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Effectiveness of health literacy through transformative learning on glycemic control behavior in adult diabetes patients: a mixed methods approach

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# Effectiveness of Health Literacy through Transformative Learning of Glycemic Control in Diabetic Adults

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This research used a mixed methods intervention design. The research aimed to: 1) study the perspectives of diabetic adults and 2) investigate the effectiveness of health literacy through transformative learning of glycemic control. In study 1, through qualitative research, the perspectives of 13 diabetic adults in Bangkok, Thailand, were examined using in-depth interviews. The findings were divided into three themes that reflected the beliefs of the patients: 1) the serious nature of the disease; 2) that made life difficult; and 3) that the glycemic control relied on patients' sense of self-reliance and efficacy. The perspectives towards health literacy consisted of two themes: 1) information must be analyzed and evaluated before usage; and 2) hierarchical relationship influences the communication between providers and patients. The study 2 was an experimental research, in which consisted of 40 diabetic adults, divided equally into 2 groups; the experimental (20 participants) and control (20 participants) group. The instrument used were the glycemic control questionnaire, and the measurement of glycated hemoglobin (A1C). The intervention consisted of 4 sessions for 4 weeks, for two hours per session, and the final session was visiting their homes. The ANCOVA and repeated measures were applied for data analysis. The results revealed that: 1) the experimental group had more glycemic control and less A1C than the control group ($p < 0.01$); and 2) the experiment group had changing and maintaining in glycemic control and A1C ($p < 0.01$). The findings of this study could be useful for healthcare providers to develop the glycemic controlling program based on the patients' contexts.

*Keywords*: transformative learning, health literacy, glycemic control, diabetic adult, mixed methods

The incidence of diabetes in the population is a considerable burden for developing countries as it reduces the quality of life, increases mortality, and drives up healthcare costs. The disease detection rate in Thailand has increased in recent years, and significant numbers of patients suffer from complications but glycemic control performed by regular examinations remains suboptimal (Deerochanawong & Ferrario, 2013). Moreover, patients with diabetes are at risk of adverse health outcomes, including heart attacks, strokes, amputations, blindness, and end-stage renal disease. Although longer duration of diabetes, poor control of intermediate risk factors (for example, blood pressure, cholesterol levels, glycemic control) and genetic susceptibility are clearly associated with the increased risk of adverse outcomes in patients with diabetes, non-clinical factors such as patients' socioeconomic and psychosocial characteristics play a key role in determining the level of risk (Murea, Ma, & Freedman, 2012; Peyrot, Mcmurry, Jr., & Kruger, 1999). Several studies have shown that early glycemic control can prevent microvascular and neurological complications in diabetes (Diabetes Control and Complications Trial Research Group, 1993).

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The long-term glycemic control is to reduce hemoglobin A1C (A1C), which refers to the average blood glucose levels during the previous 2-3 months (Sherwani, Khan, Ekhzaimy, Masood, & Sakharkar, 2016), according to guidelines set forth by the ADA and the American Association of Clinical Endocrinologists/American College of Endocrinology (AACE/ACE), respectively (American Diabetes Association, 2009; Rodbard et al., 2007). Lower levels of health literacy which have been found to be common in patients with diabetes, have been associated with worse diabetes outcomes (Ad Hoc Committee on Health Literacy for the Council on Scientific Affairs, 1999; Gazmararian et al., 1999; Schillinger et al., 2002). Diabetes requires extensive self-care, so differences in self-management behaviors associated with poorer health literacy may be the important contributors to the disparity in outcomes. Low health literacy has been associated with poor self-care in other chronic illnesses as well (Kalichman, Ramachandran, & Catz, 1999). Compared to patients with adequate health literacy, patients with limited health literacy have been shown to have difficulty understanding their medical condition and its management (Davis & Wolf, 2004; Gazmararian, Williams, Peel, & Baker, 2003; Torres & Marks, 2009; Wolf et al., 2004), are less likely to engage in self-care behaviors (Osborn, Paasche-Orlow, Davis, & Wolf, 2007), have poorer health outcomes (Bautista, Glen, Shetty, & Wludyka, 2009), and a higher risk of mortality (Baker, Wolf, Feinglass, & Thompson, 2008; Baker et al., 2007).

