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Efektivitas Intervensi Digital Berbasis Mobile Device terhadap Pengendalian Faktor Risiko Diabetes Melitus di Era Revolusi Industri 4.0

The Effectiveness of Mobile Device-Based Digital Interventions on the Risk Factors of Diabetes Mellitus Control in the Industrial Revolution 4.0

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ABSTRAK

Latar Belakang: Diabetes melitus merupakan penyakit kronis yang apabila tidak dilakukan manajemen yang tepat dapat menyebabkan gangguan mikrovaskuler maupun makrovaskuler. Indikator ketepatan manajemen diabetes dalam artikel ilmiah ini meliputi edukasi, self management (pola makan, aktifitas fisik, dan self efficacy), dan pemantauan kadar HbA1c. Mobile device berpotensi dalam alat bantu untuk manajemen diabetes melitus di era revolusi industri 4.0.
Tujuan: Memberikan informasi terkini terkait efektivitas penggunaan mobile device dalam mengendalikan faktor risiko diabetes melitus.
Metode: Penelitian ini merupakan penelitian literature review. Database elektronik yang digunakan adalah Google Scholar, Science Direct, dan Directory of Access Journals (DOAJ). Kriteria inklusi: literatur berbahasa Indonesia atau Inggris, original research, jurnal minimal 80% terindeks Sinta (jurnal Indonesia) dan terindeks Scopus (jurnal internasional), tahun terbit 2010-2020, tersedia dalam free fulltext, intervensi literatur menggunakan mobile device, memiliki luaran kadar HbA1c, pola makan, aktivitas fisik, self efficacy, dan tingkat pengetahuan. Kriteria eksklusi: referensi dengan data sekunder.
Hasil: Penelitian ini menggunakan 16 artikel ilmiah. Sejumlah 15 studi (88%) melaporkan penggunaan aplikasi mobile device dalam mengendalikan faktor risiko diabetes melitus memiliki pengukuran yang siginifikan dalam mengontrol kadar HbA1c pada 10 studi (83%) dan 2 studi tidak signifikan (17%). Luaran berupa self management dilaporkan oleh 9 studi dengan rincian hasil signifikan perbaikan pola makan pada 5 studi (83%), peningkatan aktifitas fisik pada 5 studi (63%), dan self efficacy pada 4 studi (67%). Peningkatan pengetahuan dilaporkan oleh 4 studi dengan hasil signifikan (100%).
Kesimpulan: intervensi digital berbasis mobile device cukup efektif dalam pengendalian faktor risiko diabetes melitus untuk mengontrol kadar HbA1c, meningkatan self management (perbaikan pola makan, peningkatan aktivitas fisik, dan self efficacy) dan pengetahuan.

Kata Kunci: Diabetes Melitus, Mobile Device, HbA1c

ABSTRACT

Background: Diabetes mellitus is a chronic disease which if not done properly, can cause microvascular and macrovascular disorders. Indicators of the accuracy of diabetes management in this scientific article include education, self-management (improving diet, increasing physical activity, and self-efficacy), and monitoring of HbA1c levels. Mobile devices have the potential as a tool for diabetes mellitus management in the era of the industrial revolution 4.0.
Purpose: to provide the latest information regarding the effectiveness of using mobile devices in controlling risk factors for diabetes mellitus.
Method: This study was a literature review. The electronic databases used were Google Scholar, Science Direct, and Directory of Access Journals (DOAJ). Inclusion criteria were: original research, a journal of at least 80% indexed by Sinta (Indonesian journal) and indexed by Scopus (international journal), publication year 2010-2020, intervention using a mobile device, has an output of HbA1c levels, self management (diet, physical activity, and self efficacy), and the level of knowledge. Exclusion criteria: reference with secondary data.
Result: This study used 16 scientific articles. A number of 12 studies (75%) reported the use of mobile device applications in controlling risk factors for diabetes mellitus had significant measurement results in controlling HbA1c levels in 10 studies (83%) and 2 studies were not significant (17%). Outcomes in the form of self-management were reported by 9 studies with details of the significant results of dietary improvement in 5 studies (83%), increased physical activity in 5 studies (63%), and self-efficacy in 4 studies (67%). The increase in knowledge was reported by 4 studies with significant results (100%).
Conclusion: Mobile device-based digital intervention is quite effective in controlling diabetes mellitus risk factors to control HbA1c levels, increasing self-management (improving diet, increasing physical activity, and self-efficacy) and knowledge.

