

The Effect of Lifestyle Modification on Treatment and Prevention of Type 2 Diabetes Mellitus: A Systematic Review

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Abstract— Background: The incidence of type 2 diabetes mellitus is increasing worldwide. A large proportion of these patients go undiagnosed. Enhanced prevention before onset of overt disease through lifestyle modification is crucial to reducing health complications and the economic burden attributable to cardiometabolic disease. This systematic review consolidates recent evidence on the effectiveness of lifestyle-based interventions for adults with type 2 diabetes.

Methods: In order to identify the relevant studies, we searched on different database by using terms and constructions related to the effect of lifestyle modification on treatment and prevention of T2DM. The search was restricted to studies published in English and those among adults. Studies with irrelevant titles, abstracts only and duplicates were excluded. Through inclusion and exclusion criteria, relevant studies were selected. Data was retrospectively extracted and utilized from relevant 15 studies to see the effect of lifestyle modifications on weight loss and its effect on HbA1c on type 2 diabetes.

Results: Fifteen studies were included in this systematic review. The quality assessment was done using Jadad score and a score of 2 was considered adequate. The fifteen studies recruited samples ranging from 50 to 3234 participants. The reported mean age was, on average, 48 years. The average proportion of female participants within studies was 57.9% . Mean baseline BMI was 31.95 kg/m² and mean baseline HbA1c was 7.9% . Mean post intervention BMI was 30.64 kg/m² (range, 24.5 to 35.5 kg/m²) and mean post intervention HbA1c was 6.5%. Intervention duration ranged from 4-months to ten years.

Conclusions: The results of this systemic review are consistent with conclusions of former reviews, confirming the importance of comprehensive lifestyle interventions combining diet and physical activity to decrease the incidence of type 2 diabetes in high-risk population groups and to control the disease progression in affected individuals.

Index Terms— HbA1c, Interventions, Lifestyle modifications, Prevention, Systematic review, Type 2 diabetes, Weight loss.

1 INTRODUCTION:

The incidence of type 2 diabetes mellitus is increasing worldwide. It is estimated globally the diabetes rate has risen by 45% over the past two decades. The International Diabetes Federation (IDF) estimated that the number of adults affected by diabetes in 2013 was 387 million, with a projected increase of up to 592 million by 2035 [1]. Type 2 diabetes which is formerly called non-insulin-dependent diabetes mellitus, results from the interaction between a genetic predisposition and behavioral and environmental risk factors [2]. Although the genetic basis of type 2 diabetes has yet to be identified, there is strong evidence that such modifiable risk factors as obesity and physical inactivity are the main non-genetic determinants of the disease [3], [4], [5], [6], [7], [8], [9], [10].

Obesity increases the risk of developing type 2 diabetes, and complicates management in those with the disease by increasing insulin resistance and blood glucose levels, and

increasing risk of dyslipidemia, hypertension, cardiovascular disease and mortality [11].

The diagnosis of type 2 diabetes is often delayed until complications are present [12]. Since current methods of treating diabetes remain inadequate, prevention is preferable [13]. The purpose of this review was to assess evidence from the previous researches on the effectiveness of lifestyle-based modifications interventions such as diet, exercise, and education, on change in weight and its effect on HbA1c in adults with type 2 diabetes (T2DM).

2 METHOD

2.1 Search Process

In order to identify relevant studies related to the effect of lifestyle modification in type 2 diabetes, we searched on PubMed, Google scholar and deepdyve database by using following terms and constructions: "diabetes type 2" OR

"Impaired glucose tolerance" OR "prediabetic" OR "Non-insulin dependent diabetes" AND "lifestyle modification" OR "lifestyle advice program" Or "diet" OR "weight-loss interventions" AND "prevention" OR "non-pharmacological prevention". We restricted our search to studies published in English and those among adults only. In addition, the reference lists of all included studies were scanned to identify any other relevant studies.

