Experts’ opinion on the detection and management of prediabetes in Lebanon

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Abstract
Given that the complications of type 2 diabetes can start at an early stage, early detection and appropriate management of prediabetes are essential. We aimed to develop an expert opinion on prediabetes in Lebanon to pave the way for national guidelines tailored for the Lebanese population in the near future. A panel of seven diabetes experts conducted a thorough literature review and discussed their opinions and experiences before coming up with a set of preliminary recommendations for the detection and management of prediabetes in Lebanon. Lebanese physicians employ multiple tests for the diagnosis of prediabetes and no national cut-off values exist. The panel agreed that prediabetes screening should be focused on patients exceeding 45 years of age with otherwise no risk factors and on adults with risk factors. The panel reached that fasting plasma glucose (FPG) and HbA1c should be used for prediabetes diagnosis in Lebanon. FPG values of 100–125 mg/dL or HbA1c values of 5.7%–6.4% were agreed upon as indicative of prediabetes. For the management of prediabetes, a three-step approach constituting lifestyle modifications, pharmacological treatment and bariatric surgery is recommended. There should be more focus on research on prediabetes in Lebanon. This preliminary report will be further discussed with the

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Lebanese Society of Endocrinology, Diabetes and Lipids in 2021 in order to come up with the first Lebanese national guidelines for the detection and management of prediabetes in Lebanon.

Keywords
Prediabetes, diabetes, Lebanon, consensus, screening, diagnosis, management

Introduction
The term “prediabetes” is used by the American Diabetes Association (ADA) and the American Association of Clinical Endocrinologists (AACE) to define a condition characterized by a slightly elevated blood glucose level, not high enough to be considered as diabetes but outside the normal range.\(^1,2\) Prediabetes is defined by an impaired fasting glycemia (IFG) or impaired glucose tolerance (IGT) or raised hemoglobin levels. It is also called “non-diabetic hyperglycemia” by the World Health Organization (WHO), and “intermediate hyperglycemia” by the International Diabetes Federation (IDF).\(^3,4\) It is considered a risk factor for the onset of type 2 diabetes increasing its short-term risk by 3–10 folds.\(^5\) Indeed, the yearly conversion rate of prediabetes to diabetes is 5%–10%.\(^6\) A recent meta-analysis found that people with prediabetes have an increased risk of all-cause mortality (relative risk (RR) 1.13), composite cardiovascular disease (RR 1.15), coronary heart disease (RR 1.16), and stroke (RR 1.14).\(^2\) In addition, prediabetes was also associated with an increased risk of cancer (RR 1.15).\(^4\)

In 2019, the IDF estimated that 374 million people had IGT especially those aged 50 years or less. By 2045, IGT is expected to affect 548 million adults between 20 and 79 years old representing 8.6% of the adult population. These worldwide rising numbers are also coupled with an increase in the global rate of diabetes-related morbidity and mortality.\(^3\)

The high prevalence of prediabetes is a growing problem in the Middle East. In the Arab region, 13.7 million people aged between 20 and 79 years old were reported to be living with prediabetes.\(^7\) According to the IDF, 364,000 people lived with IGT in 2019 in Lebanon; and the age-adjusted comparative prevalence of IGT was 8.4%.\(^8\)

Observational studies have revealed that diabetes complications can develop early at the stage of pre-diabetes.\(^6\) Thus, early detection and proper management of prediabetes are beneficial in delaying its progression\(^9–11\) and reducing the aforementioned complications.\(^12–14\)

Although prediabetes has a high global prevalence and is correlated with diabetes complications, national policies toward its prevention and management are only available in a few countries.\(^5\) Worldwide, countries are beginning to recommend lifestyle programs and, in some cases, pharmacological intervention with metformin.\(^15\)

Although several drugs have been assessed in trials for prediabetes, the Food and Drug Administration (FDA) has not approved any medications for its treatment or for the prevention of type 2 diabetes.\(^16\) The ADA recommends (as outlined in its 2019 Standards of Medical Care in Diabetes) that “Metformin therapy for prevention of type 2 diabetes should be considered in those with prediabetes,
especially for those with body mass index (BMI) $\geq 35 \text{ kg/m}^2$, those aged $<60$ years, and women with prior gestational diabetes mellitus.” In this expert opinion, we aimed to develop a consensus on the screening, diagnosis, and management of prediabetes in Lebanon.

