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# Weekly lifestyle counselling improves glucose level in type 2 diabetes mellitus patients

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## ABSTRACT

**INTRODUCTION**
Regular physical exercise and healthy life style have been demonstrated to improve health status of a number of populations. In adherence, counselling on life style and dietary nutrition have been one of the investigated methods to determine its effectiveness toward metabolic syndrome predictors. The aim of this study was to evaluate the effect of lifestyle change and dietary counselling on glucose level, body mass index (BMI), waist circumference, blood pressure, total cholesterol, triglycerides, low density lipoprotein (LDL), and high density lipoprotein (HDL) in type 2 diabetes mellitus (T2DM) patients.

**METHODS**
A randomized controlled trial was conducted and 26 diagnosed subjects with T2DM were enrolled in the study. After initial screening, they were randomized into the control group and the intervention group, following stratification by gender and age. The intervention group received weekly counselling and education, while the control group received counselling and education only once at the initial meeting. Independent t-test was used to compare the glucose level between the two-groups.

**RESULTS**
Lifestyle counselling and dietary modification effected a significant improvement in blood glucose (p=0.002), but not in BMI, waist circumference, total cholesterol, triglycerides, LDL and HDL. In addition, a positive time effect was found in the intervention group before and after treatment on BMI (p=0.009), waist circumference (p=0.0014), and glucose level (p=0.001). The intervention group also showed a significant positive attitude; almost all of the respondents tried to control their food intake and perform exercise regulary.

**CONCLUSION**
Dietary nutrition and lifestyle counselling improve blood glucose control in the short term.

**Key words** : Nutrition counselling, life style modification, blood glucose, T2DM

# *Konseling gaya hidup menurunkan kadar gula darah pada pasien diabetes melitus tipe 2*


## *ABSTRAK*

***PENDAHULUAN***

*Latihan fisik secara reguler dan gaya hidup sehat diketahui berpengaruh di dalam perbaikan status kesehatan masyarakat. Konseling gaya hidup dan diet gizi merupakan satu dari sekian metode yang diteliti untuk mengetahui pengaruhnya terhadap prediktor sindroma metabolik. Penelitian ini bertujuan untuk menilai pengaruh perubahan gaya hidup dan konseling gizi terhadap kadar gula, indeks massa tubuh (IMT), lingkar pinggang (LP), tekanan darah (TD), kolesterol total,* low density lipoprotein *(LDL), dan* high density lipoprotein *(HDL) pada penderita diabetes melitus tipe 2 (DMT2).*

***METODE***

*Sebuah penelitian eksperimental secara acak menggunakan kontrol mengikutsertakan 26 subjek dengan DMT2. Setelah skrining awal, subjek secara acak dibagi dalam kelompok intervensi dan kontrol. Kelompok intervensi mendapatkan konseling dan edukasi intensif mingguan dan kelompok kontrol hanya mendapatkan sekali pada pertemuan awal. Uji t-independent digunakan untuk membandingkan kadar gula darah antara kedua kelompok.*

***HASIL***

*Konseling gaya hidup dan modifikasi diet memperbaiki kontrol kadar gula darah pada kelompok intervensi bila dibandingkan dengan kelompok kontrol (p=0,002), akan tetapi tidak demikian dengan IMT, LP, sistolik, diastolik, kolesterol total, trigliserida, LDL, dan HDL. Efek positif seiring waktu ditemukan pada kelompok intevensi sebelum dan sesudah perlakuan pada IMT (p=0,009), LP (p=0,014), TDS (p=0,031), TDP (p=0,014), kadar gula (p=0.001). Pada kelompok intervensi ditemukan adanya hubungan positif; di mana seluruh responden mengatur intake makananannya dan melakukan olahraga fisik dengan teratur.*

***KESIMPULAN***

*Diet asupan nutrisi dan konseling gaya hidup memperbaiki kontrol kadar gula dalam jangka waktu pendek.*