Keywords: Diabetes Mellitus, Mobile Device, HbA1c

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INTRODUCTION

Diabetes is a serious chronic disease that occurs when the pancreas does not produce enough insulin (a hormone that regulates blood sugar or glucose), or when the body cannot effectively use the insulin it produces.[1] Diabetes type 1 and 2 are public health problems and are one of the four non-communicable diseases that are a priority to be followed up today.

WHO data in 2018 shows that diabetes is the 4th largest cause of death in the world with a percentage of 6%, after cardiovascular disease (35%), cancer (12%), and other non-communicable diseases (NCDs) (15%).[2]

Blood sugar higher than the maximum limit resulted in an additional 2.2 million deaths, by increasing the risk of cardiovascular disease, hypertension, kidney damage, and others. As many as 43% of these 3.7 million deaths occurred before the age of 70 years with a higher percentage in low- and middle-income countries than in high-income countries.[1]

Diabetes Mellitus can be caused by lifestyle changes related to poor diet and decreased levels of physical activity. One way that has been done to help individuals prevent and manage diabetes mellitus is through the use of mobile devices which are currently widely available in the community.

In the current era of the industrial revolution 4.0, digital technology has a very massive development in providing information. The development of digital technology affects activities in life by making access to the internet network easier and unlimited.[3] One of the most popular uses of digital technology in society is mobile devices.

According to the results of a 2017 Kominfo survey, the number of mobile device users in Indonesia has increased, with more than half of Indonesians owning a mobile device (66.31%).[4] In addition, based on the results of the 2018 National Internet User Penetration Survey conducted by the Association of Indonesian Internet Service Providers (APJII), the number of Indonesian internet users is 171.176 million users with an internet penetration rate of 64.8% where the total population is 264,161,600. . These internet users experienced a growth of 10.12% compared to the previous year.[5]

Seeing the increasing number of mobile device users, many researchers and health care providers take this as an opportunity to help individuals in better management of diabetes mellitus based on mobile phones by utilizing mHealth technology.

mHealth technology is defined as medical practice in public health supported by mobile devices such as mobile phones (smartphones), tablets, personal digital assistants, and patient monitoring devices.[5] The use of mobile-health technology (mHealth) aims to improve self-management skills by modifying lifestyle and improving metabolic conditions. These health practices include the use of short message services (SMS) and smartphone and tablet applications. Despite the fact that the mHealth intervention has been shown to be beneficial for diabetic patients, its impact on diabetes self-management practices has not been widely validated.[5] Most of the mHealth studies have emphasized the assessment of clinical metabolic outcomes, such as decreased HbA1c levels, rather than validating the self-management process from the patient's perspective. In some research results, there is little that explains the effect of mHealth on the self-management process.[7] The results of increasing self-management ability can be categorized as immediate results (knowledge and skill acquisition), intermediate (behavior change) and long manifestations (improved health status).[7-9]

Given the significant increase in diabetes prevalence, access to mobile devices, and potential benefits for individuals with diabetes mellitus, it is necessary to review the literature with a narrative synthesis to interpret some of the latest empirical literature related to the effectiveness of mobile device-based digital interventions for controlling risk factors for diabetes mellitus in the revolutionary era. industry 4.0.

METHODS

The design used in this study is a literature review by searching for journals and articles through electronic databases including: Google Scholar, Science Direct, and Directory of Access Journals (DOAJ). The inclusion criteria for writing this literature review include: the selected journals have been published at least in the last 10 years, namely 2010 to 2020, at least 80% are indexed nationally and internationally (indexed by Sinta for Indonesian journals and indexed by Scopus for international journals), original research, available free fulltext , an Indonesian or English language journal, the study being studied must also use a mobile device as an intervention tool, having one of the outcomes including: HbA1c levels, diet, physical activity, self-efficacy, and level of knowledge. While the exclusion criteria include: references with secondary data and outside the inclusion criteria. The search keywords are variations and combinations of the words "diabetes", "diabetes mellitus", "mobile device", "cell phone", "application", "Software", "text message", "SMS", and "short message service".