**Methodology**

A panel comprising seven reputable experts in diabetes and endocrinology; six of which are Lebanese with clinical experience in the public and private healthcare sectors in Lebanon ranging from 20 to 30 years, met on the 24th of September 2018 to understand the current status of prediabetes screening, diagnosis and treatment in Lebanon. A literature review was conducted in PubMed database using the following terms: prediabetes, impaired glucose tolerance, impaired fasting glycemia, non-diabetic hyperglycemia, Middle East, Lebanon, screening, diagnosis, prevention, management, guidelines, and recommendations. The experts selected articles that best suited the purpose of the project. The retrieved articles were discussed along with the professional opinions and experiences of the panel. No formal system was used to provide levels of evidence of the recommendations of the panel. All the recommendations mentioned herein were accepted and approved by all the experts in the panel.

**Results**

**The current situation of prediabetes in Lebanon**

There is no agreement among Lebanese physicians on the tests (nor their cut-off values) that should be employed for the diagnosis of prediabetes.

**Prevalence of prediabetes in Lebanon**

During the last 30 years, a lot of studies have been undertaken in Lebanon but the majority of them have had limitations either in the study design or in the population of the studied sample. Most of the studies gathered data from a specific region in Lebanon and not across the country. A study was conducted in 1997 on 2518 Lebanese subjects aged more than 30 years old. It showed that the prevalence of IGT was 6% (cut-off point: 110–125 mg/dL). In 2005, another study was undertaken in Beirut using the ADA 1997 criteria. This study included 3000 patients and showed that IGT prevalence was 5.1%. Another study conducted in 2017 in Greater Beirut included 500 patients aged around 45 years old and showed that diabetes prevalence was 15% compared to 40% for prediabetes.

**Screening for prediabetes**

Several factors may influence the onset of prediabetes including genetics, peripheral insulin resistance, defects in insulin secretion, glucotoxicity, lipotoxicity,
impaired incretin release, amylin accumulation, inflammation, oxidative stress, and decreased beta cell mass leading to beta cell dysfunction.\textsuperscript{21}

The ADA, in a recent statement, stated that prediabetes is linked to obesity (abdominal or visceral), dyslipidemia, high triglycerides and/or low high-density lipoprotein (HDL)-cholesterol, and hypertension. The ADA considers the screening criteria for prediabetes cited in the Supplemental Appendix Table 1.\textsuperscript{22}

The United States Preventive Services Task Force (USPSTF) recommends screening for abnormal blood glucose as part of cardiovascular risk assessment in adults aged 40–70 years who are overweight or obese. Clinicians should offer or refer patients with abnormal blood glucose to intensive behavioral counseling interventions to promote a healthy lifestyle and physical activity (Grade B).\textsuperscript{23}

According to the AACE, people who have any of the clinical risk criteria cited in the Supplemental Appendix should get tested for prediabetes.\textsuperscript{24} The AACE recommends repeating prediabetes testing every 3 years in the case of a normal range of glucose values but on an annual basis in subjects with two or more risk factors (Supplemental Appendix Table 2).

FINDRISC Diabetes Risk Calculator is a prediction tool to identify patients at risk of developing diabetes. It estimates the risk of developing diabetes and the required frequency of screening. It requires no laboratory testing and has been validated in multiple populations. FINDRISC uses age, BMI, physical activity, vegetable and fruit intake, medical treatment of hypertension, history of hyperglycemia, and family history to determine the risk of developing diabetes. Using FINDRISC to identify high-risk people and apply an educational intervention, has led to a reduction in the incidence of diabetes.\textsuperscript{25}

The Lebanese expert panel recommends that all people older than 45 years without risk factors and adults with risk factors should be screened for prediabetes. Upon comparing the risk factors mentioned by the ADA and the AACE, the Lebanese expert panel agreed that the risk factors in Table 1 should be considered on a nationwide scale in Lebanon.

The Lebanese expert panel recommended that testing should be repeated at a minimum of 3-year intervals with normal results, and should be done more

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**Table 1.** Lebanese consensus on prediabetes risk criteria.

| Risk Factor                                                                 | Criteria                                                                                     |
|----------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| Physical inactivity                                                        |                                                                                             |
| Overweight or obese adults (body mass index $\geq 25$ kg/m$^2$)             |                                                                                             |
| First-degree relative with diabetes                                        |                                                                                             |
| Women who delivered a baby weighing $\geq 4$ kg or were diagnosed with gestational diabetes |                                                                                             |
| Hypertension ($\geq 140/90$ mmHg or on therapy for hypertension)           |                                                                                             |
| HDL-C $< 35$ mg/dL and/or a TG $> 250$ mg/dL                               |                                                                                             |
| HbA1c $\geq 5.7\%$                                                       |                                                                                             |
| Impaired glucose tolerance, or impaired fasting glycemia on previous testing |                                                                                             |
| Other clinical conditions associated with insulin resistance (severe obesity, acanthosis nigricans, polycystic ovary syndrome, and history of cardiovascular disease) |

HDL-C: high-density lipoprotein cholesterol; TG: triglycerides.
frequently with abnormal findings depending on initial results (e.g. those with pre-diabetes should be tested yearly).