***Kata kunci** : Konseling nutrisi, modifikasi gaya hidup, kadar gula darah, DMT2*

## INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a metabolic disorder that is characterized by high blood glucose due to insulin resistance and relative insulin deficiency.[1] Improperly managed T2DM may cause severe complications, including renal failure, blindness, slow healing of wounds, cardiovascular diseases, and erectile dysfunction.[2] Changes in lifestyle, such as reduced physical activity, an unhealthy diet, and subsequent obesity, are the main causes of T2DM.[3] Moreover, the global burden of diabetes is rising dramatically worldwide and is having as impact a double burden of poor health, i.e. continued high rates of infectious diseases and rapidly growing noncommunicable disease prevalence, in low- and middle income countries, as well as in Indonesia. The Indonesian Basic Health Survey 2007 reported that the prevalence of T2DM patients in urban areas was 5.7% nationally, and that estimated by population size in 2030 there will be 14.7% (12 million) of the population with T2DM in urban areas and 7.2% (8.2 million) in rural areas.[4,5]

Diet, exercise and weight counselling with follow-up for patiens with diabetes have been reccomended in many DM guidelines including the Consensus on Management and Prevention of Diabetes Mellitus type II published by Perkeni (Indonesian Association of Endocrinologists) in 2011.[6] Previous researches showed that an energy-wise diet, coupled with moderate levels of physical activity, favorably prevents T2DM and delays the onset of diabetic complications.[7,8,9]

Although the application of lifestyle counselling is promising, there remains the question of its efficacy in everyday clinical practice, considering the involvement of resource-intensive interventions and the duration of the intervention itself. Consequently, further evidence is required to establish that application of lifestyle counselling and dietary nutrition modification in routine care will improve the outcomes of patients with T2DM. We therefore conducted a short term study (8 weeks) to examine the effect of routine lifestyle counselling and dietary nutrition modification on T2DM patients.

## METHODS

### Study design

This study was an 8-week randomized controlled trial conducted on East Semarang residents and was performed between March and July 2011.

### Research subjects

Diabetes mellitus type 2 was defined as high fasting (≥200 mg/dL) or high random plasma glucose (≥126 mg/dL).[6] Patients with T2DM were recruited after being diagnosed previously by primary care physicians (PCPs) affiliated with Primary Health Care (PHC) in East Semarang. To select the participants, the researchers performed a preliminary screening of 65 medical records of patients who had been diagnosed with T2DM. Sample size was determined for two independent samples with effect size of 0.3, an $\alpha$ of 0.05 and a â of 0.2, which resulted in 26 subjects to be enrolled in the study. The study subjects were selected using inclusion criteria as follows: i) previously diagnosed with T2DM; ii) body mass index (BMI) >25 kg/m$^2$; iii) having abdominal obesity with a waist circumference of ≥90 cm for males and ≥80 cm for females [10]; iv) having resided in East Semarang for at least 5 years; and v) being 50-60 years old. Patients were excluded from the study if they had i) alcohol consumption; and ii) T2DM complications (stroke, diabetic gangrene, etc).

Subsequently the subjects were randomly assigned to the intervention and control group for an 8-week study period. To our knowledge, this 8-week period is considerably longer than the 4 weeks used in previous published studies on therapeutic life style modification.[11]

### Dietary intervention and lifestyle modification

The 8-week intervention was given during weekly home visit sessions (one hour per session for counselling and one hour for exercise). The intervention consisted of 5 components: (1) health screening (blood pressure and body weight check), (2) counseling, (3) exercise, (4) counseling, and (5) diet. All of the data sampling was undertaken according to standards as described elsewhere. The intervention for the intervention group is described in Table 1, while the control group received only an educational booklet and counselling at the first meeting and no further education or intervention for the subsequent 8 weeks.

### Education

Participants in the intervention group received health information from the researchers, including a definition of T2DM, and information on exercise, diet, risk factors, related disease (e.g., hypertension, hyperlipidemia, obesity) and self-care. Details of this intervention is presented in Table 1. An educational booklet which contained this information was also given to the participants.

