong, Taiwan, South Korea, Singapore, Japan, Malaysia, Pakistan, India, China, and a combination of China and India. The study with the most significant number of participants was researched by Tian et al[41] with 2086 participants, while the fewest was Tsang et al[42] with only 19 participants. The types of studies analyzed are also quite diverse, such as prospective observational studies, quasi-experiments, pilot studies, and RCTs. Figure 3 illustrates the distribution of studies from various Asian countries based on study design.

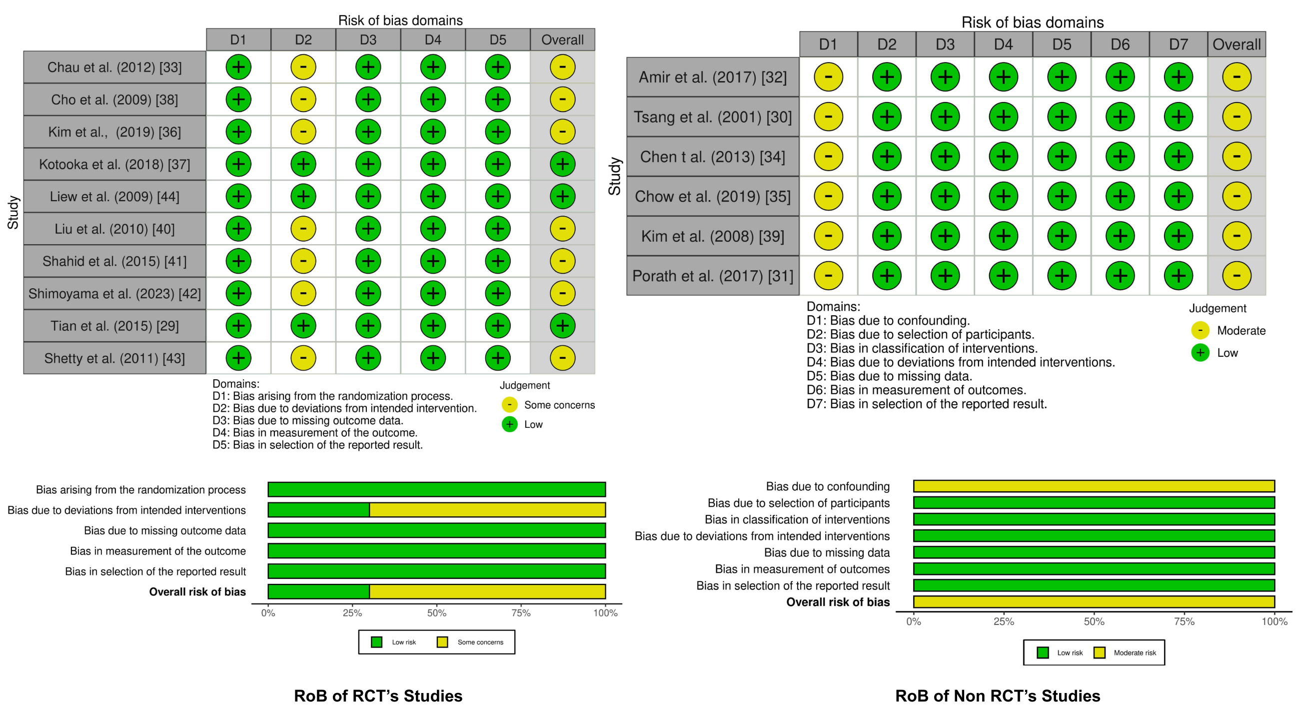


**Figure 2** Risk of Bias Assessment Results.[27–42]

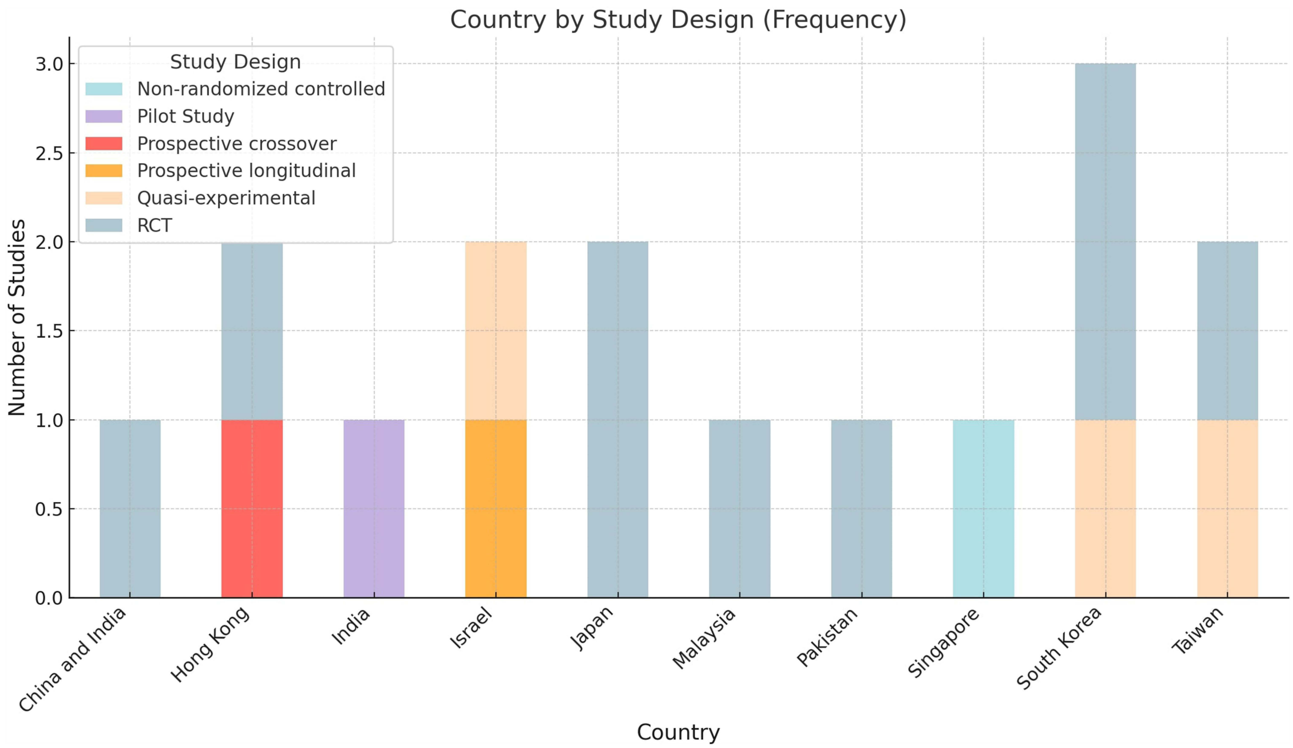


**Figure 3** Country by Design.

## Characteristics of Participants

The characteristics of the various studies reviewed showed quite wide variations in terms of the number of participants and the average age (see Table 1). The average age of participants in these studies ranged from 30 to nearly 80 years, with the age range also being quite diverse. Tsang et al [42] involved participants with the youngest average age, namely 30 years (±8.0), while Porath et al[37] reported the mean age of the oldest participants was 79.6 years (±7.4). Overall, the majority of participants were patients with chronic diseases such as heart failure, type 2 diabetes, chronic obstructive pulmonary disease, and other cardiovascular conditions, with the proportion of men varying from around 34% to more than 90% in some studies.

## Analysis of Delivery Method in Remote Monitoring

This review categorized remote monitoring into three types: automated remote monitoring systems, patient-reported monitoring systems, and personalized remote monitoring via telecommunication (see Table 2). These three categories reflect various approaches to implementing remote monitoring that can be adapted to clinical needs, available technology, and the preferences of patients and healthcare professionals.

### Theme I: Automated Remote Monitoring Systems

Interventions in this category utilize electronic devices that automatically record and transmit patients' physiological data to monitoring systems without requiring intensive manual input from the patients. Seven studies were identified within this category that employed various types of wearable technologies, body sensors, and telemonitoring tools capable of collecting patient health data either continuously or at regular intervals.[27–29,31,33,34] The data is immediately forwarded to the monitoring center or medical personnel for analysis and follow-up.