Prediabetes diagnostic tests, fasting plasma glucose, and HbA1c cut-off values

Several blood tests and biomarkers can be used to diagnose prediabetes. The WHO uses the IFG defined as fasting plasma glucose (FPG) levels of 110–125 mg/dL and IGT as 2-h PG of 140–200 mg/dL after ingestion of 75 g of oral glucose.26 The ADA has the same cut-off value for IGT (2-h plasma glucose of 140–200 mg/dL) but a lower cut-off value for IFG (FPG of 100–125 mg/dL) and additionally considers HbA1c to diagnose prediabetes with levels ranging from 5.7% to 6.4%.22 The IDF has set the following cut-off points for prediabetes diagnosis: FPG between 100–125 mg/dL or 2-h glucose following ingestion of 75-g glucose load levels between 140 and 199 mg/dL. The IDF also recognizes an increased level of HbA1c as a tool to diagnose those with prediabetes.27

In this regard, the panel agreed on FPG and HbA1c as the preferred tests for the diagnosis of prediabetes in Lebanon and the adopted cut-off points were as follows:

- FPG for prediabetes diagnosis: 100–125 mg/dL as per the IDF guidelines
- HbA1c 5.7%–6.4% as per the ADA guidelines

Table 2. Lebanese consensus on prediabetes management.

| Step                  | Description                                                                 |
|-----------------------|-----------------------------------------------------------------------------|
| **Lifestyle management** | Should be recommended for all subjects with prediabetes for 3–6 months.  
                                 5%–10% of weight loss  
                                 Moderate intensity exercise (30 min five times per week or 1 h three times per week)  
                                 Healthy diet  
                                 Elderly people (>50 years old) should have a regular cardiac checkup before starting to exercise  
                                 Consider DSME (diabetes self-management education) and DSMS (diabetes self-management support) whenever possible |
| **Pharmacotherapy**    | Should be considered taking into account the cost, the beneficial effects, the side effects  
                                 Metformin XR is viewed as the first-line treatment.  
                                 If metformin XR is not available then immediate-release metformin can be used alternatively  
                                 Other options (e.g. alpha glucosidase inhibitors such as acarbose, liraglutide, and pioglitazone) could be considered in certain cases |
| **Bariatric surgery**  | For morbidly obese patient with prediabetes |

Behavioral lifestyle programs should be the cornerstone of all efforts to reduce the risk of conversion from prediabetes to type 2 diabetes. No pharmacologic agents
are currently approved for the management of prediabetes. However, pharma-
cotherapy targeted at managing non-diabetic hyperglycemia may be considered in
high-risk patients after individual risk-benefit assessment.8

Lifestyle intervention in prediabetes should aim to reduce weight by 5% to 10%
and maintain it for long periods of time. To achieve this objective, a program of
regular moderate-intensity physical activity for 30–60 min daily is recommended at
least 5 days per week along with a diet that includes caloric restriction, increased
fiber intake, and (in some cases) carbohydrate intake limitations.8 Many studies
demonstrated the positive effects of lifestyle intervention during a period ranging
from 2.8 to 6 years.10,28–30

Diabetes self-management education (DSME) and diabetes self-management
support (DSMS) programs are appropriate for people with prediabetes to help pre-
vent or delay the onset of diabetes.31 Therefore, during the Diabetes Prevention
Program (DPP) (N = 3234), intensive lifestyle intervention effectively prevented
progression from IGT to type 2 diabetes by 58% compared to 31% with pharma-
cotherapy with metformin.10 Maintenance of long-term weight loss was assessed in
a study that included 2766 patients; results showed a regain in weight in the life-
style arm, with weight change being the same at 10 years for both lifestyle and met-
formin. Over this time period, the decrease in the incidence of type 2 diabetes was
almost the same for both groups.32

