

# The impact of mobile telenursing on fasting blood glucose levels in diabetes: an interventional study

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## ABSTRACT

**Introduction:** High blood glucose levels in individuals with diabetes mellitus (DM) can lead to various complications, highlighting the need for adequate management. Diabetes Self-Management Education has been proven effective in controlling glycaemic events and preventing DM complications. Telenursing is a promising method for educating DM patients. This study aimed to determine the effectiveness of cell phone-based telenursing on fasting blood glucose (FBG) levels of people with DM.

**Materials and Methods:** This study used a quasi-experimental on 84 participants with DM, which was randomised into intervention (n=42) and control (n=42) groups. The intervention group was provided with health education through booklets and cell phone-based telenursing for four sessions and four sessions of follow-up, while the control group was given health education according to standards from the health centre (Puskesmas). All respondents had their FBG levels checked before, one month, and two months follow-up. The data were analysed using paired sample t-tests, independent samples t-test, and repeated ANOVA.

**Results:** The mean FBG measurements in the intervention group prior to treatment were 210.88mg/dL, decreased to 173.21mg/dL in the first month, and 177.48mg/dL in the second month (follow-up), while the control group started at 206.36mg/dL, decreased to 182.55mg/dL in the first month, and 191.64mg/dL in the second month. The difference between the two groups was not significant in both the intervention and control groups, p=0.181.

**Conclusion:** Health education through mobile phone-based telenursing and standard health centres both affect FBG levels of people with DM.

## KEYWORDS:

People with diabetes mellitus, health education, telenursing, cell phone, fasting blood glucose

## INTRODUCTION

Diabetes mellitus (DM) is one of the diseases whose prevalence continues to increase in the world.<sup>1</sup> DM has become a global public health problem.<sup>2</sup> The World Health Organization (WHO) estimates that more than 420 million people worldwide have DM. The International Diabetes

Federation (IDF) estimates that by 2030, around 643 million people will suffer from DM. It is estimated that by 2045, it will increase to 783 million. Indonesia is ranked fifth in 2021 for the number of people with 19.5 million people in the age groups 20-79 years with DM and by 2045 it is estimated to increase to 28.6 million.<sup>3</sup> North Sulawesi ranked the 4th highest in Indonesia (3.6%),<sup>4</sup> Sangihe Islands Regency is seventh out of 15 districts in North Sulawesi (2.54%). During the period from January to December 2021, the Enemawira Puskesmas in the rural area of Sangihe Islands Regency recorded the highest prevalence of diabetes mellitus (DM) with 387 visits. This was followed by Kendahe Puskesmas with 177 visits, and Kuma Puskesmas with 88 visits. All these cases involved patients with unstable blood glucose levels.<sup>5</sup> DM remains a global health issue with adverse impacts if left untreated, leading to the emergence of complications.

High blood glucose levels in people with DM are due to the inability of insulin to function effectively, which can lead to various complications.<sup>6,7</sup> The mortality and morbidity rates in people with DM are related to microvascular and macrovascular complications.<sup>8</sup> Optimal glycaemic control can overcome these problems through prevention or delay of complications and can be achieved if people with DM adhere to self-management behaviours such as healthy diet, physical activity, blood sugar monitoring, taking medication regularly, avoiding stress and adequate coping.<sup>9-11</sup> The success of DM self-management activities as described above, help to promote and maintain good health.<sup>12</sup> On the other hand, uncontrolled blood glucose levels in people with DM can lead to severe complications, requiring appropriate management.