In particular, health literacy, defined as "the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions", has been theorized to be one important, non-clinical factor that may decrease the risk of adverse outcomes in diabetes (Institute of Medicine (US) Committee on Health Literacy, 2004). A recent study examined potential mechanisms through which health literacy impacts on health behavior and health status, there were significant paths from health literacy to knowledge, knowledge to self-efficacy, self-efficacy to physical activity and physical activity to health status (Osborn, Paasche-Orlow, Bailey, & Wolf, 2011). The mechanisms linking health literacy to diabetes self-care and clinical outcomes are poorly understood from the cognitive domain (Paasche-Orlow & Wolf, 2007; von Wagner, Steptoe, Wolf, & Wardle, 2009). Therefore, it is essential to clarify about the significance of cognitive function to gain more health literacy. This may be beneficial for diabetic adults to change some perspectives for self-directed learning, and transformational learning.

Transformative learning (TL) is the concept about the transformation of point of view, which involves changing existing beliefs and thought patterns through the use of discourse and critical reflection (Mezirow, 1991, 2000). TL allows participants to engage in knowledge construction, acting with facilitators to apply new information and broaden existing schemes of meaning (Dirkx, 1998). According to Mezirow (1991), this is accomplished through a ten-phase process: first the presence of a disorienting dilemma, then self-examination, critical assessment of assumptions, recognition of discontent and identification with similar others, exploration of new options, planning, acquiring knowledge to support plans, experimenting with new roles, building confidence, reintegration, and renegotiation of relationships (Kitchenham, 2008, p.105; Mezirow, 1991). During these stages the learner uses critical reflection and discourse to evaluate information, skills, roles, and perspectives (Mezirow, 1991). Key components of Mezirow's theories, including the disorienting dilemma, critical reflection, and discourse, will be explored in relation to transformative self-care in this research. All of Mezirow's transformative learning process can be applied to transformations related to healthcare. Critical learning can result from the application of Transformational Learning Theory with adults living with diabetes since the majority have to make decisions about self-managing their diabetes

(Funnell, 2006; Skovlund, Peyrot, & on behalf of the Dawn International Advisory Panel, 2004). Self-management is crucial to maintaining target glycemic levels and preventing complications in these individuals.

This TL should include skills for assessment of the validity and applicability of knowledge or ideas (Mezirow, 1997). Critical refection and the ability to critically assess information and develop priorities are important actions for adults striving for health (Nutbeam, 1999). Long-term care may assist in fostering critical reflection in self-care and self-management in patients. Models where the patient is seen on a regular basis with plans made for incremental implementation of new behaviors and skills may allow the patient time to critically reflect on the information received and use the provider or health learning community as a source of feedback in this process.

## Study Overview

An intervention mixed methods design was used in this study. The design involves the combination of qualitative and quantitative methods (Creswell, 2015). A qualitative study was conducted first to explore patients' perspectives on their diabetes in some depth and their levels of health literacy in relation to their diabetes. The knowledge and understanding of the patients' needs were assessed from this, and then they were informed about the contents of the intervention, the design of which followed the Transformational Learning Model (Mezirow, 1991). An embedded data from the qualitative study was used to develop the health-literacy through transformative learning program on glycemic-control in Adult Diabetes. The program was then implemented in quantitative study as a quasi-experimental research.

### Ethical Considerations

This research was approved by the Institutional Human Research Ethics Committee, Srinakharinwirot University (SWUEC 032/59E). Informed consent was obtained from all the participants.

## I. Study 1

The objective of study 1 was to study the perspectives of diabetic adults. Study 1 also considered the findings into developing health literacy with transformative learning intervention on glycemic control of diabetic adults.

## Method

### Participants

The population of this study were adults with type 2 diabetes mellitus aged between 21-59 years in 2017. For the first study, the thirteen participants, who had information-rich cases (Palinkas et al., 2015). They were recruited by using purposive sampling. Additionally, they attended to their routine clinic appointments and were willing to participate in this study. The inclusion criteria were including; 1) a diagnosis of type 2 diabetes mellitus for at least 5 years, 2) the glycemic index testing in the past six months by comparing with the standard glycemic

control level less than 126 mg/dl (American Diabetes Association, 2014). It could be divided in to two groups; the uncontrolled glycemia group (the fasting plasma glucose sample more than 126 mg/dl) and the controlled glycemia group (the fasting plasma glucose less than 95 mg/dl).

**Interview Process**

Interview sessions were conducted at the participants' homes in Bangkok. A semi-structured interview guide was used, and is summarized in Table 1, with examples of open-ended questions to collect in-depth information. The questions and the structure of the interview was kept simple and did not present literacy challenges to the participants.