In the SCALE obesity and prediabetes study, patients treated with liraglutide
showed an 8.4 kg weight reduction compared to a loss of 2.8 kg in patients receiv-
ing placebo. Among patients who were normoglycemic at screening, 7.2% of those
treated with liraglutide had prediabetes after 56 weeks of follow-up compared with
20.7% of those receiving placebo. Among patients who were already prediabetic
with prediabetes at screening, 30.8% of those treated with liraglutide continued to
exhibit prediabetes at 56 weeks of follow-up compared with 67.3% of patients
receiving placebo.33

A study conducted in Lebanon combining liraglutide and metformin showed a
significant improvement versus metformin alone in weight loss, HbA1c values,
plasma lipids, and the percentage of subjects who reverted to normoglycemia or
remained in a state of prediabetes.34 Bariatric surgery is the most effective way to
decrease weight. It induces a significant and sustainable improvement in the meta-
bolic profile of obese patients and decreases the incidence of type 2 diabetes. There
are many types of laparoscopic surgery including laparoscopic adjustable gastric
banding (LAGB), laparoscopic sleeve gastrectomy (LSG), and laparoscopic gastric
bypass surgery (LRYGB). The best results and outcomes are obtained with
LRYGB.35 The three-step approach for prediabetes management agreed upon by
the Lebanese expert panel is summarized in Table 2.

**Metformin dose in prediabetes**

In the DPP study, subjects were randomly assigned to 850 mg metformin twice
daily (n = 1073) or placebo (n = 1082) and followed for 2.8 years. The results
showed excellent adherence to metformin—despite gastrointestinal side effects—and a 31% decrease in the risk of developing diabetes with metformin. The optimal benefit was observed in patients with BMI $\geq 35$ kg/m$^2$—a 50% reduction in the risk of progression to type 2 diabetes. A reduction of 1.7 kg was observed in the metformin group versus 0.3 kg weight gain in the placebo group. The weight reduction leading to improved insulin sensitivity and pancreatic function is viewed as a possible mechanism for reducing the risk of progressing to frank diabetes.$^{10,36,37}$

Similarly, in the Canoe trial where metformin (500 mg) twice daily was combined with rosiglitazone (2 mg) in 103 patients, there was a beneficial effect in preventing the conversion of IGT subjects to type 2 diabetes.$^{38}$

The Lebanese expert group concluded that management of prediabetes should be as follows:

- Therapy should be initiated with one tablet of metformin XR 500 mg once daily with the evening meal.
- After 10–15 days, dose uptitration should be considered if the glycemic profile (in terms of FPG, 2-h PG following 75 g OGTT, and HbA1c) did not change; in order to drive values into the normal range.
- A gradual uptitration of the metformin dose may improve gastrointestinal tolerability. The maximum recommended dose is 2000 mg XR once daily with the evening meal.
- If metformin XR is not available, then metformin immediate release (IR) can be used as an alternative formula. In such a case, the dose should be divided with meals.

Limitations

There are some limitations to this consensus; it was not based upon a systematic review of the literature, and the expert panel was not multidisciplinary.

Conclusions

A literature review of the existing data on prediabetes and a thorough professional discussion between seven diabetes experts resulted in a consensus on screening, diagnosis, and management of prediabetes in Lebanon (Figure 1).

The panel agreed that FPG and HbA1c are the preferred tests for the diagnosis of prediabetes in Lebanon. All people older than 45 years without risk factors and adults with risk factors should be screened for prediabetes. Due to the lack of local studies, the panel agreed that Lebanese physicians should adopt cut-off points of international guidelines in their diagnosis of prediabetes. These are as follows:

- FPG: 100–125 mg/dL as per the IDF guidelines
- HbA1c: 5.7%–6.4% as per the ADA guidelines
The panel agreed on a three-step approach for prediabetes management; lifestyle modifications, pharmacotherapy (metformin is the drug of choice in case of failure of lifestyle intervention), and bariatric surgery.

**Figure 1.** Lebanese algorithm for prediabetes management and screening. DSME: diabetes self-management education; DSMS: diabetes self-management support; FPG: fasting plasma glucose.
The panel concluded that research data on diabetes and prediabetes in Lebanon is lacking and that this preliminary report needs to be further discussed with the Lebanese Society of Endocrinology, Diabetes and Lipids in 2021 in a quest to bring forward the first Lebanese national guidelines for the detection and management of prediabetes in the Lebanese population.

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**Ethical approval**
Ethical approval was not sought for the present study because this was a review article and did not involve any patients.