Several studies use a variety of devices to support the monitoring system. Amir et al (2017) used a wearable vest to automatically measure lung fluid, which helped reduce the number of heart failure readmissions.[27] Chau et al utilized a telecare kit with oxygen and respiratory sensors that automatically send data.[28] The tools kit includes a specially designed mobile phone, a respiratory rate sensor, and a pulse oximeter.[28] Chen et al combined real-time vital data

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**Table 2** Characteristics of Remote Monitoring

| Ref | Intervention | Delivery Method | Monitored Component | Outcomes |
|---|---|---|---|---|
| **Theme I: Automated Remote Monitoring Systems** | | | | |
| Amir et al, 2017[27] | Remote Dielectric Sensing (ReDS) technology-guided therapy | Wearable vest for daily ReDS lung fluid volume readings | • Daily lung fluid volume<br>• BNP (B-type natriuretic peptide) and patient weight | Reduce HF readmissions |
| Chau et al, 2012[28] | Telecare service | Telecare kit (Mobile phone, pulse oximeter RR sensor) with data transmission to online platform | Physiological monitoring plus medication and breathing reminders, monitoring oxygen saturation, pulse and respiration rate. | High satisfaction; no significant difference in quality of life or hospital readmission between groups |
| Chen et al, 2013[29] | Synchronous telehealth services | Instant transmission of vitals plus telephone support | BP, pulse, ECG, oximetry, glucometry monitoring. | Significant reduction in hospital admission rates and length of stays; cost savings |
| Cho et al, 2009[30] | Mobile phone glucometer vs Internet-based glucose monitoring system | Mobile phone with integrated glucometer and web platform | • Blood glucose (via glucometer integrated in mobile phone)<br>• Patients also record medication, lifestyle changes, symptoms related to diabetes management | HbA1c significantly decreased; high satisfaction and adherence. |
| Chow et al, 2019[31] | Telemonitoring vs Structured Telephone Support | Telemonitoring using Bluetooth-enabled devices (daily weight, BP, HR) combined with teleeducation and telesupport | Body weight, blood pressure, heart rate, symptom surveys. | • Reduced heart failure-related bed days at 180 days and 1 year<br>• Lower all-cause bed days and mortality at 1 year in telemonitoring group<br>• Improved patient self-care maintenance and confidence scores<br>• Estimated healthcare cost savings (~SGD 2774) |
| Kim et al, 2019[33] | Personal Health Record (PHR) + wearable vs PHR app only | Mobile app + wristband activity tracker | Weight, daily step counts, sleep log, stress, blood pressure | • Significant weight reduction in both intervention groups (app + wearables and app only)<br>• App + wearables group had higher physical activity levels |
| Kotooka et al, 2018[34] | Home telemonitoring for heart failure | Home telemonitoring system involving wireless electronic scales, blood pressure monitors, and pulse rate monitors that transmitted physiological data daily via internet to a telemonitoring center staffed by nurses. | Body weight, blood pressure, pulse rate, and body composition. Monitoring nurses reviewed these data daily and contacted patients or their physicians if data crossed predefined thresholds. | No significant difference in composite end-point (death or rehospitalization); feasible telemonitoring |
| **Theme II: Patient-Healthcare Reported Monitoring Systems** | | | | |
| Kim et al, 2008[32] | SMS + Internet self-monitoring intervention | SMS and Internet-based weekly feedback on self-recorded glucose and medication data via website | HbA1c, fasting plasma glucose (FPG), 2-hour post-prandial glucose (2HPPT) | • Significant HbA1c and postprandial glucose improvements.<br>• Intervention helps maintain blood glucose levels and reduce body weight |

