A 12-hour comprehensive nutrition care benefits blood glucose level and weight gain and improves outcomes in pregnant women with gestational diabetes mellitus

Kun Yuan¹, Haoyuan Wang², Yujia Chen², Sijie Li², Qiang Wang³, Yanmin Cao⁴, Shuqing Gao⁵, Xiaoli Xu⁶, Qi Xie⁵

¹Nursing Department, The Fourth Hospital of Shijiazhuang, Shijiazhuang 050011, China; ²School of Basic Medical Sciences, Hebei Medical University, Shijiazhuang 050017, China; ³Department of Thoracic Surgery, The First Hospital of Hebei Medical University, Shijiazhuang 050000, China; ⁴Emergency Department, The Fourth Hospital of Shijiazhuang, Shijiazhuang 050011, China; ⁵Department of Nutrition, ⁶Medical Record Department, The Fourth Hospital of Hebei Medical University, Shijiazhuang 050011, China

Contributions: (I) Conception and design: K Yuan, Q Xie; (II) Administrative support: S Gao, Q Xie; (III) Provision of study materials or patients: Q Wang, X Xu; (IV) Collection and assembly of data: K Yuan; (V) Data analysis and interpretation: H Wang, Y Chen, Y Cao, Q Xie; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Qi Xie, MS. Department of Nutrition, The Fourth Hospital of Hebei Medical University, Shijiazhuang 050011, China. Emai: w1420174542@126.com.

Background: Gestational diabetes mellitus (GDM) is associated with adverse outcomes and neonatal complications. Its prevalence has been rapidly increasing over the last decade; it is estimated that one in six pregnant women are diagnosed with GDM. Thus, an effective management approach is necessary for women with GDM. This study investigated the effect of a 12-h comprehensive nutrition care (12h-HNC) on the metabolism and outcomes of pregnant women with GDM and neonatal birth weight and hypoglycemia.

Methods: The study included 312 pregnant women with GDM at 24–28 weeks of gestation who were treated in our department from January 2014 to December 2016. They were randomly assigned to receive a 12h-HNC (12h-HNC group, n=158) or traditional one-time nutrition guidance (control group, n=154). Maternal blood glucose levels and weight gain, as well as maternal and neonatal outcomes were evaluated and compared between the groups.

Results: Compared to those in the control group, patients in the 12h-HNC group had significantly lower 2-h postprandial glucose levels (P<0.05), lower average weight increase (P<0.05), and better outcomes (P<0.05). Neonatal birth weight and incidence of macrosomia were significantly lower in the 12h-HNC group. The incidence of cesarean section was similar in the two groups (P>0.05).

Conclusions: The 12h-HNC enabled better blood glucose and weight increase control, improving both maternal and neonatal outcomes in women with GDM. This comprehensive nutrition intervention may achieve favorable effects in clinical practice.

Keywords: Gestational diabetes mellitus (GDM); 12-h comprehensive nutrition care (12h-HNC); pregnancy outcome; neonatal birth weight

doi: 10.21037/apm.2020.03.16

View this article at: http://dx.doi.org/10.21037/apm.2020.03.16
Introduction

Gestational diabetes mellitus (GDM) is defined as any degree of glucose intolerance with onset or first recognition during pregnancy (1,2). In recent years, changes in lifestyle, unhealthy dietary behaviors, insufficient activity, and later childbearing have contributed to the increased incidence of GDM, which was reported to be up to 9.6% (3). GDM is associated with considerable risks to both the mother and the developing fetus (4,5). Previous studies have shown that poor blood glucose level control is associated with increased risk of abortion, preterm labor, gestational hypertension, and infection (6,7). Furthermore, high blood glucose levels in the gestation period increase the incidence of negative fetal and neonatal outcomes, such as macrosomia, deformity, and neonatal asphyxia (8-10). In addition, long-term clinical follow-up studies have indicated that up to 50% of women with GDM may develop diabetes over 20–30 years after pregnancy (11,12). Due to its gravity and dramatically increasing incidence, GDM is considered one of the most urgent health challenges of this century (13-15).