The management of DM by implementing a healthy lifestyle (nutritional therapy and physical activity/exercise) and taking anti-hyperglycaemia drugs both orally and/or by injection can be facilitated through education and self-management support, which are crucial components of caring for individuals with DM.<sup>13,14</sup> Intervention methods used in urban areas may not be as effective in rural areas, so it is necessary to understand the appropriate strategies for rural needs and evaluate them to plan management strategies.<sup>15</sup> The management of people with DM needs to be carried out on an ongoing basis so that their knowledge, skills and abilities can increase, as well as activities that support the behaviour of people with DM.<sup>16</sup> Obstacles may arise, including limited access and low socioeconomic conditions in patients with chronic diseases because one or two visits are not enough to control their disease.<sup>17</sup> Therefore, effective and

economical management of people with DM requires education using technology such as telenursing, which is very useful for the care and follow-up of people with DM.<sup>18</sup>

Several studies apply telenursing in reducing glucose levels in people with DM, including telenursing via WhatsApp® in the form of videos and chats,<sup>19</sup> and also using ZOOM® media.<sup>20</sup> However, these studies require internet facilities. At the same time, the islands, especially those in Indonesia, are not all accessible by the internet network. Therefore, these methods are not suitable especially for those who reside in border areas where internet access is limited. The benefits of telenursing are easier access and cost-effective health services.<sup>21</sup> The use of cellular phones serves to monitor the therapy of people with DM and save time and transportation costs, especially for those who live on the islands, which have difficult access to health service centres.<sup>22</sup> Many people on the Sangihe islands live on the coast and mountains, where they do not have access to the internet, and transportation to the Puskesmas is difficult. This study aimed to determine the effectiveness of cell phone-based telenursing on fasting blood glucose (FBG) levels of people with DM.

## MATERIALS AND METHODS

The research design was quasi-experimental; the research was conducted in the working area of Puskesmas Kendahe, Puskesmas Enemawira and Puskesmas Kuma in Sangihe Islands Regency Indonesia, from June to September 2022. The inclusion criteria are people diagnosed with DM, can read and write, have a cell phone, aged  $\geq 40$  years and cooperative. The sample size estimation was performed using the Isaac and Michael formula. The required sample was 84 participants divided into intervention (n=42) and control (n=42) groups. The sampling method was probability sampling with a simple random sampling technique. Pre-intervention data were collected before the intervention, while post-intervention data were collected after providing health education through telenursing at the first month and the second follow-up. The same procedure applies to the control group also.

The intervention and control groups were given a booklet,<sup>23</sup> and the treatment group were given health education through cellular phone-based telenursing, namely the provision of health education consisting of eight sessions conducted once a week with a duration of 10-15 minutes via cellular phone, each session containing different material accompanied by follow-up. While the control group will be directly given health education according to the standards of the health centre (Puskesmas).

### Instrument

Data collection was carried out using a questionnaire consisting of respondent demographic data and a management knowledge questionnaire (DSCKQ-30).<sup>24,25</sup> The DSCKQ-30 questionnaire is used to assess diabetic patients' knowledge about modifiable lifestyles through 18 questions, adherence to diabetes self-care practices through eight questions, and the consequences of uncontrolled blood glucose levels through four questions. Each correct answer

receives a score of 1, while incorrect answers receive a score of 0. The English version of this questionnaire has been validated with a Cronbach's alpha of 0.89.24 The average correlation coefficient ranges from 0.59 to 0.68. Meanwhile, the Indonesian version has been validated with a Cronbach's alpha of 0.939.25 The observation sheet for FBG level measurements, conducted using the Accu-Chek Active glucometer from Roche, with the GB model, which has been standardised and certified by the International Organisation for Standardisation (ISO) - 15197 in 2013. The measurements of fasting blood glucose levels for each respondent were carried out by nurses.<sup>26</sup>

### Data Analysis

The results of this study were analysed using paired samples t-test, independent samples t-test and repeated ANOVA.

### Ethical Approval and Consent to Participate

This study has received ethical permission from the ethics commission of the Faculty of Public Health, Hasanuddin University. After receiving information about the purpose and procedures of the study, respondents could decide to voluntarily participate in this study by signing informed consent and receiving an explanation that they could withdraw from the study at any time and for any reason.