| | | | | |
|---|---|---|---|---|
| Liu et al (2011)[36] | Mobile phone-based interactive asthma self-care system | Mobile phone-based interactive software installed on patients' phones for daily symptom tracking and management advice.<br>Data uploaded via GPRS to a central server where asthma control status was assessed and management advice was sent back to patients instantly. | Peak expiratory flow rate (PEFR), asthma symptom scores (sleep quality, coughing severity, breathing difficulty, daily activity limitation), and reliever medication use. | • Improved asthma control measured by increased PEFR, better lung function (FEV1), fewer exacerbations and unscheduled visits, and improved quality of life over 6 months. |
| Porath et al (2017)[37] | Proactive multidisciplinary telecare center | Telecare system with phone and EMR integration.<br>A multidisciplinary telecare service including remote consultation and monitoring, with personal nurses coordinating care and proactive phone contact, supported by integrated EMR and clinical protocols. | Clinical status of frail elderly patients with complex chronic conditions, including comorbidities, hospitalization data, medication adherence, and health service utilization. | • Significant reduction in hospital days and costs, lower monthly healthcare costs, improved care quality |
| Shahid et al (2015)[38] | Mobile phone direct calls every 15 days | Telephone calls to patients to discuss self-monitoring blood glucose (SMBG), medication adherence, diet, physical activity, and lifestyle. | Monitoring of self-monitoring: HbA1c levels, SMBG adherence, following diet, physical activity, medication intake, BP, LDL, | • It is helpful in lowering HbA1c levels in the intervention group through direct communication with the diabetic patients.<br>• Lowering LDL and following a diabetic diet plan can reduce HbA1c in these patients and help prevent future complications. |
| Shimoyama et al (2023)[40] | ICT-based telenursing intervention program | Tablet (telemonitoring + telehealth counseling) | Daily input of vital signs and symptoms, telemonitoring, health counseling, nursing interventions for exacerbation prevention | Reduced hospitalizations and hospital days, improved quality of life, enhanced self-care ability. |
| Tsang et al (2001)[42] | Hand-held electronic diary with feedback | Handheld electronic diary + phone modem | Recording dietary intake and blood glucose, immediate nutritional feedback, Email consultation with health professionals | Significant HbA1c reduction, high patient satisfaction, and acceptability |
| **Theme III: Personalized Remote Monitoring via Telecommunication** | | | | |
| Liew et al, 2009[35] | Text messaging reminder vs telephone reminder vs no reminder | SMS and telephone call reminders 24–48 hours pre-appointment | Patient attendance to scheduled follow-up appointments. | • Both text messaging and telephone reminders significantly reduced non-attendance rates compared to no reminder.<br>• Text messaging was found to be as effective as telephone reminders but more cost-effective. |
| Shetty et al (2011)[39] | SMS reminders reinforcing prescription adherence | SMS (text messages) | Adherence to medication, diet, physical activity in type 2 diabetes patients | Improved medication adherence and diabetes management |
| Tian et al (2015)[41] | Multifaceted simplified management program for CVD risk | Smartphone-based Electronic Decision Support System operated by Community Health Workers | Lifestyle counseling (smoking cessation, salt reduction), medication prescription (antihypertensives, aspirin), monthly CHW visits | Increased medication use (antihypertensive, aspirin), reduced systolic blood pressure, no significant lifestyle changes |

**Abbreviations**: PHR, Personal Health Record; SMBG, Self-Monitoring Blood Glucose; BP, Blood Pressure; BNP, B-type Natriuretic Peptide; ECG, Electrocardiogram; PEFR, Peak Expiratory Flow Rate; FEV1, Forced Expiratory Volume in 1 second; LDL, Low-Density Lipoprotein; ICT, Information and Communication Technology; NPPV, Noninvasive Positive Pressure Ventilation; SMS, Short Message Service; EMR, Electronic Medical Record; RR, Respiratory Rate; FPG, Fasting Plasma Glucose; 2HPPT, 2-hour Post-Prandial Glucose; QoL, Quality of Life.


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transmission with telephone support.[29] Data from digital medical devices (manometer, oximeter, glucometer, and ECG) are automatically transmitted in real-time to the telehealth center via an internet connection.[29]

Cho et al used a mobile phone with an integrated glucometer for automatic blood sugar monitoring, which successfully reduced HbA1c with high compliance rates.[30] Chow et al telemonitoring using Bluetooth devices for body weight, blood pressure, and heart rate can reduce hospitalization days and deaths and improve patient self-care.[31] These measurements are transmitted wirelessly via a central console with an internal SIM card to a back-end monitoring platform for viewing by the nurse and the patient's tablet device for self-monitoring by the patient.

Similarly, Kim et al, who used a wearable activity tracker that monitored weight, steps, sleep, and blood pressure.[33] Patients were monitored using a mobile app (MyHealthKeeper), a Samsung Charm wearable device for physical activity, and a WatchPAT diagnostic tool for sleep breathing measurements. The collected data was integrated into the hospital's electronic medical record (EHR) system via the Samsung Health platform, which is connected to the PHR app.[33]

Lastly, Kotooka et al used a wireless device that sent daily data.[34] The primary tool used for patient monitoring is a combination of electronic scales with body composition meters, blood pressure measuring devices (sphygmomanometers), and data receiver devices that transmit data wirelessly to the monitoring center. While the primary outcome was not statistically significant, the system demonstrated feasibility in routine use.