Based on the initial search results, the authors found 271 scientific articles. After being excluded based on the year of publication and the publication index, 29 scientific articles were found that were included in the criteria for this literature review, 12 other journals did not meet the criteria. After going through the identification process, 16 scientific articles were found that were included in the criteria for this literature review, 13 other

journals do not meet the established criteria. This is due to several factors including: mobile devices are not listed as the main study criteria, the year the journal has been published is more than 10 years, the journal has not been indexed by Scopus or Sinta, and many research results show insignificant figures. All journals were independently reviewed and coded by the authors. The data extracted included the country of research location, research methods, duration of the study, target criteria (inclusion and exclusion), as well as research results obtained (HbA1c, self management (diet and physical activity), self-efficacy, and increased knowledge (Fig. 1).
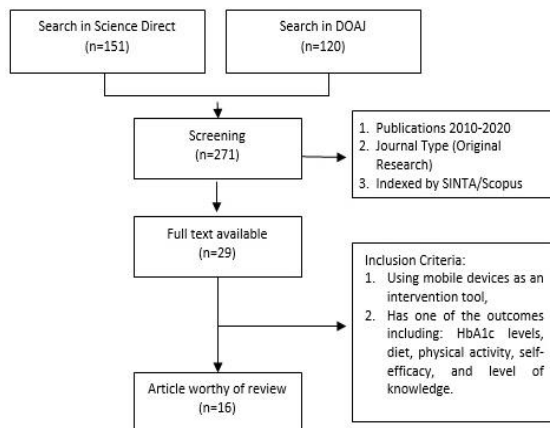

Figure 1. PRISMA Diagram

RESULTS AND DISCUSSION
Study Design and Subject

All research results reviewed are examining the effectiveness of using mobile phones from the patient's perspective where there is a role for health workers as providers of mobile device applications. The sample size ranged from 12 to 781 subjects, with 71% of the studies being adult subjects (18–88 years) and 29% of the studies being adolescent subjects (10–17 years). Subjects with Type 1 Diabetes Mellitus were used in 35% of the studies, 35% had patients with Type 2 Diabetes Mellitus, and 12% of the studies had patients with both types of diabetes, and 18% of the studies did not report this information. More than half of the studies (58%) used the Randomized Controlled Trial (RCT) method in their study. Meanwhile, 2 studies used the Prospective Case Study (PCS) method and 2 studies used a quasi-experimental pre-post test method. The other two studies used the RCT & PCS method and a cross-sectional online survey. The duration of the studies carried out ranged from 6 weeks to 3 years. Twelve of the 16 studies described the inclusion and exclusion criteria of participants. Having comorbidities was the most commonly stated exclusion factor in the study (42%), while the most frequently reported inclusion criterion was the age of the participants involved (82%). A total of 16 studies reviewed stated that the research locations were Asia (n=5), Africa (n=1), America (n=4), Australia (n=2), and Europe (n=4) with occurring in developed countries. 92% (n=11) and 8% developing countries (n=1).

Mobile Device Technology

In supporting the research on the effectiveness of mobile device applications as controlling Diabetes Mellitus, more than half of the studies used the subject's personal cellphone (65%), while 24% of cellphones were provided, and 12% was not reported in the study. Regarding the applications used, a total of 24% of studies stated that the application was paid, 5% of studies with unpaid applications, and more than half of the studies (71%) did not report in the study. Seventy-one percent of studies use specific study apps that have more functionality or features than just a simple text message. The types of application features are diaries/logs, reminders, information/education, motivation/self-efficacy, problem solving, counseling, and blood sugar monitoring. Messages reminding participants to do an activity were used in 75% of the studies. Four studies (25%) only used messages as a form of educational intervention for participants with tips and information about diabetes and reminders of health control schedules. Eighty-one percent of studies reported using a diary to record data such as blood glucose readings, calorie consumption, or physical activity. Based on 5 studies (29%) stated the level of satisfaction of respondents in using diabetes control applications and 12 studies (71%) did not report this information.

The existence of the mHealth intervention is currently considered quite effective in promoting lifestyle changes which include improving diet, increasing physical activity, and adherence to health control. Several recent studies have successfully conducted trials based on cell phone text messages, targeting patients with asthma, obesity, smoking, and diabetes[10]. In addition, recent research has shown that the mobile-based diabetes management program (mHealth) has an effect on improving glycemic control among patients with diabetes control difficulties[11]. Mobile device health applications are useful for those who are trying to adopt a healthy lifestyle in their daily life. The application of new and advanced technology to clinical practice, further increases patient awareness of the possible effects of severe disease without proper self-management. The diversity of types of mobile device applications with potential health benefits is considered very important, especially in controlling risk factors for diabetes mellitus.