Table 1

*Interview guideline*

| Discussion Topic | Examples of Specific Probes |
| --- | --- |
| Experiences of being diabetic patient | Can you explain about situation since you found out that you have diabetes? How about treatment and difficulty self-care? |
| | When you have a follow-up with the doctor, how difficult do you communicate with the doctors? |
| Glycemic control behavior | When you see a doctor for follow-up the treatment, which topic do you ask the doctor? |
| | In your opinion what are the strategies to take care yourself when you found out that you have diabetes? |
| Condition toward practices for glycemic control | Do you think of being diabetes affect to you? How? |
| | Do you think self-monitoring of blood glucose was useful for you? |

**Data Analysis**

All the interviews were recorded digitally, transcribed verbatim, checked and analyzed using thematic analysis with pattern matching. The group of patients with good glycemic control were analyzed separately from those with poor glycemic control. Qualitative validation criteria were then applied to the data, these included; triangulation: convergence sought among multiple sources of information (interview transcripts, relevant theory and between the authors) to identify and develop themes and validate the data. The results were checked by the authors independently and there was a high level of agreement as the topics of interest were clearly identified in the interview schedule.

## Results of Study 1

From The finding of the result, it showed that nine participants were uncontrolled glycemia and four participants were controlled glycemia. This Study 1 was about examining the perspectives of diabetic adults. The result of Study 1 produced the following significant findings: It also revealed that patients' perspectives on diabetes mellitus could be divided into three primary themes which were: i) diabetes mellitus was not a serious disease. As one diabetic

adult elaborated: *"Diabetes- we can live together with it. One is not going to die if you have good self-care and self-control"*; ii) diabetes had mellitus made life difficult. As one diabetic adult stated: *"I got crisis in my life and was unemployed as a result of diabetic coma"*; and iii) diabetic patients who were able to control their blood sugar levels believed that the success of glycemic control relied on patients' sense of self-reliance and efficacy. According to one diabetic adult, *"The complications can be prevented and also managed by a daily self-care. Taking control of blood sugar level is our responsibility, not caregiver's! If there is negligence in self-care, then there is a price to pay by the complications"*. These findings illustrated how diabetic adults perceived diabetes.

In regard to the perspectives towards health literacy in adult diabetic patients, the research was summarized in two themes of i) Methods for evaluate Health information and ii) hierarchical relationship between physician and patients. The patients who could glycemic control believed that the ideal information obtained and used for diabetes self-care must be analyzed and evaluated before usage on the other hand, patients who could not do the same thing believed the health information from product reviews of well-known people must be effective and useful for health without examination. It also suggested that the extent of patients' knowledge on diabetes also affected their decision-making regarding information analysis. If the patients had more knowledge about diabetes self-care, they would tend to assess information based on its credibility before practical uses. As a diabetic adult mentioned "Health information that I utilize to take care myself, have to analyze before using it". Regarding communication among medical providers and patient. The effective communication with the good relationship from the medication providers made patients feel free to ask questions. On the contrary, the uncontrolled patients felt doctors were very difficult to talk with because of the hierarchical relationship, the doctor's status seemed higher than the patients. Patients perceived that, in the hierarchical relationship, the doctor had higher status than them. As doctors were respectful and formidable, this perception influenced how information was communicated and transferred between medical providers and patients. As a diabetic adult pointed out "Dare not to ask the doctor because he is obviously highly educated".

## Discussion

This study allowed comparisons to be made about how diabetes was understood and managed by patients with markedly different levels of glycemic control in terms of experience of diabetic adult, and condition related to health literacy. The diabetic adults with better glycemic control levels displayed higher levels of health literacy in relation to their management of their diabetes. This was supported the findings of reinforced the value of an intervention for patients with lower levels of health literacy. The findings together with the knowledge gained from previous research and theory informed the development of a health literacy program incorporating transformative learning process to improve glycemic control in diabetic adults in study 2.

## II.    Study 2

The objective of Study 2 was to investigate the effectiveness of health literacy with transformative learning on diabetic adults' glycemic control. We hypothesized that developing health literacy with transformative learning program would improve glycemic control and A1C.

The knowledge and understanding of the patients' needs was assessed from qualitative study, then informed the contents of the intervention, the design of which followed the transformational learning model (Mezirow, 1991).

## Method

The intervention was evaluated as a randomized control trial, with an experimental and a control group. using purposive matched sampling to construct the two groups. The experimental group received the program for developing health literacy which aimed to improve behaviors related to glycemic control. The intervention consisted of ten sessions with ten activities and was delivered for 4 weeks. The control group also received the health education program for diabetes. The delivery was identical to that of the experiment group.