## Theme II: Patient and Healthcare-Reported Monitoring Systems

Interventions in this category rely on patients and providers actively entering health data through digital media, such as mobile apps, SMS, or web platforms.[32,36–38,40,42] Patients regularly report vital signs, symptoms, or self-measurements (eg, blood sugar, blood pressure, or respiratory symptoms). The system then provides automated feedback or supports healthcare providers in monitoring the patient's condition based on the reported data.

Patients use various digital methods to report their health in the monitoring system. Kim et al used SMS and internet-based interventions to monitor blood glucose levels and medication compliance in diabetic patients.[32] Patients input their data regularly via the website and receive weekly feedback, which has been shown to significantly reduce HbA1c and postprandial glucose levels. In addition, Liu et al developed a mobile phone-based interactive self-care system for asthma patients, in which patients reported daily symptoms such as sleep quality, cough, difficulty breathing, and restricted activities due to asthma.[36] Data is automatically sent via GPRS to a central server, and patients receive real-time management advice.[36]

Shimoyama et al reported an ICT-based telenursing program that combined telemonitoring with remote counseling using tablets.[40] Patients independently input daily vital signs and symptoms, which are then monitored by nurses for early intervention to prevent exacerbations.[40] Tsang et al developed a handheld electronic diary that allowed patients to record food intake and blood glucose levels in real-time.[42] This device provides instant nutritional feedback as well as providing Email consultation with a healthcare professional.[42] The intervention demonstrated a significant reduction in HbA1c as well as high levels of patient satisfaction and acceptance of the system.[42]

Shahid et al used routine telephone calls every 15 days to discuss the results of self-monitoring of blood glucose levels, medication compliance, diet, and physical activity of diabetes patients.[38] Previously, patients were taught to do their own blood sugar measurements routinely, using a glucometer. Patients must record the results of these measurements in the SMBG form provided.[38] The combination of self-monitoring of blood sugar, regular intervention calls for reinforcement and education, and regular clinical check-ups is effective in improving blood sugar control and healthy living habits in diabetes patients in areas where direct access to health facilities is difficult.[38]

In contrast to Porath et al's research, they introduced a multidisciplinary telecare approach integrating telephone and electronic medical records (EMR) by Maccabi Telecare Center (MTC).[37] Previously automated patient data from connected telecare devices is then input by the MTC Personal Nurse. MPN actively monitors patient conditions remotely via telephone, virtual visits, or data from connected medical devices (eg, online glucometer).[37]

## Theme III: Personalized Remote Monitoring via Telecommunication

This intervention combines direct communication with active monitoring between patients and health workers through telecommunication media such as telephone, video calls, voice messages, and short messages.[35,39,41] Through this two-way interaction, health workers provide consultation and education and continuously monitor the patient's health condition.

A primary focus is using personalized telecommunications technology to support patient adherence to treatment and improve attendance at healthcare services. One common approach is sending reminders via SMS or phone calls to ensure patients attend follow-up appointments and comply with their medication prescriptions. Liew et al showed that reminders via SMS and telephone calls sent 24–48 hours before the scheduled visit significantly reduced the rate of patient no-shows compared to no reminders.[35] In addition, Shetty et al examined SMS reminders reinforcing adherence to medication prescriptions, diet, and physical activity in patients with type 2 diabetes.[39] This intervention successfully improved medication adherence and overall diabetes management.

In the context of CVD, Tian et al developed a multifaceted risk management program involving an electronic decision support system operated by community health workers via smartphones.[41] The program provides lifestyle counseling, management of antihypertensive and aspirin medications, and regular visits by health workers. The results showed increased use of essential medicines and decreased systolic blood pressure, although significant lifestyle changes were not achieved.[41]

## Monitoring Component and Outcomes of Remote Monitoring

The monitoring components vary but can generally be classified into three main themes (see Figure 4). In the first theme, automated remote monitoring systems, wearable devices such as medical vests, telecare kits with sensors, and smart-phone-integrated digital electronics provide continuous and objective physiological data. Daily monitoring of vital parameters such as blood pressure, heart rate, oxygen saturation, and physical activity offers a holistic overview of the patient's health status.