1) Mobile Device Intervention with Decreased HbA1c levels

A total of 12 studies reported the use of mobile device applications in controlling risk factors for diabetes mellitus, namely controlled HbA1c levels (table 1). In 10 studies showed positive results related to the effect of using mobile devices on increasing control and decreasing HbA1c levels.[1–10]. Mobile phones are a promising platform for engaging patients in chronic care because most patients have them and regularly use mobile devices. A meta-analysis study by Liu and Ogwu showed a decrease in HbA1c by an average of 0.39% in 12 studies using mobile phone interventions. [21] The use of applications in mobile devices associated with diabetes combined with once per week messages from health workers can significantly improve glycemic control (HbA1c) in adults with Type 1 Diabetes Mellitus.[2] These

results suggest that consultation frequency has a tremendous impact on glycemic control (HbA1c) in the patient population.[3]

However, with different results, another study showed that the measurement of HbA1c was not significantly reported by 2 studies (17%).[11,12] No change in measurement results may occur due to heterogeneous patients, the presence of comorbidities, inhomogeneous implementation of the intervention, or possible effects of the program. 23 Meanwhile, other contributing factors are related to respondent compliance during the research period and the researchers did not review the level of willingness of respondents to participate.[8]

During the study, new and improved versions of mobile devices entered the market and participants reported this as the reason for several cases of low cell phone usage given to participants.[12] Equipment may be out of date when using RCTs to test mobile device interventions due to the lengthy inclusion process. The lack of findings in studies related to behavior change also occurs due to the lack of a major component in the application available for people with type 2 diabetes.[12] Applications should be designed in the context of current guidelines for the treatment of type 2 diabetes to improve self-management.[13,14]

In the 2012 Mulvaney study, it was found that the results of controlling HbA1c levels were not significant due to the small sample size so that it could limit generalization.[11] The method used in the study also affects the results of the study. When using appropriate historical controls can provide a more robust design than single group designs. Randomized Controlled Trials will need to be conducted to establish clinical efficacy.

2) Mobile Device Intervention with Self Management

Diabetes self-management support interventions include a combination of tools designed to reach patients, including brochures, phone calls, and websites. Interventions that use mobile devices (mHealth) have the potential to facilitate self-management, education, and support28. This self-management component includes improving diet, increasing physical activity, and self-efficacy.

The use of mobile devices in controlling risk factors with self-management outcomes was reported by 9 studies with detailed results of significant improvements in diet in 5 studies (63%)[4,5,7,15,16] and 1 study was not significant (17%)[8], increased physical activity 5 studies with significant results (83%)[4,5,7,10,17] and 3 studies were not significant (37%)[6,11,15] and increased self-efficacy in 4 studies with significant results (67%)[4,5,7,10] and 2 studies were not significant (33%) [2,8]. *Participants' self-management improved during the study period in a seven-day period experiencing an increase in healthy eating patterns (p=0.03)*[4].

In Zhou's 2016 study, self-management scores including diet and exercise habits improved in the control group. However, the increase in patients in the intervention group was greater than in the control group[7]. The contribution of the Welltang mobile device application, providing the ability to integrate customized behavior support within the context of a self-

management plan and providing contextually relevant and temporally relevant messages to influence patients' daily decision-making[18]. The system in the application helps patients to change their diet in terms of calories and nutritional balance as well as evaluate the effect of blood glucose with data. Another result is being able to increase attention to diet and exercise in relation to blood glucose which can describe improved diabetes control in patients in the intervention group[7].