Table 1. Eight-week dietary nutrition and life style modification intervention

| Program Contents (weekly performed) | | Duration (minutes) |
|---|---|---|
| Health status check | Blood pressure, body weight | 5 |
| Counseling | Diabetes mellitus complications, food diary, exercise adherence, and health status | 20 |
| Education | 1 Self-evaluation of health status<br>Education on writing out food and exercise diaries (motivation to perform own exercise three times per week)<br>2. Definition of diabetes mellitus<br>3. Diet for diabetes mellitus<br>4. Exercise for diabetes mellitus<br>5. Diabetes mellitus and complications | 30 |
| Exercise | Warm-up<br>Stretching<br>Strength training<br>Rhythmic dancing<br>Cool dancing | 60 |
| Wrap up | | 5 |

**Exercise**

Participants attended one supervised session per week and were encouraged to do home-based walking exercises for 45 minutes. Supervised training included warm-up, stretching, strength training, rhythmic dancing, and cool dancing. The training was modeled after the consensus statement of the American Diabetes Association.[12]

**Diet**

Subjects were suggested to have more fruit, vegetables, reduce intakes of carbohydrate, saturated fat, total fat and cholesterol. We provided a daily food diary for each subject. During the home visits, we calculated total calories based on the participants' food diary. To assess the intakes of carbohydrate, fat, protein and minerals, we used the Food Frequency Questionnaire (FFQ) and calculated these using Nutrisurvey software.[11]

**Health counselling**

On each home visit, 20 minutes of counselling time was allocated for the diet-based food diary, exercise adherence, and health status (blood pressure, body weight). Problems in applying the intervention were also discussed. We obtained primary data for sample identity including name, date of birth, and occupation, which were collected by interviewing every subject using a standardized questionnaire.

**Anthropometric indicators**

Body weight was measured with a high-precision scale of 0.001 kg. Weights were taken at the same time at each session; prior to weight measurement, the participants were asked to remove their shoes. Waist circumference was measured midway between the lowest rib and the iliac crest. The sphygmomanometer was applied at the standard location for blood pressure measurement, which is the upper arm, with the stethoscope at the elbow crease over the brachial artery.[13] The average of 2 measurements was used, taken at a 2- or 3-minute interval with the subject in a sitting position after resting for at least 15 minutes.

**Biochemistry panels**

Blood samples were obtained from the antecubital vein with the subject in a seated position. Samples were collected and analyzed at the Prodia Laboratory with an autoanalyzer. To minimize the influence of any incidental acute phase reaction, participants were requested not

to perform any major physical activity before collection of blood samples.

**Statistical analysis**

Statistical analysis was performed using SPSS 17.0 for Windows. Descriptive analysis was used to evaluate the demographic and clinical characteristics of the subject. We used the Shapiro-Wilks test to evaluate the normality of data with $p>0.05$. The t-test was used to compare all variables between the two groups. All p values are 2-sided, and a p value of less than 0.05 was considered statistically significant.

**Ethical clearance**

This study was approved by the Ethics Committee of the Faculty of Medicine, Diponegoro University/Dr Kariadi Hospital (No:072/EC/FK/RSDK/2011). Proper informed consent was obtained from each participant.

**RESULTS**

**Characteristics of the participants**

The characteristics of the participants in the intervention and control groups are presented in Table 2. Their mean age was 51.8 years