At present, there is no effective approach for the treatment of GDM. Hence, a new intervention is urgently needed. Currently, medical nutrition therapy (MNT) is the most common method to address the dietary requirements of women with GDM (16,17). However, MNT has obvious shortcomings, including the lack of follow-ups (18,19). The 12-h comprehensive nutrition care (12h-HNC) is a newly developed approach in the treatment of GDM that was established at The First Hospital of Beijing. It consists of nutritious meals for diabetic patients (3 meals and 2 snacks), postprandial exercise with guidance, and nutrition health education for diabetics. The specific process is shown in Figures 1 and 2. Appropriate nutrition recipes not only provide adequate calories and nutrition for pregnant women, but also prevent postprandial hyperglycemia and starvation ketosis. Accordingly, we calculated the total calories needed in a day for each patient and tailored the nutrition recipe to the patients' individual needs.

Methods

Study design, participants, and definitions

Pregnant women with GDM at 24–28 weeks of gestation treated at The Fourth Hospital of Shijiazhuang from January 2014 to December 2016 were recruited. GDM was diagnosed as the presence of at least one of the following three findings in the 75-g oral glucose tolerance test: fasting plasma glucose (FPG) >5.1 mmol/L, postprandial blood glucose at 1 hour (1h-PBG) >10.0 mmol/L, and/or postprandial blood glucose at 2 hours (2h-PBG) >8.5 mmol/L. Patients with acute complications due to preexisting diabetes were excluded from the study. All patients were provided with written informed consent.

Interventions

Patients were randomly assigned to a 12h-HNC group (n=158) or a control group (n=154). Those in the control group received traditional one-time nutrition guidance. For the 12h-HNC group, patients were kept in our department from 7:00 a.m. to 7:30 p.m., accompanied by one dietitian and one nurse. The 12h-HNC included nutritious meals for diabetic patients (3 meals and 2 snacks), postprandial exercise with guidance, and nutrition health education for diabetics. The specific process is shown in Figures 1 and 2. Appropriate nutrition recipes not only provide adequate calories and nutrition for pregnant women, but also prevent postprandial hyperglycemia and starvation ketosis. Accordingly, we calculated the total calories needed in a day for each patient and tailored the nutrition recipe to the patients’ individual needs.

Outcome measurement

We recommended that patients monitor all-day blood glucose levels at least once per week. The patients’ weight increase, FPG, and 2h-PBG were recorded before delivery. After delivery, relevant patient data were obtained from the hospital electronic medical records, including pregnancy outcomes, neonatal birth weight, and incidence of neonatal
Figure 1 Study flow. Pregnant women underwent oral glucose tolerance test. Those who were diagnosed with gestational diabetes mellitus (GDM) were randomly assigned to an intervention group or a control group. The former received a 12-h comprehensive nutrition intervention, and the latter received routine nutrition guidance. At the end, the data were collected and analyzed.
The procedures of 12h-HNC

7:00–7:15
1. To the nutrition clinic
2. Monitor fasting glucose and weight.

7:15–9:15
1. Breakfast (nutrition diet)
2. Postprandial exercise (pregnant women).

9:15–10:00
1. Monitor glucose 2h after breakfast
2. morning snack (Individual).

10:00–11:30
1. Diabetes knowledge education

11:30–14:00
1. Monitor glucose before lunch
2. lunch (Individual)
3. Postprandial exercise
4. noon break.

14:00–15:00
1. Monitoring glucose 2h after lunch
2. afternoon snack (Individual)
3. Monitoring fetal heart rate

15:00–16:30
1. Healthy education (Principles of food calorie and preparation + Exercise guidance)

16:30–17:00
1. One-on-one nutritional guidance

17:00–18:30
1. Monitoring glucose before dinner
2. dinner (Individual)
3. Postprandial exercise.

18:30–19:30
1. Monitoring glucose 2h after dinner
2. Individual nutrition guidance.