2.2 Study Selection

To select studied relevant for this review, we screened titles and abstracts using a three-step process. At the first step, each one of us independently selected studies based on abstracts and titles. Then rejected all those with irrelevant titles, abstracts only and duplicates. After that we cross- matched our findings and retrieve the applicable studies. Finally, 15 studies were screened by reading the full papers.

The study selection was guided by the following inclusion criteria:

Reported on intervention outcomes from a randomized / look ahead trial.

Were conducted in adults (age ≥ 18 years old) and BMI ≥ 24

Were conducted in those with IFG/IGT or diagnosed with T2DM

Primarily focused on weight loss.

Through lifestyle interventions.

Studies with comparison groups which could be control/usual care or other intervention

Published in English.

2.3 Exclusion criteria:

Conducted in diabetic type 1.

Weight change and HbA1c outcomes were not reported.

2.4 Data Extraction and Synthesis

The following data were extracted and tabulated: study methodology (e.g. study design and sample size), Participant characteristics (e.g. mean age, mean body mass index [BMI]), intervention details (e.g. duration of contact and mode of delivery) and the intervention effect (i.e. mean [SD] change from baseline to follow-up for weight and HbA1c outcomes).

2.5 Assessment of Study Quality

We used the Oxford quality scoring system (Jadad score) to assess the quality of each study and minimize the risk of bias. Three questions were asked and answered by a "yes" or a "No" for each study. The questioner is composed of three questions that includes if the study was described as randomized, double blind and/ or was there withdrawals and dropouts. Each "yes" was scored with one point and each "No" with zero point. An additional point was added if the randomization or double blind was described appropriately in the study. The score was used to interpret the results but no study was excluded on this basis.

Study	Population	Intervention	Variable of interest	Comparison	Type of assessment	Time
D. L. Ellsworth et al. 2016 [14]	Intensive: ≥ 18 y.o., IGT/IFG, BMI ≥ 30 , HTN $\geq 140/90$ mmHg or high total cholesterol ≥ 200 mg/dL Moderate: ≥ 18 y.o., IFG/IGT =, BMI ≥ 25 , or high total cholesterol ≥ 200 mg/dL	Intensive Lifestyle modification	Diabetes prevention, Control of diabetes	Moderate lifestyle modification	HbA1C, BMI	1 year
A Goday et al. 2016 [15]	30-65 y.o. T2DM, BMI 30-35	Weight-loss program	Control of diabetes	Standard hypocaloric diet	HbA1C, BMI	4 months

Archana Gupta Et al. 2014 [16]	25-75 y.o. T2DM, IFG, BMI \geq 25	Lifestyle modification and dietary intervention	Control of diabetes	Routine care	HbA1C, BMI	1 year
Vegard Nilsen Et al. 2011 [17]	Mean age 46, BMI \geq 37, prediabetic	Lifestyle modification	Diabetes prevention	Routine care	HbA1C, BMI	18 months
Ghada Asaad Et al. 2016 [18]	Mean age 59.2 y/o, T2DM, BMI \geq 25	Lifestyle modification	Control of diabetes	Routine care	HbA1C, BMI	6 months
Knowler WC et al 2002 [13]	\geq 25 y.o. Non- diabetic, IFG, BMI \geq 24	Lifestyle modification (weight loss program)	Diabetes prevention	Metformin	HbA1C, BMI	2 years
Elizabeth B. Lynch, et al 2015 [19]	\geq 18 y.o., uncontrolled T2DM, BMI \geq 24	Lifestyle modification	Glycemic control	Routine care	HbA1C, BMI	12 months
Anita P. Courcoulas et al 2015 [20]	25-55 y.o. T2DM, IFG, BMI \geq 30	Lifestyle modification	Control of diabetes	Bariatric surgery	HbA1C, BMI	3 years
The Look AHEAD Research Group 2011 [21]	45-76 y.o. T2DM, BMI \geq 25	Lifestyle modification	Control of diabetes	Routine care	HbA1C, BMI	4 years
A. Ramachandran et al. 2006 [22]	40- 50 mean age, IGT, BMI 24-28	Lifestyle modification	Diabetes prevention	Metformin	HbA1C, BMI	3 years
Elizabeth J. Mayer- davis et al 2007 [23]	\geq 25 y.o. IGT, BMI \geq 24	Lifestyle modification (weight loss intervention)	Diabetes prevention	Placebo	HbA1C, BMI	1 year
S. Sonomtseren et al. 2016 [24]	\geq 25 y.o. T2DM, BMI \geq 25	Lifestyle modification (Weight loss intervention)	Control of diabetes	Routine care	HbA1C, BMI	6 months
Jaakko Tuomilehto, et al. 2001 [25]	40- 65 y.o. IGT, BMI $>$ 25,	Lifestyle modification	Diabetes prevention	Routine care	HbA1C, BMI	3 years
Angela O'Dea et al.	$>$ 18 y.o. IFG/IGT, BMI \geq 24	Lifestyle modification	Delay onset of DM	Routine care	HbA1C, BMI	1 year