For the experimental and control groups measurements were taken at three points; 1) at baseline A1C levels were tested; health literacy, and glycemic control were assessed; 2) after finishing the program, health literacy and glycemic control were assessed; 3) at three months follow up A1C, health literacy and glycemic control were assessed.

### Participants

Type 2 diabetic adults from two communities in Bangkok were recruited, and participants were used randomly matched pair selection groups for age, education level and health literacy score, thereby eliminating any bias toward random allocation. A sample size was calculated by using estimating sample size with power analysis (alpha = 0.05, power = 0.80) suggested a sample size of 40 diabetic adults which divided into 20-experiment group and 20-control group. The participants' ages ranged from 27 to 58 years ($M = 43.98$, $SD = 3.92$). In terms of educational level, 7.5% (3) had obtained less than high school education, 50% (n = 20) had obtained high school, and 42% (n = 17) had obtained an associate bachelor's degree. The majority or 75% (n = 15) of the participants had been diagnosed for 5 to 14 years ($M = 7.5$, $SD = 2.45$) and diagnosis of diabetes for greater is 5 years was 25% (n = 10)

The inclusion criteria were: i) clinical diagnosis of type 2 diabetes since at least 5 years; ii) age of 21 and 60; iii) poor reading and writing skills but not cognitively impaired and able to read and sign a consent form; iv) test of A1C ≥7.0% or a FBS more than 125 mg/dl; and v) low health literacy scores.

Exclusion criteria included: i) diagnosed as dementia or psychosis (by health provider report or chart review); ii) other complex health conditions; or iii) impaired glucose tolerance condition, that was impact to glycemic control.

### Intervention and Procedure

Enrollment for the Transformative Learning Intervention started from June to September 2017. Participants were asked to complete surveys regarding their baseline health literacy, glycemic control and A1C. All sessions were conducted by two researchers. They have qualified and specialized in diabetes care.

The first 4 sessions of the Transformative Learning Intervention used the theory of transformative learning and health literacy; were as follows: First session was to perspective transformation for encouraging the participants to become uncertain about their views, which a

person's behavior in glycemic control and daily diabetes self-management activities. This session used concept of transformative learning in step 1-4, included; 1) disorienting dilemma; 2) self-examination; 3) sense of alienation; and 4) relating discontent to others. This process used role play and critical self-reflection. Second session was to search for guidelines and planning daily activities for the participants to explore and plan their new practices individually about glycemic control, communication with doctors and applying health information to their health care. This session used the concept of transformative learning in step 5-6, included; 5) exploration of options for new roles, relationships, and actions; and 6) planning of a course of action. This process used critical debate. Third session was to develop glycemic control skills, analysis of health information skills and develop communication skills for practicing for transaction communication for health information with health care professionals. These practices were analyzed on health media-sharing sites, such as YouTube, Facebook and Line, etc., included; analyzing the massages, acknowledgement of the purpose, checking of source and comments for collected quality and safety information. This session used concept of transformative learning in step 7, included; 7) acquisition of knowledge and skills for implementing one's plans. This process used role play. Finally, fourth session was to build self-confidence in changing health behaviors for reviewing daily diabetes self-management activities plans. This session used concept of transformative learning in step 8-9, included; 8) provisional trying of new roles; and 9) building of competence and self-confidence in new roles and relationships. This process used critical debate and feedback learning.

After the 4 sessions were finished, the final session was to home visit for providing health information and suggestions to review the successes and failures arising from their conduct. This session used concept of transformative learning in step 10, included; 10) a reintegration into one's life on the basis of conditions dictated by one's perspective, and assessed with glycemic control questionnaire and A1C, then after 3 months (follow-up) were re-assessed.

## Outcome Measures

The primary outcome of the study was glycemic control defined as the act of self-care that effect to normal glycemic control. The Glycemic Control Questionnaire was developed from Lorig et al. (1996). Using the 4-rating scale from "Never" to "More than 3 times a week" (Cronbach's Alpha = 0.81). Higher score had more glycemic control than lower score. Back translation technique was used for translating the behavior questionnaire from English to Thai language. After the translation is completed, it is validated by experts and field tested to insure that target population will comprehend all questions.

Secondary outcomes include change in A1C defined as the amount of blood sugar (glucose) attached to hemoglobin after 3 months of the transformative learning intervention, as well as the change in number of participants in each diabetic category (i.e., normal, type 2 diabetes) from the beginning of enrollment to after 3 months of intervention.