## RESULTS

Table I shows no difference in the average characteristics of respondents. In other words, the intervention and control groups were equal/homogeneous in age, marital status, occupation, income, duration of DM diagnosis, family history, pre-test on FBG and knowledge of self-care management. The results of statistical tests in Table II showed that the intervention group experienced an increase in self-care management knowledge one month after being given health education through telenursing using cellular phones ( $p < 0.001$ ), as well as one month later still showed an increase in knowledge after follow-up ( $p < 0.001$ ). This was also evidenced by the results of the repeated ANOVA test which showed a significant value of the increase in knowledge. In contrast, the control group in the first month did not show a significant change in knowledge ( $p = 0.860$ ), after follow-up it was seen that there was an increase in knowledge ( $p = 0.057$ ), this was also evidenced by the repeated ANOVA test ( $p = 0.587$ ). Table III shows that FBG levels in the first month decreased in both the intervention group ( $p < 0.001$ ) and the control group ( $p = 0.017$ ), but in the following month, FBG in both groups increased on average intervention (n=177.48) and control (n=191.64). Table IV shows that there was a difference in knowledge of self-care management before ( $p = 0.297$ ), the first month ( $p < 0.001$ ), and the next one month ( $p < 0.001$ ) after telenursing in the intervention and control groups. Still, it differed from the results of the examination of FBG levels, both before ( $p = 0.687$ ) and after the first month ( $p = 0.462$ ). The following one month ( $p = 0.181$ ) did not show any difference because both groups showed a decrease in FBG levels, but when viewed from the mean value of the intervention group, FBG levels showed the greatest decrease.

Table I: Basic characteristics of respondents (n = 84)

Variables	Intervention group (42) Mean (SD) n %	Control group (42) Mean (SD) n %	P
Age	56.52 (7.46) n %	57.36 (8.97) n %	0.645*
Gender:			
Male	15 (35.71)	5 (11.90)	0.010**
Female	27 (64.29)	37 (88.09)	
Marital status:			
Not married	1 (2.38)	0 (0.00)	0.580**
Marry	36 (85.71)	36 (85.71)	
Widow/widower	5 (11.90)	6 (14.29)	
Education level:			
Did not finish elementary school	4 (9.52)	1 (2.38)	0.035**
Elementary school	17 (40.47)	23 (54.76)	
Junior high school	13 (30.95)	6 (14.29)	
Senior high school	4 (9.52)	11 (26.19)	
Bachelor	4 (9.52)	1 (2.38)	
Work:			
Housewife	25 (59.52)	31 (73.81)	0.142**
Merchant	1 (2.38)	2 (4.76)	
Civil servant	3 (7.14)	2 (4.76)	
Self-employed	1 (2.38)	4 (9.52)	
Miscellaneous	12 (28.57)	3 (7.14)	
Income:			
< Rp.1,000,000	25 (59.52)	27 (64.29)	0.653**
≥ Rp. 1,000,000	17 (40.47)	15 (35.71)	
Duration of DM diagnosis:			
1-5 Years	26 (61.90)	31 (73.81)	0.591**
6-10 Years	11 (26.19)	8 (19.05)	
11-15 Years	2 (4.76)	2 (4.76)	
16-20 Years	3 (7.14)	1 (2.38)	
Family history of DM:			
None	16 (38.10)	22 (52.38)	0.188**
There is	26 (61.90)	20 (47.62)	
FBG pre-test	210.88 (50.54)	206.36 (51.99)	0.687*
Pre-test self-care management knowledge	17.95 (4.54)	18.93 (3.97)	0.297*

\*Independent samples t-test \*\* Chi-square test t

## DISCUSSION

The results showed a significant difference between the intervention group providing health education through cellular phone-based telenursing, and the control group, with health education for people with DM from the Puskesmas. This is in line with research, which states that the treatment group experienced an increase in DM knowledge at baseline and follow-up. The intervention consisted of education with a duration of two hours every two months for one year and continued regular follow-up every two months.<sup>27</sup> Education in digital content, in general, is one of the effective ways to increase the knowledge in managing the health and care of people with DM.<sup>28</sup> Self-care management knowledge is information obtained through personal experience or professional orientation, which individuals acquire to manage their health conditions.<sup>29</sup> Field research indicated low levels of respondents' knowledge regarding self-management before the intervention, but a significant change occurred after receiving one month of education through mobile phone-based telenursing intervention and follow-up for the next month. This proves that providing health education through mobile phone-based telenursing is effective in improving self-management knowledge among individuals with DM in the intervention group.