Measurement of specific biomarkers, such as B-type natriuretic peptide, along with reminder systems for medication and lifestyle changes, serve as essential pillars in facilitating the management of chronic conditions. Significant outcomes include reduced hospitalization rates, improved clinical parameters such as HbA1c, decreased mortality, and enhanced physical activity and quality of life. However, it is essential to note that specific outcomes, such as subjective quality of life and readmission risk, showed no significant change in several studies, indicating the need for a more integrative and personalized approach.

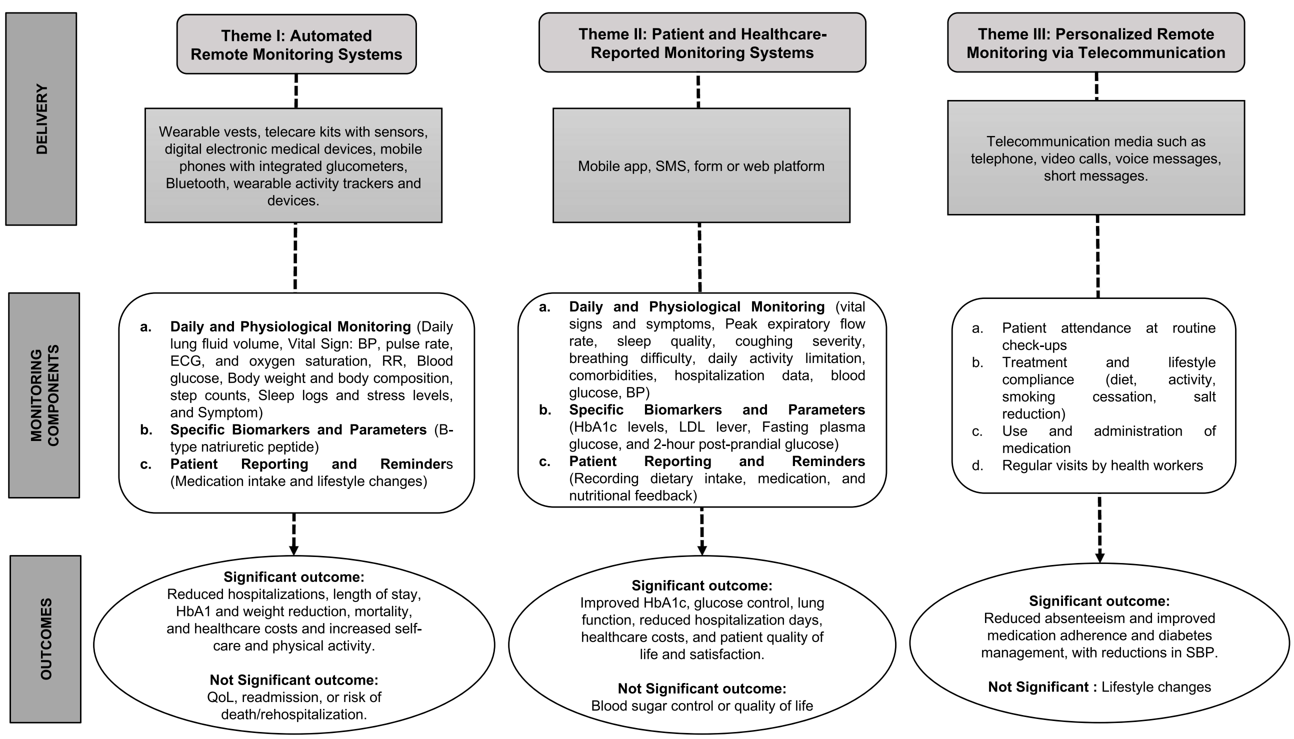


**Figure 4** Delivery Method, Monitoring Component, and Outcomes.

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The second theme, Patient and Healthcare-Reported Monitoring Systems relies on direct reporting by patients and healthcare professionals through digital platforms such as mobile applications, SMS, and online forms. The device emphasizes monitoring symptoms, vital signs, and daily activities reported by patients, as well as relevant biomarker data such as HbA1c levels and postprandial plasma glucose. The integration of reminders and nutritional feedback facilitates increased patient engagement in self-management. Significant outcomes reflect improvements in glucose control, reduced hospitalization days, and enhanced quality of life.

The third theme, Personalized Remote Monitoring via Telecommunication, utilizes communication media such as telephone calls, video calls, and voice messages to support more personal and direct patient engagement. Monitoring focuses on attendance at routine visits, medication adherence, and lifestyle modifications, including diet, physical activity, and smoking cessation. Through this approach, significant outcomes reported include reduced absenteeism and improved medication adherence, including better diabetes management and lower systolic blood pressure. Lifestyle changes remain a less significant outcome, indicating ongoing challenges in achieving long-term behavioral modification through telecommunication-based interventions.