## Data Analyses

Statistical analyses were conducted using SPSS. Descriptive statistics were used to describe the participants using Chi-square tests of categorical data for comparison between the intervention and the control group, found no significant difference. Before testing the hypotheses, check the assumption, such as normality, compound symmetry etc. For hypotheses testing, the data were analyzed by ANCOVA and repeated measure ANOVA. Statistical significance was set at $p \leq 0.05$.

## Results of Study 2

Glycemic control and A1C increased from baseline to posttest and follow up in the two group as presented in Table 2.

Table 2

*Mean and standard deviations of the glycemic control and A1C measures baseline, post-test and follow-up for the two groups*

| Test time | Treatment | AIC | | Glycemic control | |
|-----------|-----------|------|------|------|------|
| | | M | SD | M | SD |
| Baseline | Experiment | 7.20 | 0.52 | 59.15 | 2.89 |
| | Control | 7.39 | 0.34 | 61.00 | 3.42 |
| Post-Test | Experiment | - | - | 82.30 | 2.56 |
| | Control | - | - | 53.95 | 7.15 |
| Follow-Up | Experiment | 6.61 | 0.58 | 81.05 | 2.09 |
| | Control | 7.24 | 0.38 | 55.95 | 4.41 |

Firstly, an ANCOVA, with baseline glycemic control as a covariate variable, was performed to determine differences in glycemic control between the intervention group and the control group. The overall F revealed a significant difference in the mean of post-test scores of glycemic control between the groups ($F_{(1,37)} = 249.40$, $p < 0.001$). A post-test with post hoc tests showed that the intervention group reported significantly higher glycemic control scores than the control group (Mean difference = 28.36, Effect size = 1.85); and the overall F revealed a significant difference in the mean of follow-up scores of A1C between the groups ($F_{(1,37)} = 18.05$, $p < 0.001$). A follow-up with post hoc tests showed that the intervention group reported significantly lower A1C scores than the control group (Mean difference = -0.49, Effect size = 0.84)

The statistical analysis of glycemic control and A1C in the intervention group were performed with an ANOVA with repeated measures. The result revealed that the glycemic control were affected by time ($F_{(1.17, 45.54)} = 10.62$, $p < 0.001$). For glycemic control, there were significant differences at baseline, post-test and 3-month follow-up in the intervention group ($p < 0.05$), as present in Figure 1.
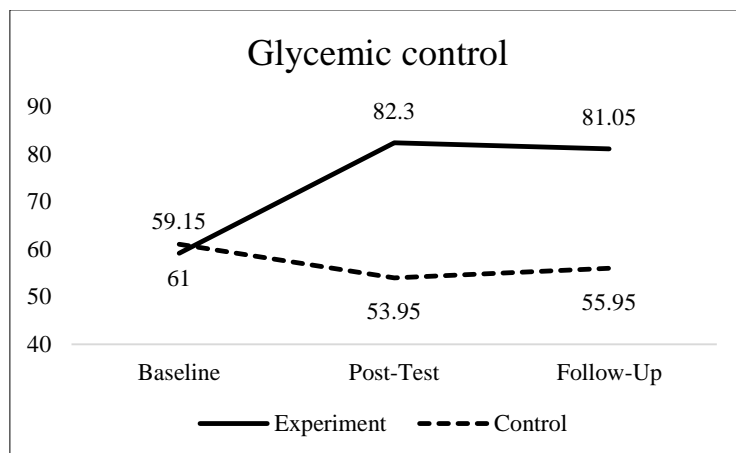


*Figure 1.* Glycemic control means comparison between time in the intervention group