Table 2. Baseline descriptive statistics of the subjects by treatment groups

| Variables | Intervention (n=13) | Control (n=13) | p |
|---|---|---|---|
| Gender | | | |
| Male | 4 (44.4%) | 3 (23.1%) | 0.474 |
| Female | 9 (55.6%) | 10 (76.9%) | |
| Age (years) | 51.3 ± 5.2 | 52.3 ± 1.6 | 0.277 |
| Education | | | |
| Uneducated | 1 (7.7%) | 0 (0.0%) | 0.175 |
| Elementary school drop-out | 0 (0.0%) | 1 (7.7%) | |
| Elementary school | 4 (30.7%) | 5 (38.4%) | |
| Junior high school | 5 (38.4%) | 4 (30.7%) | |
| Senior high school | 2 (15.4%) | 3 (23.1%) | |
| One year diploma (D1) | 1 (7.7%) | 0 (0.0%) | |
| Occupation | | | |
| Housewife | 6 (46.1%) | 7 (46.7%) | 0.336 |
| Laborer | 1 (7.7%) | | |
| Employee | 1 (7.7%) | 1 (7.7%) | |
| Private sector | 4 (30.7%) | 3 (23.1%) | |
| Retirement | 1 (7.7%) | 2 (15.4%) | |
| Smoking | 1 (7.7%) | 1 (7.7%) | 0.535 |
| Income | | | |
| <IDR 1,000,000 | 5 (38.4%) | 6 (46.1%) | 0.245 |
| IDR 1,000,000 - 2,000,000 | 4 (30.7%) | 3 (23.1%) | |
| IDR>2,000,000 | 4 (30.7%) | 4 (30.7%) | |
| Exercise habit (3 times/week) | 1 (7.7%) | 2 (15.3%) | |
| Carbohydrate intake (kCal/day) | 1332.7 ± 89.9 | 1276.9 ± 82.7 | 0.227 |
| Calorie intake (kCal/day) | 2470.8 ± 76.9 | 2450.6 ± 94.2 | 0.211 |
| Waist circumference (cm) | 95.9 ± 10.9 | 95.1 ± 6.8 | 0.163 |
| BMI (kg/m$^2$) | 27.9 ± 3.4 | 28.2 ± 4.1 | 0.241 |
| Blood glucose (mg/dL) | 275.5 ± 19.2 | 323.5 ± 22.6 | 0.186 |
| SBP (mmHg) | 145 ± 20.4 | 144.6 ± 13.9 | 0.125 |
| DBP (mmHg) | 92.5 ± 18 | 89.2 ± 12.7 | 0.197 |

Expressed in mean ± SD; IDR=rupiah; BMI=body mass index; SBP=systolic blood pressure; DBP=diastolic blood pressure

Table 3. Mean of BMI, waist circumference, blood pressure, and glucose level, by treatment group after 8 weeks intervention

| | Intervention | Control | p |
|---|---|---|---|
| Waist circumference (cm) | 95.2 ± 11.13 | 94.5 ± 6.92 | 0.106 |
| Body mass index (kg/m$^2$) | 27.4 ± 4.15 | 27.6 ± 3.37 | 0.745 |
| Blood glucose (mg/dL) | 226.4 ± 100.01 | 310 ± 102.24 | 0.002 * |
| SBP (mmHg) | 133.1 ± 10.32 | 136.1 ± 15.43 | 0.729 |
| DBP (mmHg) | 80.0 ± 6.45 | 82.7 ± 11.84 | 0.969 |
| Cholesterol (mg/dL) | 209.8 ± 37.03 | 221.8 ± 48.1 | 0.486 |
| Triglycerides (mg/dL) | 221.8 ± 22.2 | 254.07 ± 20.3 | 0.206 |
| LDL (mg/dL) | 113.46 ± 38. 6 | 127.6 ± 45.2 | 0.952 |
| HDL (mg/dL) | 46.9 ± 10.5 | 45.9 ± 8.4 | 0.206 |

SBP=systolic blood pressure; DBP=diastolic blood pressure; LDL=low density lipoprotein; HDL=high density lipoprotein

(SD=3.8), and most (26.9%) of the respondents worked in the private sector, with monthly incomes of less than 1,000,000 IDR. Their educational status was relatively moderate, with 9 participants being senior high school graduates (34.62%). During the study course, there were no drop-outs or cases lost to follow up, because the researchers were engaged in the study by home visiting.

### Effects of the dietary counselling and lifestyle modification intervention

The means of outcome measures for the treatment groups at 8 weeks post baseline are presented in Table 3. There was a significant reduction in the intervention group for blood glucose compared to the control group. At week 8 we could not identify any improvement for total cholesterol (p=0.486), triglycerides (p=0.20), LDL (p=0.951), and HDL (p=0.87).