## Discussion

This review aims to explore the delivery method of remote monitoring systems among patients with chronic diseases, focusing on studies in Asia. Chronic patient monitoring systems are increasingly developing along with information and communication technology advances, especially with the increasing need for effective and efficient chronic disease management. In this review, monitoring systems are grouped into three primary delivery methods: automated remote monitoring systems, patient-reported monitoring systems, and personalized remote monitoring via telecommunication. These three methods demonstrate different approaches to collecting and responding to data.

First, automated remote monitoring systems rely on electronic devices that automatically record patient physiological data such as blood pressure, heart rate, oxygen saturation, and specific biomarkers without requiring intensive manual input from the patient.[27–29,31,33,34] Amir et al used a wearable vest capable of automatically measuring lung fluid to manage heart failure, which was shown to reduce readmission rates.[27] The main advantage of this method is the ability to provide continuous and objective data, allowing clinical interventions to be carried out more quickly and in a timely manner. In addition, various sophisticated devices such as telecare kits that combine oxygen and respiratory sensors,[28] and integrated glucometers on mobile phones showed high effectiveness in controlling chronic diseases, especially diabetes and cardiovascular diseases.[30] This is consistent with the findings of Chen et al, who reported significant reductions in hospitalization rates and care costs using synchronous telehealth, which sends vital data in real time to a monitoring center.[29] Additionally, wearable activity trackers that continuously monitor weight, physical activity, and other vital signs also improve patient compliance and health outcomes.[33]

Second, patient-reported monitoring systems rely on the active participation of patients in reporting their health data via mobile applications, SMS, or other digital platforms.[32,36–38,40,42] This method increases patient involvement in self-management and allows for two-way interaction between patients and health workers. Kim et al showed that monitoring via SMS and internet providing weekly feedback significantly reduced HbA1c levels in diabetic patients.[32] This approach has proven effective in increasing patient awareness and compliance with treatment and healthy lifestyles.[32] In addition to diabetes, self-reporting is also effective for other diseases, such as asthma, where patients report daily symptoms and receive real-time management advice via mobile phone.[36]

Although the patient-reported monitoring system relies on patient reporting, the device was is able to reduce emergency visits and improve quality of life, proving that active patient involvement significantly impacts chronic disease management.[36,37,40] Porath et al added a multidisciplinary telecare dimension that integrates patient and healthcare provider data in a coordinated system, significantly reducing hospitalization days and care costs.[37] However, reliance on patient reporting also brings challenges, especially regarding data accuracy and consistency, which are sometimes affected by subjective factors such as patient motivation and digital literacy. Therefore, supervision by professional health workers is crucial to ensure that reported data is valid and interventions are targeted.

Another category of monitoring system is personalized remote monitoring via telecommunication. This method uses direct communication media such as telephone, video call, and SMS to increase patient engagement and clinical support.[35,39,41] Liew et al reported that reminders via SMS and phone can significantly reduce patient no-show rates, which is critical in maintaining continuity of care.[35] Shetty et al demonstrated the efficacy of SMS reminders in improving adherence to medication, diet, and physical activity in type 2 diabetes patients.[39] This approach is also applied in cardiovascular risk management through an electronic decision support system operated by community health workers.[41] Although personalized communication has successfully increased adherence, long-term lifestyle behavior changes such as diet and physical activity remain challenging, indicating the need for more comprehensive intervention integration.

In terms of monitoring components, automated systems provide objective and continuous biometric and physiological data, including blood pressure, heart rate, oxygen saturation, and biomarkers such as BNP, which are essential for early detection of disease exacerbations.[27,34] These data allow health workers to intervene more quickly, such as adjusting medications or providing emergency care. Then, patient-reported monitoring emphasizes collecting subjective data in the form of symptoms, self-measured vital signs, and the patient's daily activities.[32,37,38,40]

This expands the monitoring dimensions to focus not only on physiological parameters but also on the patient's functional condition and quality of life. As developed in previous studies, interactive applications provide added value in improving self-management and patient education in real time.[32,37,40] Meanwhile, personalized telecommunication focuses more on monitoring patient behavior and compliance. The monitoring components in this method include patient attendance at visits, compliance with treatment, and lifestyle change efforts that are monitored through direct communication interactions.[35,39,41] While it does not provide direct biometric data, this component is critical to ensuring long-term treatment continuity and success.[35,39]