19:30
1. Create a WeChat group, give a recommend diet and blood glucose monitoring form

12h-HNC end

Figure 2 The process of the 12-h comprehensive nutrition intervention. It lasted from 7:00 a.m. to 07:30 p.m. and included recommended diet, exercise guidance, and health education, tailored per the patients’ individual needs.
### Table 1 The nutrition diet and nutrient recommendation in 12-hour comprehensive intervention

<table>
<thead>
<tr>
<th>Meal</th>
<th>1,800–1,900 kcal recipe</th>
<th>1,900–2,000 kcal recipe</th>
<th>2,000–2,100 kcal recipe</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Breakfast</strong></td>
<td>Fresh milk 250 mL</td>
<td>Soya bean milk 300 mL</td>
<td>Fresh milk 250 mL</td>
</tr>
<tr>
<td>Sugar-free whole wheat bread 70 g</td>
<td>Sugar-free whole wheat bread 70 g</td>
<td>Sugar-free whole wheat bread 70 g</td>
<td></td>
</tr>
<tr>
<td>A marinated egg about 60 g</td>
<td>Boiled egg 60 g</td>
<td>Boiled egg 60 g</td>
<td></td>
</tr>
<tr>
<td>Fungus with celery (fungus 10 g, celery 40 g)</td>
<td>Mixed cabbage 50 g</td>
<td>Mixed bamboo shoots 50 g</td>
<td></td>
</tr>
<tr>
<td>Sesame oil 1 g</td>
<td>Sesame oil 1 g</td>
<td>Sesame oil 1 g</td>
<td></td>
</tr>
<tr>
<td><strong>Extra meal</strong></td>
<td>Apple 100 g</td>
<td>Orange 100 g</td>
<td>Pomelo 200 g</td>
</tr>
<tr>
<td>Soda cracker 25 g</td>
<td>Soda cracker 25 g</td>
<td>Walnut 30 g</td>
<td></td>
</tr>
<tr>
<td><strong>Lunch</strong></td>
<td>Seaweed shrimp soup (seaweed 10 g, some shrimp)</td>
<td>Winter melon tofu soup (winter melon 40 g, tofu 50 g)</td>
<td>Cabbage tofu soup (cabbage 50 g, tofu 50 g)</td>
</tr>
<tr>
<td>Shrimp fried cucumber (shrimp 50 g, cucumber 100 g)</td>
<td>Mushroom fried chicken (chicken 50 g, mushroom 50 g)</td>
<td>Steamed fish 100 g</td>
<td></td>
</tr>
<tr>
<td>Mushrooms and Cole (mushrooms 30 g, Cole 100 g)</td>
<td>Cardamom and oats (naked oats 150 g, some cardamom)</td>
<td>Garlic vegetable 150 g</td>
<td></td>
</tr>
<tr>
<td>Multigrain rice (rice 50 g, black rice 25 g)</td>
<td>Multigrain rice (rice 50 g, black rice 25 g)</td>
<td>Multigrain rice (rice 50 g, black rice 25 g)</td>
<td></td>
</tr>
<tr>
<td>Edible oil 13 g</td>
<td>Edible oil 13 g</td>
<td>Edible oil 13 g</td>
<td></td>
</tr>
<tr>
<td><strong>Extra meal</strong></td>
<td>Orange 100 g</td>
<td>Tomato 100 g, whole wheat bread 25 g</td>
<td>Boiled corn 200 g</td>
</tr>
<tr>
<td><strong>Dinner</strong></td>
<td>Spinach tomato soup (spinach 20 g, tomato 30 g)</td>
<td>Seaweed shrimp soup (seaweed 10 g, some shrimp)</td>
<td>Needle mushroom tomato soup (needle mushroom 20 g, tomato 30 g)</td>
</tr>
<tr>
<td>Broccoli fried meat (lean meat 50 g, broccoli 100 g)</td>
<td>Celery fried meat (lean meat 50 g, celery 100 g)</td>
<td>Garlic sprouts fried meat (garlic sprouts 100g, lean meat 50 g)</td>
<td></td>
</tr>
<tr>
<td>Fried bitter gourd (bitter gourd 100 g)</td>
<td>Garlic broccoli (broccoli 150 g)</td>
<td>Fried winter melon (inter melon 200 g)</td>
<td></td>
</tr>
<tr>
<td>Whole wheat bread 75 g</td>
<td>Whole wheat bread 75 g</td>
<td>Whole wheat bread 75 g</td>
<td></td>
</tr>
<tr>
<td>Edible oil 11 g</td>
<td>Edible oil 11 g</td>
<td>Edible oil 14 g</td>
<td></td>
</tr>
<tr>
<td><strong>Extra meal</strong></td>
<td>Fresh milk 250 mL</td>
<td>Fresh milk 250 mL</td>
<td>Fresh milk 250 mL; soda cracker 25 g</td>
</tr>
</tbody>
</table>