The control group, there was also an increase in knowledge, although the change was not significant. This is because respondents received a module in the form of a booklet at the beginning and were educated by health workers at the Puskesmas every time they came to check their health. Booklet is a printed media that aims to disseminate information in the form of text and images and has several advantages, namely easy to learn at any time because it is in the form of a book, besides that, booklets can collect a lot of information and are very suitable for use as educational media for people with DM.<sup>30,31</sup> Currently, health literacy plays an important role in the management of DM. Maximum health literacy will enable a person to access, understand and use health information and services in making decisions about health care.<sup>12,32</sup> The control group was not given the intervention of telephone-based telenursing. Thus, understanding self-care management could be a faster change; this is because patients who visit the Puskesmas, in addition to checking their health, also get education through health workers. Education is provided in groups, one-way (lecture), and discussions are held if any of the participants want to ask about the material that has been presented, making it difficult to evaluate the patient's understanding of the material that has been given. Follow-up is also carried

Table II: Results of analysis of differences in knowledge of self-care management before and after telenursing in the intervention and control groups.

Knowledge Variable	Intervention group		p-value	Control group		p-value
	Mean (SD)	Mean Difference (SD)		IK95%	Mean (SD)	
Before telenursing	17.95 (4.54)	-5.07 (3.89)	0.000*	18.93 (3.97)	-0.17 (6.06)	0.860*
One month after telenursing	23.02 (2.19)	-7.05 (4.55)	0.000*	19.10 (4.47)	-0.64 (2.13)	0.057*
Two months after telenursing	25.00 (1.38)	-8.47 - -5.63		19.57 (3.91)		

\* paired samples t-test; a Repeated ANOVA-pairwise comparison (Bonferroni)

Table III: Results of analysis of differences in fasting blood glucose levels before and after telenursing in the intervention and control groups

Fasting blood glucose level	Intervention group		p-value	Control group		p-value
	Mean (SD)	Mean Difference (SD)		IK95%	Mean (SD)	
Before telenursing	210.88 (50.54)	37.67 (56.38)	0.000*	206.36 (51.99)	23.81 (62.04)	0.017*
One month after telenursing	173.21 (56.94)	33.41 (43.06)	0.000*	182.55 (58.70)	14.71 (45.42)	0.042*
Two months after telenursing	177.48 (43.38)			191.64 (52.43)		

\*paired samples t-test; a Repeated ANOVA-pairwise comparison (Bonferroni)

**Table IV: Results of analysis of differences in knowledge of self-care management and fasting blood glucose levels between the intervention group and the control group.**

Variables	Mean (SD)	p-value	Mean difference (95% CI)
Knowledge			
Before telenursing			
Intervention group (n = 42)	17.95 (4.54)	0.297*	-0.98 (-2.83-0.87)
Control group (n = 42)	18.83 (3.97)		
One month after telenursing			
Intervention Group (n = 42)	23.02 (2.19)	0.000*	3.93 (2.40-5.46)
Control Group (n = 42)	19.10 (4.47)		
Two months after telenursing			
Intervention Group (n=42) Control Group (n=42)	25.00 (1.38) 19.57 (3.91)	0.000*	5.43 (4.16-6.70)
Fasting blood glucose levels			
Before telenursing			
Intervention Group (n=42)	210.88 (50.54)	0.687*	4.52 (11.19 - -17.73)
Control Group (n=42)	206.36 (51.99)		
One month after telenursing			
Intervention Group (n=42) Control Group (n=42)	173.21 (56.94) 182.55 (58.70)	0.462*	-9.33 (12.62 - 234.44)
Two months after telenursing			
Intervention Group (n=42) Control Group (n=42)	177.48 (43.38) 191.64 (52.43)	0.181*	-14.17 (10.50 - -35.06)