These three methods do not consistently yield positive effects on the measured outcomes. Several studies present contrasting results.[28,29,31,33,34,40] For example, three studies found that remote patient monitoring interventions had no significant effect on mortality and readmission rate.[28,31,40] Additionally, another study reported no significant differences in physical activity, food intake, sleep, or stress between the telemonitoring intervention group and the control group.[33] Over the long term, this intervention also did not show a significant impact on changes in self-care or the quality of life in patients with chronic diseases.[28,40]

These three methods synergistically provide varying but complementary clinical results. Automated monitoring systems effectively reduce hospitalization rates, improve clinical parameters such as HbA1c and blood pressure, and reduce mortality in heart failure, DM and COPD.[27,28,31] However, the effects on quality of life still show variations that require further personalized approaches. Patient-reported monitoring significantly improved glucose control and quality of life, decreased hospitalization days, and increased patient participation in disease management.[32,36,37,40] However, limitations emerged in long-term consistency and effectiveness on mortality outcomes, indicating the need for strengthening clinical support systems. Personalized telecommunication has successfully increased medication adherence and reduced absenteeism, which is essential to preventing complications and successful chronic management.[35,39] However, its impact on long-term lifestyle changes is still limited, which is a concern in developing future interventions.

## Implication for Practice

The Asian context, which is this study's primary focus, has challenges related to technology access, health infrastructure, and the culture of digital technology use. Tian et al's study in rural China and India confirmed that the success of cardiovascular risk management programs is highly dependent on the active role of community health workers and the adaptation of technology to local conditions.[41] Therefore, the practical implications of this review are the need for a holistic approach that integrates automated technology with patient reporting and personal communication, accompanied by health worker training and self-care-based patient education, to improve understanding and engagement.[43–46] This strategy is expected to improve clinical outcomes, reduce complications, and reduce long-term care costs.

## Strengths and Limitations of Study

This review followed the rigorous PRISMA guidelines and employed robust methodological quality assessments using tools from the Joanna Briggs Institute and Cochrane Risk of Bias instruments. Including diverse study designs such as randomized controlled trials, quasi-experimental, and observational studies from multiple Asian countries allowed for a comprehensive and regionally relevant synthesis of evidence on remote monitoring. The thematic analysis approach enabled a rich exploration of different delivery models and monitoring components, thus providing valuable insights into how these interventions function in practice.

However, the review is limited by excluding non-English language publications, which may have introduced language bias and omitted potentially relevant regional studies. Additionally, most studies had relatively short follow-up periods, limiting the ability to assess the durability of intervention effects, particularly with respect to lifestyle changes and patient-centered outcomes. The heterogeneity of intervention types and outcome measures also hindered the possibility of a meta-analysis, reducing the precision with which effect sizes could be estimated. Furthermore, some included studies demonstrated risks of bias related to confounding factors and lack of blinding, which must be considered when interpreting the results.

## Conclusion

Internet-based remote patient monitoring represents a promising approach for chronic disease management in Asia, with demonstrated benefits including fewer hospital readmissions and improved clinical indicators like blood sugar and blood pressure control and enhanced patient adherence to treatment protocols. The review revealed that automated monitoring systems provide continuous and objective physiological data, facilitating timely clinical interventions, while patient-reported systems and personalized telecommunication approaches improve patient engagement and self-management. However, the impact on long-term lifestyle modification and quality of life remains variable, underscoring the need for more integrative and patient-centered intervention models.

The integration of remote patient monitoring systems offers a valuable solution for chronic disease management, particularly in resource-limited settings. These technologies enable healthcare providers to deliver more frequent and timely interventions, optimizing healthcare resources. Additionally, the system empower patients to monitor and manage their health, enhancing engagement in their care. For successful implementation, systems must be accessible, user-friendly, and culturally adapted. Personalized support and education are essential to maximize patient benefits. Future research should focus on scaling these technologies across Asia, addressing barriers like digital literacy and access, and integrating them into existing healthcare infrastructures. The goal is to create a sustainable model that improves patient outcomes, reduces healthcare costs, and supports long-term health across the region.

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