In Chao's 2019 research, he found that (1) self-efficacy can influence the IPMF (interactive personalized management framework) intervention method and behavior change model, and (2) mobile device applications can be used to improve self-management plans.[10]

Based on the frequency of access to mobile device application features, patients show a preference for self-management which can affect overall adherence and clinical outcomes. The system collects data on heterogeneity of lifestyle, knowledge and feelings of patients about the disease, self-efficacy, self-motivation of health improvement elements, and risk conditions.[10]

Different self-management outcomes reported by 2 other studies (22%) with non-significant results.[8,11] No change in measurement results may occur due to heterogeneous patients, the presence of comorbidities, inhomogeneous implementation of the intervention, or possible effects of the program.[12] While other contributing factors are related to respondent compliance during the research period and the researchers did not review the level of willingness of respondents to participate.[8]

The results were not significant in Olmen's study due to the study design used, the level of the LTFU (Loss-to-follow-up) variable, heterogeneity of intervention implementation, and the tools used for data collection19. Meanwhile, other causes of insignificant results were reported on the grounds that the sample size was too small and the duration of the study was short.[2]

3) Mobile Device Intervention with Knowledge Enhancement

In writing this literature review, it was found a number of 4 studies with significant outcomes in the form of increased knowledge due to the use of mobile device applications in controlling risk factors for diabetes mellitus.[6,7,10,19] Various studies have found that diabetes self-management in the form of education increases diabetes knowledge, self-care behavior8 and clinical outcomes such as low HbA1c levels.[20]

An interactive and patient-centred educational approach with experiential-based delivery methods (beyond mere knowledge acquisition) was found to be effective in supporting informed decision making and meaningful behavior change. Technologies such as computerized individual assessment to support effective goal setting on patient choice can enhance interactive education and patient-centred methods.[21] Interventions to increase knowledge and intrinsic motivation aim to improve glycemic control (HbA1c), broaden perceptions of competence, and improve self-management skills in managing diabetes.

In Zhou's 2016 study, diabetes-related knowledge increased in the control group. However, the increase in patients in the intervention group was greater than in the control group. Patient knowledge leads to integrating customized behavior support in the context of the patient's specific clinical care plan and provides contextually and temporally relevant messages to influence patient's daily decision making.[18]

The concept of using applications to deliver information or education in disease management and control is not new. Mobile devices to deliver technology-based education and support are vital components of quality diabetes management. Diabetes education and diabetes management support through applications are proven to increase knowledge, increase the frequency of self-care/management behavior among diabetics, and improve health outcomes for patients, namely monitoring HbA1c35 levels. Seeing this, monitoring and support from health care providers has an important role in achieving the desired clinical goals. The use of mobile devices, especially text messages (SMS) and applications is a solution to go further in achieving health and quality of life in controlling diabetes risk factors.

The implication for future research is that researchers using the RCT methodology must carefully consider the interaction and control of personal studies and providers received by each group. This will help ensure the study results include the effects of the application, not from additional support.[22] Future researchers should also consider head-to-head comparisons of multiple applications. This study design will provide adequate attentional control and will be more patient-centered because patients know the application, they want to use in their treatment but do not know which one is most appropriate for them.

In a clinical context, the authors suggest HCP (Health Care Process) feedback should be central in all application designs and complemented by dynamic automated feedback. Future technologies should also be supported by behavioral change theory and elements of gamification to achieve greater effects on HbA1c control and improve patient compliance with diabetes applications.[23,24]

The advantages contained in this literature review are reviewing international journals indexed by Scopus with experimental/interventional study designs so that the effects of a treatment can be seen, in this case the use of information system technology to control diabetes mellitus. The journals used have been published no more than the last 10 years. In addition, research in the journals used was carried out in both developed and developing countries to see the diversity of the results obtained.

The drawback of writing this literature review is the limited reference related to diabetes mellitus prevention interventions using mobile devices in developing countries, so the effectiveness of using this system if applied in Indonesia is unknown.

Strengths and weaknesses

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the effects of a treatment can be seen, in this case the use of information system technology to control diabetes mellitus. The journals used have been published no more than the last 10 years. In addition, research in the journals used was carried out in both developed and developing countries to see the diversity of the results obtained.

The drawback of writing this literature review is the limited reference related to diabetes mellitus prevention interventions using mobile devices in developing countries, so the effectiveness of using this system if applied in Indonesia is unknown.

CONCLUSION

Based on a review of the results of a review of 17 studies, the majority of studies show that mobile device-based digital interventions are quite effective in controlling risk factors for diabetes mellitus including controlling HbA1c levels, improving diet, increasing physical activity, self-efficacy, and level of knowledge. Therefore, the development of similar studies, especially in Indonesia, can be carried out to formulate appropriate mobile device-based digital interventions.

ACKNOWLEDGEMENT

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