Results of an analysis of changes in health behavior (food control, weight control, exercise ≥3 times per week) are shown in Table 4. It was shown that the subjects in the control group did not practice food control, weight control, or adherence to exercise with a frequency of at least 3 times per week. This is different from the situation in the intervention group which showed improvement in exercise habit and a more positive attitude on food intake control.

## DISCUSSION

Our results indicate that in the implementation of short-term (8 weeks) dietary nutrition and lifestyle counselling program, which consisted of screening, education, exercise, diet and counseling, a positive effect in glucose control and improved health behavior was obtained.

This suggests that despite the short duration of the intervention (8 weeks, with 8 counselling sessions and 8 times structured exercises), the program can improve glycemic control over a relatively short period. This study confirmed the previous study conducted by Oh et al., which

Table 4. Changes in health behavior after dietary nutrition and lifestyle modification

| Categories | Groups (n=13) | N (%) (Pre) | Post | $x^2$ | p |
|---|---|---|---|---|---|
| Food control, yes | Experimental | 0 (0) | 11 (84.6%) | 9.905 | 0.02 |
| | Control | 0 (0) | 3 (23.1%) | | |
| Weight control, yes | Experimental | 0 (0) | 12 (92.3%) | 12.764 | 0.00 |
| | Control | 0 (0) | 3 (23.1%) | | |
| Exercise ≥3/wk, yes | Experimental | 1 (15.3) | 12 (92.3%) | 10.04 | 0.01 |
| | Control | 2 (7.7) | 4 (30.7%) | | |

showed that comprehensive therapeutic lifestyle modification can improve metabolic syndrome within 4 weeks.[11]

Other published literature also suggested the beneficial influence of lifestyle counselling on glucose control.[8,12] Our result was supported by the positive behavior shown in the intervention group, which contributed to the glycemic control performance. It is known that glycemic control education for T2DM patients consists of meal planning and dietary modification,[14] which was also provided in each home counselling session for the intervention group.

Daily incorporation of low glycemic index (GI) carbohydrates in meal planning can be an effective diabetes self-management strategy not only for glycemic control but also for weight management.[15] However, in our study there was no significant effect post-intervention in the intervention group vs the control group with respect to BMI reduction. Most of the respondents in the intervention group made effort to exercise regularly, which showed a time positive effect and positive health behavior from the baseline data in the intervention group. It has been found that regular exercise without weight loss results in a reduction in skeletal muscle lipid content coincident with an increase in skeletal muscle mass in T2DM populations.[16] These results might explain the insignificant differences in body weight in our study. Moreover, a study conducted by Kim et al. suggested that regular exercise (3 times per week) was associated with a significant reduction in intramuscular triglycerides and an increase in glucose transporter 4 protein ($GLUT_4$) protein expression and fatty acid oxidation capacity (â-hydroxyacyl-CoA dehydrogenase) as measured by percutaneous biopsy.[17] Taken together, our study show that although there was no significant body weight reduction, which ultimately affect BMI, it had demonstrated the utility of exercise without weight loss as a strategy to improve skeletal muscle morphology, independent of age, race, and obesity.

Waist circumference is a well-known predictor for the risk of T2DM.[18] Abdominal obesity is a stronger risk factor than overall obesity often expressed as body mass index (BMI) for the future development of T2DM.[19] Although we could not find a significant effect on waist circumference in our intervention group, there was a decremental tendency (reduction of 0.7 ± 0.75 cm).

Previously, a study published by Morrison et al.,[8] concluded that lifestyle counselling in a primary setting is associated with a faster improvement in blood pressure. It is recommended that controlling blood pressure must be a priority in the management of persons with T2DM, due to the fact that up to 80% of patients will develop microvascular disease or die from it. The development of nephropathy and retinopathy was contributed significantly to by the blood pressure increment, therefore blood pressure control is a must in T2DM patients.[20] In our intervention group, we had a significant reduction of 7.67 ± 2.52 mmHg (p=0.031) from the baseline data. Although we could not find a significant difference between intervention and control group, there was a positive effect from engagement of participants in exercise, which could explain the diminishment of exercise which reduces sympathoadrenergic activity and enhance prostaglandin mechanism.[21] Moreover increased production of nitric oxide results in endothelium dependent-vasodilatation which lowers BP.[22] Endothelial dysfunction also characterizes individuals with impaired glucose tolerance, insulin resistance and T2DM, suggesting that insulin resistance and endothelial (vasodilatory) dysfunction are intimately linked.[23]