2015 [26]						
Guangwei Li et al 2008 [27]	Mean age 44.7 , IGT, BMI ≥24	Lifestyle modification	Diabetes prevention	Routine care	HbA1c, BMI	20 years

Table 1: A summary of methods of included studies

y.o.= years old , FG= fasting glucose, IFG= impaired fasting glucose, IGT= impaired glucose tolerance, T2DM= type 2 diabetes mellitus, BMI= body mass index in kg/m² , HbA1c= hemoglobin A1c

3 RESULTS

The search identified 335 studies. Of these, we read 22 research having relative titles. Five of these studies were excluded based on abstract. Two systematic reviews were excluded. Fifteen studies were included in this systematic review.

The fifteen studies recruited samples ranging from 50 to 3234 participants. The reported mean age was, on average, 48 years (range, 44 to 60 years). The average proportion of female participants within studies was 57.9% (range, 20.7 to 100%). Mean baseline BMI was 31.95 kg/m² (range, 25.8 to 36.4 kg/m²) and mean baseline HbA1c was 7.9% (range,

7.3 to 9.8%). Mean post intervention BMI was 30.64 kg/m² (range, 24.5 to 35.5 kg/m²) and mean post intervention HbA1c was 6.5% (range, 5.5 to 7.34%). Intervention duration ranged from 4-months to ten years. Nine studies compared lifestyle intervention to a control group, which received usual care or some form of brief diabetes education [3], [4], [5], [7], [9], [11], [13], [14], [15]. The other six studies compared lifestyle intervention to an intervention comparison group (i.e. no control).

Summarization of the Results on Effectiveness of Lifestyle-based Interventions for People with Type 2 Diabetes or impaired glucose tolerance

Author	Sample Size	Men	Women	Mean age	Duration of intervention	Baseline BMI (kg/m ²)	Post intervention BMI(kg/m ²)	Baseline HbA1c %	Post intervention HbA1c%
D. L. Ellsworth et al [14]	327	163	164	60.3	1 year	34	33	7.6	6.9
A Goday et al [15]	89	31	58	54.53	4 months	33.07	32.88	6.89	6.88
Archana Gupta et al [16]	56	35	21	50.1	1 year	28	25	8.91	6.72
Vegard Nilsen et al [17]	213	106	107	46	18 months	36.4	35.5	5.8	5.5
Ghada Asaad et al [18]	73	39	34	59.2	6 months	32.5	32	8.0	7.3
Knowler WC et al [13]	3234	1043	2191	50.6	2 years	34	33.2	5.91	5.91

Elizabeth B. Lynch, et al [19]	256	114	142	49.6	1 year	27.6	25.9	6.9	6.6
Anita P. Courcoulas et al [20]	61	11	50	47.3	3 years	35.7	34	7.8	6.82
The Look AHEAD Research Group [21]	5145	2109	3036	58.7	4 years	36	33.2	7.6	7.2
A. Ramachandran et al [22]	531	421	110	45.9	3 years	25.8	25.8	6.2	6.2
Elizabeth J. Mayer-davis et al [23]	2934	955	1979	>25	1 year	>24	----	6.9	6.5
S. Sonomtseren et al [24]	92	42	50	48	6 months	31.5	29.9	8.5	6
Jaakko Tuomilehto, et al [25]	522	172	350	55	3 years	31.1	30.2	7.9	6.4
Angela O'Dea et al [26]	50	0	50	50	1 year	35.49	33.93	5.37	5.33
Guangwei Li et al [27]	576	312	264	44.7	10 years	26.2	24.5	7.76	7.34

Table 2: A summary of the results of included studies.