**Informed consent**
Informed consent was not sought for the present study because this was a review article and did not involve any subjects.

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**Supplemental material**
Supplemental material for this article is available online.

**References**
1. Bansal N. Prediabetes diagnosis and treatment: a review. *World J Diabetes* 2015; 6(2): 296–303.
2. Cai X, Zhang Y, Li M, et al. Association between prediabetes and risk of all-cause mortality and cardiovascular disease: updated meta-analysis. *BMJ* 2020; 370: m2297.
3. Diabetes Federation International. IDF diabetes atlas 2019. International Diabetes Federation, 2019, p. 1. [http://www.idf.org/about-diabetes/facts-figures](http://www.idf.org/about-diabetes/facts-figures) (accessed 6 April 2020)
4. Huang Y, Cai X, Qiu M, et al. Prediabetes and the risk of cancer: a meta-analysis. *Diabetologia* 2014; 57(11): 2261–2269.
5. Garber A, Handelsman Y, Einhorn D, et al. Diagnosis and management of prediabetes in the continuum of hyperglycemia—when do the risks of diabetes begin? A consensus
statement from the American College of Endocrinology and the American Association of Clinical Endocrinologists. *Endocr Pract* 2008; 14(7): 933–946.

6. Tabák AG, Herder C, Rathmann W, et al. Prediabetes: a high-risk state for diabetes development. *Lancet* 2012; 379(9833): 2279–2290.

7. Boutayeb A, Lamli ME, Boutayeb W, et al. The rise of diabetes prevalence in the Arab region. *Open J Epidemiol* 2012; 2(2): 55–60.

8. International Diabetes Federation. Age-adjusted comparative prevalence of IGT, %. IDF diabetes atlas 9th edition, https://diabetesatlas.org/data/en/indicators/6/ (2019, accessed 6 April 2020).

9. Yip W, Sequeira I, Plank L, et al. Prevalence of pre-diabetes across ethnicities: a review of impaired fasting glucose (IFG) and impaired glucose tolerance (IGT) for classification of dysglycaemia. *Nutrients* 2017; 9(11): 1273.

10. Knowler WC, Barrett-Connor E, Fowler SE, et al. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. *N Engl J Med* 2002; 346(6): 393–403.

11. Gillies CL, Abrams KR, Lambert PC, et al. Pharmacological and lifestyle interventions to prevent or delay type 2 diabetes in people with impaired glucose tolerance: systematic review and meta-analysis. *BMJ* 2007; 334(7588): 299.

12. Chiasson J-L, Josse RG, Gomis R, et al. Acarbose treatment and the risk of cardiovascular disease and hypertension in patients with impaired glucose tolerance. *JAMA* 2003; 290(4): 486–494.

13. Ratner R, Goldberg R, Haffner S, et al. Impact of intensive lifestyle and metformin therapy on cardiovascular disease risk factors in the diabetes prevention program. *Diabetes Care* 2005; 28(4): 888–894.

14. DREAM Trial Investigators; Dagenais GR, Gerstein HC, Holman R, et al. Effects of ramipril and rosiglitazone on cardiovascular and renal outcomes in people with impaired glucose tolerance or impaired fasting glucose: results of the Diabetes REduction Assessment with ramipril and rosiglitazone Medication (DREAM) trial. *Diabetes Care* 2008; 31(5): 1007–1014.

15. Halliday M. First drug approved for diabetes prevention. Glucophage SR (sustained-release metformin) has gained new approval for use in preventing diabetes, https://www.mims.co.uk/first-drug-approved-diabetes-prevention/diabetes/article/1434274 (2017, accessed 6 April 2020).

16. Khardori R. What are the FDA-approved drugs for treatment of prediabetes or prevention of type 2 diabetes mellitus (DM)? https://www.medscape.com/answers/117853-6619/what-are-the-fda-approved-drugs-for-treatment-of-prediabetes-or-prevention-of-type-2-diabetes-mellitus-dm (2020, accessed 6 April 2020)

17. Cefalu WT and Riddle MC. More evidence for a prevention-related indication for metformin: let the arguments resume! *Diabetes Care* 2019; 42(4): 499–501.

18. Salti I, Khogali M, Alam S, et al. Epidemiology of diabetes mellitus in relation to other cardiovascular risk factors in Lebanon. *East Mediterr Heal J* 1997; 3(3): 462–471.