Intensive counselling resulted in a significant change in glucose level in the intervention group (p=0.002), in contrast to the control group. Several trials in clinical setting have previously documented the benefit of

lifestyle counselling on control of glucose.[8,11] Application of carbohydrate-restricted diets (CRD) and diets comprised of foods with a low GI is considered to improve insulin resistance and metabolic syndrome, potentially preventing the development of T2DM.[24] Integration of lifestyle modification using low carbohydrate interventions is effective for improving and reversing T2DM.[25] Regarding the effectiveness of the intervention in our study, introduction of low glucose intake was successful in lowering the blood glucose level in the time frame of 8 weeks. Recent studies have shown that under conditions of carbohydrate restriction, fuel sources are shifted from glucose and fatty acids to fatty acids and ketones, leading to improvement in surrogate markers of cardiovascular disease.[26] The 8-week dietary counselling and lifestyle modification program could not identify group and time interactions in total cholesterol, LDL and HDL. However, there was a positive time effect, as we found a decrement tendency (pre- and post- counselling cholesterol: 220 ± 42 mg/dL and 209.08 ± 37.03 mg/dL, respectively; pre- and post- counselling LDL: 132.5 ± 38.6 mg/dL and 113.46 ± 38.6 mg/dL, respectively; pre- and post counselling triglycerides: 263.15 ± 49.12 mg/dL and 221.8 ± 22.2 mg/dL) respectively. A longer study time would be beneficial to address this question.

Thus our data show that intensive lifestyle counseling, which involved glycemic control of diabetes mellitus, is effective in reducing the glucose level of study subjects, which is in support of the current treatment guidelines for patients with diabetes. Moreover, a study conducted by Egede, who examined lifestyle modification in T2DM, revealed that patients with diabetes appeared to modify behavior in response to the advice of physicians.[27]

The duration of intervention period remains questionable. A few clinical trials of lifestyle counselling with a follow-up of longer than 12 months provided evidence for lasting effects of lifestyle counseling.[28] However, there are some studies which suggest that the effect of intensive diet and exercise may not be durable.[29,30] Taken these studies into consideration, we should also assess the importance of life style counselling and its positive impact on patient behavior and health outcomes. Lifestyle counselling is time consuming, therefore time limitations of practice sessions from the health practitioner remains cumbersome. In that context, implementation of current guidelines may require modification of the prevalent physician-patient treatment care, with more involvement of mid-level providers, such as nurse practitioners, physician assistants, nutritionists, or exercise physiologists. Another alternative is to implement group counselling sessions. This experimental study involved 26 subjects with intensive (weekly) lifestyle modification. It was a population-based study, where the researchers visited each house and performing dietary counselling and lifestyle modification intervention. Therefore, we were able to develop a more interpersonal relationship to the patients and share the decision making in participatory research approaches. Home visits to diabetic people by a trained and educated health care provider will improve adherence to dietary advice, lifestyle intervention, and physical activity promotion. Among the limitations of this study that may first be mentioned is the small sample size and the limited geographic region in which this study was conducted. Thus, the interpretation of this study should be done with caution, and a larger study is needed in the future. Second, the intervention period in our study was short. There is a need to conduct a study of longer duration to examine whether the effects are sustainable over time.

## CONCLUSIONS

This finding suggests that a systematic weekly therapeutic life style modification program can improve blood glucose level even though it is only provided for a short-term period (8 weeks). Other studies are needed to identify whether this positiveness of patients' attitude in following dietary counselling and lifestyle

modification is durable and eventually will lead to long-term outcomes, such as mortality, morbidity and improvement in quality of life (QOL) in T2DM patients.

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