### Table 2 Ratio of nutrition

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>1,800–1,900 kcal, nutrient ratio [g (%)]</th>
<th>1,900–2,000 kcal, nutrient ratio [g (%)]</th>
<th>2,000–2,100 kcal, nutrient ratio [g (%)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein</td>
<td>90.3 (20.0)</td>
<td>95.5 (20.1)</td>
<td>102.3 (20.5)</td>
</tr>
<tr>
<td>Lipid</td>
<td>51.7 (25.5)</td>
<td>55.9 (26.5)</td>
<td>65.6 (29.5)</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>249.6 (54.7)</td>
<td>253.7 (53.4)</td>
<td>250.1 (50.0)</td>
</tr>
<tr>
<td>Dietary fiber</td>
<td>23.4</td>
<td>25.1</td>
<td>35</td>
</tr>
</tbody>
</table>
Table 3 The baseline characteristics of pregnant women with GDM in two groups

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Intervention group (n=158)</th>
<th>Control group (n=154)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (x±s)</td>
<td>31.92±3.75</td>
<td>31.83±4.61</td>
<td>0.78</td>
</tr>
<tr>
<td>&lt;30, [n (%)]</td>
<td>72 (45.57)</td>
<td>76 (49.35)</td>
<td></td>
</tr>
<tr>
<td>30–35, [n (%)]</td>
<td>86 (54.43)</td>
<td>78 (50.65)</td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m²) (x±s)</td>
<td>21.82±2.8</td>
<td>22.33±2.76</td>
<td>0.08</td>
</tr>
<tr>
<td>FPG (mmol/L)</td>
<td>5.2±0.82</td>
<td>5.1±0.93</td>
<td>0.73</td>
</tr>
<tr>
<td>1h-PBG (mmol/L)</td>
<td>10.4±1.65</td>
<td>10.5±1.71</td>
<td>0.69</td>
</tr>
<tr>
<td>2h-PBG (mmol/L)</td>
<td>9.0±1.42</td>
<td>8.9±1.23</td>
<td>0.66</td>
</tr>
<tr>
<td>Career [n (%)]</td>
<td></td>
<td></td>
<td>0.58</td>
</tr>
<tr>
<td>Civil servant</td>
<td>29 (18.25)</td>
<td>25 (16.23)</td>
<td></td>
</tr>
<tr>
<td>Self-employed</td>
<td>16 (10.13)</td>
<td>18 (11.69)</td>
<td></td>
</tr>
<tr>
<td>Employee</td>
<td>52 (32.91)</td>
<td>46 (29.87)</td>
<td></td>
</tr>
<tr>
<td>Institution</td>
<td>43 (27.22)</td>
<td>40 (25.97)</td>
<td></td>
</tr>
<tr>
<td>Unemployed</td>
<td>18 (11.39)</td>
<td>25 (16.23)</td>
<td></td>
</tr>
<tr>
<td>Education [n (%)]</td>
<td></td>
<td></td>
<td>0.69</td>
</tr>
<tr>
<td>Secondary specialized school and below</td>
<td>17 (10.77)</td>
<td>19 (12.34)</td>
<td></td>
</tr>
<tr>
<td>Postsecondary specialized college</td>
<td>65 (41.14)</td>
<td>69 (44.81)</td>
<td></td>
</tr>
<tr>
<td>University and above</td>
<td>76 (48.10)</td>
<td>66 (42.86)</td>
<td></td>
</tr>
<tr>
<td>Childbirth</td>
<td></td>
<td></td>
<td>0.09</td>
</tr>
<tr>
<td>Multipara</td>
<td>95 (60.13)</td>
<td>86 (55.84)</td>
<td></td>
</tr>
<tr>
<td>Primipara</td>
<td>63 (39.87)</td>
<td>68 (44.16)</td>
<td></td>
</tr>
</tbody>
</table>