BMI: body mass index

3.1 Quality Assessment:

Jadad score [28] was used to assess the quality of the studies. Since all the studies we found about this topic are

not double blinded, a score of 2 or more was considered adequate.

Out of the fifteen studies, six studies scored 3 [17], [18], [22], [25], [26], [27] and nine studies scored 2 [14], [15], [16], [13], [19], [20], [21], [23], [24].

4 DISCUSSION

Comprehensive systematic review of randomized clinical trials was conducted to assess the effect of a multifaceted lifestyle intervention and weight loss on patient-centered outcomes, such as progression to type 2 diabetes for high-risk patients and progression of the disease in Adults with type 2 diabetes mellitus. Compared with the usual care

and health education, this intervention resulted in a significant reduction in Body Mass Index and HbA1c. Based on the results of these studies, lifestyle-based weight loss intervention in marked improvements in glycemic control according to HbA1c levels. These results are similar to those found in other earlier reviews [29], [30]. Modest weight loss of at least 5% of body weight is encouraged for people with type 2 diabetes who are overweight or obese [31]. Cardiovascular disease (CVD) is the leading cause of death among diabetic patients. Lifestyle interventions have the potential to improve several risk factors for CVD such as glycemic control, blood pressure and lipids [18].

Among the fifteen studies reviewed here, the types of interventions applied and parameters of assessment differ characteristically. The highest reduction in body mass index was 2.8 kg/m² achieved by The Look AHEAD group using intensive lifestyle modification by following a strict diet and doing regular exercises [21] and the greatest reduction in HbA1c achieved was 2.5% achieved by S. Sonomtseren et al [24] using in-person counseling and telephone follow up to instruct participants about their dietary modifications and exercise activities.

The biggest weakness of most studies is that the follow up of the participants stopped after the intervention period. Only one study was concerned about the maintenance of the results after the intervention [21] and post intervention follow-up showed that weight gain is very common after large weight loss making it very important to follow the subjects afterwards [21].

From the reviewed studies, when other interventions compared with lifestyle modifications. Lifestyle modifications through nutrition and physical activity remain the most effective intervention in reducing body weight and improvement of glycemic control or/and prevention of T2DM through weight reduction than hypocaloric diet [15], use of metformin only [13], [22] Bariatric surgery only [20] or placebo [23].

4.1 Limitations

We had faced some limitations doing this systematic review. These are mainly related to the shortage of time, lack of experience, and restriction to studies published in English language. Also the shortage of the amount of free full text researches was one of the biggest limitations. Another limitation is that the studies used in this systematic review used different components of intervention and ways of assessment and comparison. Also, Assessment of quality of studies revealed methodological shortcomings. The quality of studies was moderate, and some of studies were poorly reported: randomization methods, assessor blinding, approaches to missing data were not mentioned clearly.

5 CONCLUSION:

The results of this systemic review are consistent with conclusions of former reviews, confirming the importance of comprehensive lifestyle interventions combining diet and physical activity to decrease the incidence of type 2 diabetes in high-risk population groups and to control the disease progression in affected individuals.

Evidence-based and interdisciplinary approaches, drawing upon clinical/behavioral, pharmacological, and genomic evidence need exploration in future trials of lifestyle-based interventions among those with type 2 diabetes to improve their effectiveness. Furthermore, future studies need to report on outcomes that are important for informing translation into practice such as cost-effectiveness and longer-term maintenance post intervention.

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