\*independent samples t-test

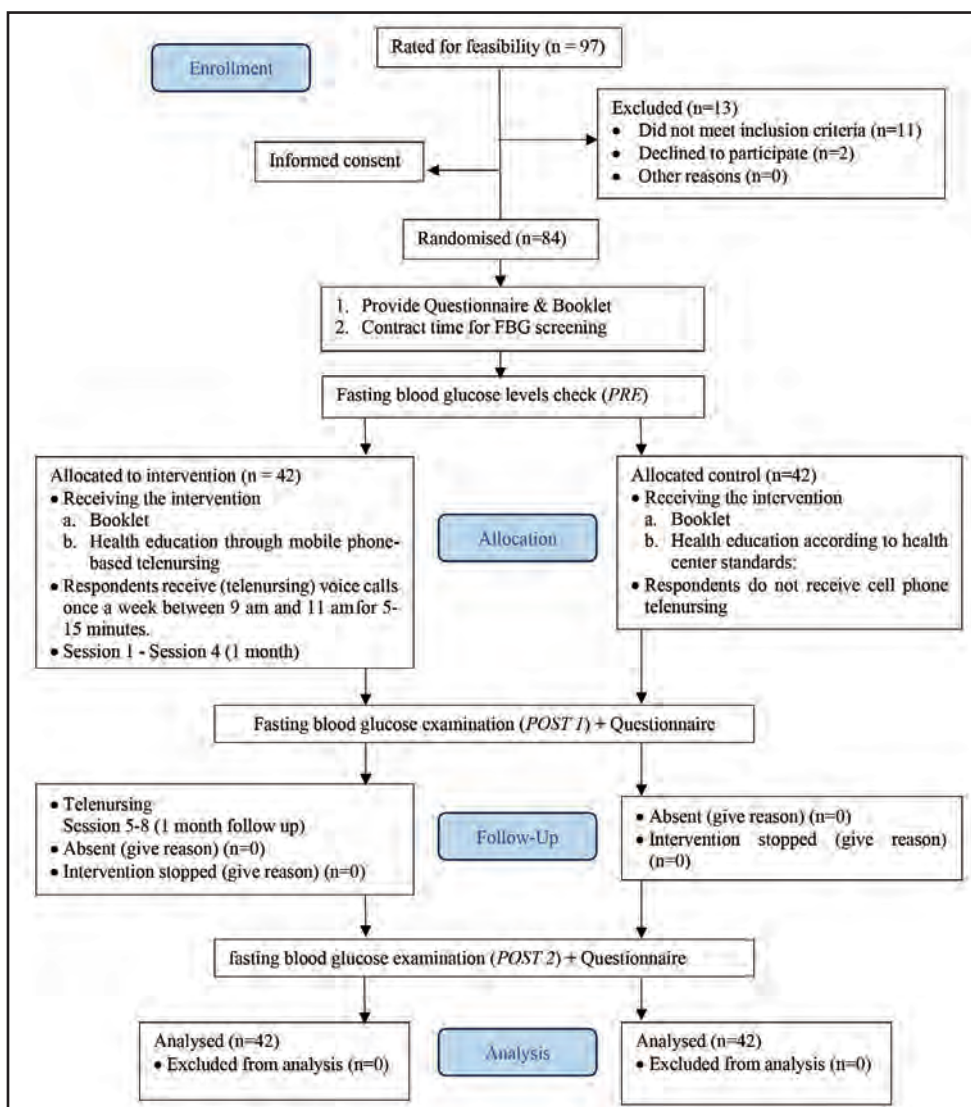


Fig. 1: Consort diagram



out during patient visits. Therefore, active and continuous health education will provide substantial control over patients to be active in increasing interest in health literacy, specifically in DM.