Moreover, the result revealed that the A1C were affected by time ($F_{(1, 39)}$ = 30.32, $p <$ 0.001). For A1C, there were significant differences at baseline, and 3-month follow-up in the intervention group ($p < 0.05$), as present in Figure 2.
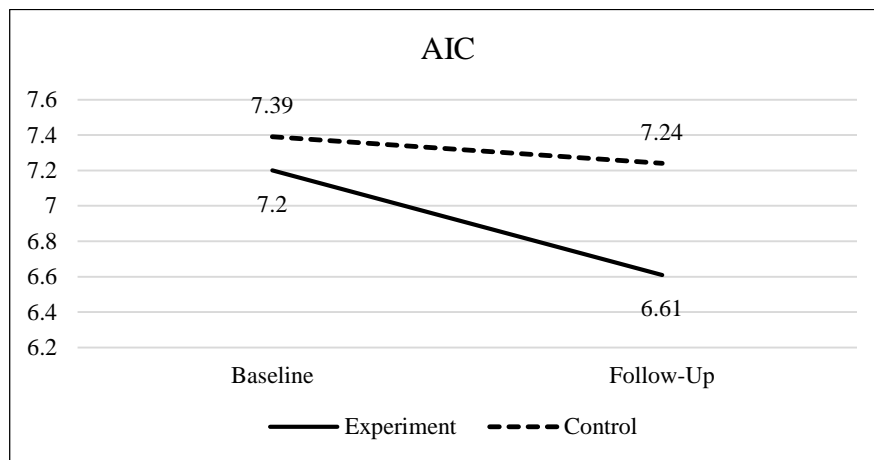


*Figure 2.* A1C means comparison between time in the intervention group

## Overall Discussion and Conclusion

The main study on an intervention program was designed to induce behavior change for glycemic control**.** The findings showed that follow-up assessment after 1 month and 3 months, had found that the glycemic control interventions included; food consumption behavior; physical activity; drug usage; and stress reduction measures. The sample population shows a statistically significant increase at .05, measured against prior to joining the study. Compared to the controlled group, they also showed significant difference at .05 as well. Which can be used to explain that the program subjected to this study shows the learning methodology that focus on internal behavioral changes which led to the behavioral adjustments that allowed glycemic control. The idea employs perception adjustments that result in new behaviors. The internal learning process uses analytical tool to allow acknowledgement of the problem, or the needs, through analysis, evaluation, and sharing of experiences to come to conclude that allows the individual to make sense of the perceived information. That leads to the changes of the distorted perception (Hein, 2004), and encourages critical discourse. They are the foundation of the health literacy program that improves cognitive factors among adult living with diabetes, including social and intellectual skills in self-care. The final outcome of this transformative learning process is the integrated health behavior of the sample population and new lifestyle. The findings are in alignment with Functional Health Literacy (Nitri & Stewart, 2009) that uses transformative learning, through fostering curiosity of the learner, and reflections of self-care information. Basic information includes; what is diabetes, eating behaviors, physical activity, medications, complications from DM, and self-management. After the program had been initiated, the research samples showed an increased functional health literacy, which coincides with Susic's studies (Susic, 2009) whose study on interactive health literacy was promoted through activities that encourages searches for quality health information, health literacy, and understanding of one's health.  Furthermore, other elements included decision making in health-related issues, testing, evaluation of physical activities and in the ability to identify correct health information.

**Reduction in A1C;** The result of this study shows that after testing A1C among the sample and controlled group of the study, there are differences after three months into the program. Also, there are differences between pre-program and 3 months' post-program closure, for instance, the objective of testing for blood sugar level is to confirm the variants in glycemic control. Glycemic control is a result of consistent behaviors that aligns with the diagnosis of diabetes, to evaluate treatment results and glycemic control in diabetes patients. Screening for A1C is a method that can be an indicator of long-term glycemic control (Sherwani et al., 2016). The screening for hemoglobin A1c or glycated hemoglobin would show the sugar level during the period of 120 days (American Diabetes Association, 2014) therefore the biochemical variant is the blood glucose level and is a health outcome variant resulting from the individual's health behavior. This study showed the glycemic control level in DM patients, aligns with the concept of health literacy, and it contributes to appropriate health behaviors and positive outcomes towards health (Nutbeam, 2008).

## Research Limitations

Testing for A1C, the researcher had achieved them from the subjects of the study who had received medical checkups from their health facilities and had submitted the lab test results to the researcher for documentation. Hence, the A1C results are taken from different laboratories, which may produce slight inconsistencies between the results.

## Recommendations

The study has found that perception of self-care of DM patient is the key factor in health behavioral changes. Therefore, a study on health system which promotes health literacy among the public is crucial to ensure the understanding of a sustainable self-care concept.

Due to time limitation, this study had only used three months of data. There should be a long-term study (12 months) on the effectiveness of the program (or more), to study the sustainability of the program. Also, that will show when the re-training would be required for the target sample.

This is a dynamic group program for developing a cognitive skills and social skills. Therefore, the program should increase recruitment of participants to at least 12 cases for maintaining a dynamic group.

Another recommendation is about the importance of creating the communication between patient and physician. A more thorough research should be developed to study communicative methods that the physician employs. Experimental study or participatory study would be useful methodology in this regard.

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