19. Hirbli KI, Jambeine MA, Slim HB, et al. Prevalence of diabetes in greater Beirut. *Diabetes Care* 2005; 28(5): 1262.

20. Nasrallah MP, Nakhoul NF, Nasreddine L, et al. Prevalence of diabetes in greater Beirut area: worsening over time. *Endocr Pract* 2017; 23(9): 1091–1100.

21. Dorcely B, Katz K, Jagannathan R, et al. Novel biomarkers for prediabetes, diabetes, and associated complications. *Diabetes Metab Syndr Obes* 2017; 10: 345–361.

22. American Diabetes Association. 2. Classification and diagnosis of diabetes: standards of medical care in diabetes—2018. *Diabetes Care* 2018; 41(Suppl. 1): S13–S27.
23. Siu AL. Screening for abnormal blood glucose and type 2 diabetes mellitus: U.S. preventive services task force recommendation statement. *Ann Intern Med* 2015; 163(11): 861–868.

24. Handelsman Y, Bloomgarden ZT, Grunberger G, et al. American Association of Clinical Endocrinologists and American College of Endocrinology – clinical practice guidelines for developing a diabetes mellitus comprehensive care plan – 2015. *Endocr Pract* 2015; 21(Suppl. 1): 1–87.

25. Vandersmissen G and Godderis L. Evaluation of the Finnish diabetes risk score (FINDRISC) for diabetes screening in occupational health care. *Int J Occup Med Environ Health* 2015; 28(3): 587–591.

26. World Health Organization (WHO), International Diabetes Federation. Definition and diagnosis of diabetes mellitus and intermediate hyperglycaemia: report of a WHO/IDF consultation. Cambridge University Press, 2006, pp.1–50. Geneva, Switzerland.

27. IDF. IDF diabetes atlas eighth edition. *International Diabetes Federation*. 2017, pp.1–150. https://diabetesatlas.org/upload/resources/previous/files/8/IDF_DA_8e-EN-final.pdf (accessed 6 April 2020).

28. Eriksson J, Lindström J, Valle T, et al. Prevention of type II diabetes in subjects with impaired glucose tolerance: the Diabetes Prevention Study (DPS) in Finland. Study design and 1-year interim report on the feasibility of the lifestyle intervention programme. *Diabetologia* 1999; 42(7): 793–801.

29. Lindström J, Ilanne-Parikka P, Peltonen M, et al. Sustained reduction in the incidence of type 2 diabetes by lifestyle intervention: follow-up of the Finnish Diabetes Prevention Study. *Lancet* 2006; 368(9548): 1673–1679.

30. Li G, Zhang P, Wang J, et al. The long-term effect of lifestyle interventions to prevent diabetes in the China Da Qing Diabetes Prevention Study: a 20-year follow-up study. *Lancet* 2008; 371(9626): 1783–1789.

31. Haas L, Maryniuk M, Beck J, et al. National standards for diabetes self-management education and support. *Diabetes Care* 2012; 35(11): 2393–2401.

32. Diabetes Prevention Program Research Group. 10-year follow-up of diabetes incidence and weight loss in the Diabetes Prevention Program Outcomes Study. *Lancet* 2009; 374(9702): 1677–1686.

33. Pi-Sunyer X, Astrup A, Fujioka K, et al. A randomized, controlled trial of 3.0 mg of liraglutide in weight management. *N Engl J Med* 2015; 373(1): 11–22.

34. Sara S, Tarek W and Elizabeth AJ. GLP-1 agonist liraglutide and metformin combination may reverse prediabetes. *J Endocrinol Diabetes Obes* 2018; 6(1): 1113.

35. Hutter MM, Schirmer BD, Jones DB, et al. First report from the American College of Surgeons Bariatric Surgery Center Network. *Ann Surg* 2011; 254(3): 410–422.

36. Hostalek U, Gwilt M and Hildemann S. Therapeutic use of metformin in prediabetes and diabetes prevention. *Drugs* 2015; 75(10): 1071–1094.

37. Aroda VR, Knowler WC, Crandall JP, et al. Metformin for diabetes prevention: insights gained from the Diabetes Prevention Program/Diabetes Prevention Program Outcomes Study. *Diabetologia* 2017; 60(9): 1601–1611.

38. Zinman B, Harris SB, Neuman J, et al. Low-dose combination therapy with rosiglitazone and metformin to prevent type 2 diabetes mellitus (CANOE trial): a double-blind randomised controlled study. *Lancet* 2010; 376(9735): 103–111.
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