Providing information about DM disease management, if carried out continuously and repeatedly within a specific time accompanied by monitoring, will have an impact on strengthening and changing one's behaviour towards a particular situation.<sup>33,34</sup> Telephone follow-up is a beneficial and inexpensive method of assessing and assisting client care issues. It can also help with early detection of complications. It can inform the patient about the possibility of complications, so that prompt and appropriate treatment can be given to the client.<sup>35</sup>

The findings of this study indicate that there was a decrease in the FBG levels of the subjects in the first month following the telenursing intervention, but there was an increase in the following month. This occurred because the day before the FBG level examination, some respondents attended weddings, religious ceremonies, celebrations and other events, where food and drinks that were high in glucose were available (in the customs of the people in the Sangha islands, sweet food will bring good luck to those who organize celebrations), to honour the organisers of the celebration, guests must consume the food that has been served even though they know it will have an impact on increasing FBG levels. The decrease in FBG levels in people with DM has a positive impact on the implementation of telenursing via cellular phone for 10 to 15 minutes for four sessions and follow-up four sessions. This is supported by previous research, which states that there is a decrease in blood glucose levels for those who receive telephone calls from the nurse coordinator every Thursday (10-12 am) for 5-15 minutes.<sup>19</sup> Another study reported that education given to the intervention group in 1 meeting/week for 30 minutes within 4 weeks and regular follow-up by telephone (telenursing) for 12 weeks and FBG measurements taken before and after the activity can reduce the FBG levels of the intervention group.<sup>36</sup>

The control group in this study showed a decrease in FBG levels after receiving education in the first month and experienced a slight increase in FBG levels during the examination in the second month, although not given telenursing, but still given a booklet.<sup>23</sup> The same applies to the intervention group and education from health workers at the health centre. The advantage is that a person can be more precise in receiving information because it is equipped with text pictures and attractive designs tailored to the target through booklets containing DM education received by respondents.<sup>37</sup> Health literacy is an important asset that supports various health actions to improve well-being and prevent and manage poor health for the better.<sup>38</sup> This supports the idea that patients who are given booklets without telenursing education experience a decrease in blood glucose levels because with increased literacy, the community is interested in making changes from the information obtained.

The results of this study indicate that both the intervention and control groups showed changes in mean values, both in knowledge of self-care management which impacted the decrease in FBG levels. It is also observed that there was no difference in FBG levels among people with DM in the intervention and control groups. However, the average decrease in FBG levels in the intervention group was significantly higher compared to the control group. This is due to the difficulty in achieving a decrease in FBG levels to normal limits because of complicating factors and physiological damage in blood sugar regulation, which typically remain constant.<sup>39</sup> This study also demonstrates that providing health education through mobile phone-based telenursing accompanied by follow-up is not sufficient to change someone's habits regarding consuming high-sugar foods, which will ultimately impact the blood sugar control of respondents. This is consistent with previous researchers who stated that barriers related to habits include deliberate non-compliance, difficulty in changing old habits, culture, busy work schedules, and inadequate access due to uncertain or seasonal food supplies.<sup>40</sup> Therefore, it is crucial to conduct continuous and sustainable follow-up.

#### LIMITATION

Although this study is a quasi-experimental study comparing between the group given telenursing with conventional therapy, several unmeasured factors that may have influenced the study findings, such as: the study did not fully account for potential confounding variables that could impact self-care management knowledge and fasting blood glucose (FBG) levels. Factors such as socioeconomic status, comorbidities, dietary habits, physical activity levels and adherence to the intervention may have affected outcomes but were not adequately controlled in the analysis. Cultural practices, such as customary celebrations involving high-sugar foods, may have influenced FBG levels and confounded the study results. Cultural factors were not explicitly addressed or controlled for in the study, potentially affecting the interpretation of the findings. External factors, such as stress levels and health conditions, may have influenced FBG levels and were not adequately considered in the study design or analysis. The study primarily focused on self-care management knowledge and FBG levels as outcomes. Other relevant outcomes, such as quality of life or healthcare utilisation, were not included in the assessment, potentially limiting the understanding of the broader impact of the intervention, which should be explored in future studies.

#### CONCLUSIONS

This study also indicates that health education through mobile phone-based telenursing can improve the knowledge of people with diabetes mellitus regarding self-care management with a 1-month education duration followed by weekly follow-ups for a month. However, in contrast to the control group receiving education according to the standards of the health centre, there was an increase in knowledge after the follow-up. Meanwhile, there was no difference in the reduction of fasting blood glucose levels in both groups because both groups showed a significant decrease in fasting blood glucose levels.

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