hypoglycemia.

Statistical analysis
Data are expressed as mean ± standard deviation or n (%). Intergroup differences were analyzed using a two-tailed Student’s t-test or χ² test. P values of <0.05 were considered statistically significant. All statistical analyses were performed with the SPSS statistical software package version 21.0.

Results
A total of 312 pregnant women with GDM were enrolled in this study, with 154 in the control group and 158 in the 12h-HNC group. The baseline characteristics of patients in both groups are shown in Table 3. In the comparative analysis, patients in the 12h-HNC group had significantly lower 2h-PBG levels (Figure 3, P<0.05) and average weight increase (Figure 4, P<0.05) than those in the control group.

In the comparison of the pregnancy outcomes between the two groups, patients in the 12h-HNC group had a significantly lower incidence of gestational hypertension, premature rupture of membranes, and preterm labor (Figure 5, P<0.05). However, there was no significant difference in the incidence of cesarean section (P>0.05). Neonatal birth weight and incidence of macrosomia were significantly lower in the 12h-HNC group than in the control group (Figure 6, P<0.05).

Discussion
The prevalence of GDM has been rapidly increasing in recent years worldwide and has increased significantly over the past two decades in China (20). GDM is associated with increased incidence of adverse maternal, fetal, and neonatal
outcomes and increased risk of subsequent diabetes mellitus for mothers (21,22). Women with GDM have high blood glucose levels and abnormal glucose tolerance. It has been widely demonstrated that hypoglycemic therapy in GDM can improve pregnancy outcomes (23). However, the side effect of hypoglycemic agents on pregnant women remains unknown, and many patients refuse to receive hypoglycemic therapy. Furthermore, maintaining a healthy weight is also important. It has been reported that women with obesity are more likely to develop GDM. Liu et al. suggested that high rates of gestational weight gain, particular during early pregnancy, might increase a woman’s risk of GDM (24). Logan et al. showed that women with GDM were at higher risk of later metabolic disease (25). Black et al. demonstrated that obesity could lead to adverse outcomes regardless of the presence of GDM during pregnancy (26). Therefore, it is equally important to control both the weight increase and the blood glucose levels in women with GDM.

Traditional MNT is the most commonly used method for controlling blood glucose levels in women with GDM (27). However, its efficacy is unsatisfactory because of the lack of follow-ups. In this study, we proposed a new intervention, called the 12h-HNC, to enhance blood glucose level control in pregnant women with GDM. The 12h-HNC consists of nutrition recipes, postprandial exercise, health education, and regular follow-ups. During the 12h-HNC, patients learned to formulate a reasonable diet themselves and exercise in moderation, which helped them to control their blood glucose levels and weight increase. Patients who received 12h-HNC regularly monitored their blood glucose levels themselves. Moreover, the proper diet and exercise lowered the weight increase in these patients. Our continuous follow-up was an important measure to improve patient compliance, which made up for the shortcomings of MNT.

Comparison of patients’ outcomes showed that the 12h-HNC could reduce the risk of gestational hypertension, premature rupture of membranes, and preterm labor. Furthermore, consistent with the findings of previous studies (28), our results showed that the 12h-HNC had a positive effect on controlling neonatal birth weight and incidence of macrosomia. This intervention could lower the blood glucose levels, which helped to lower newborns’ weight. We found no significant difference between the two groups in the incidence of cesarean section, which was inconsistent with our previous findings. We speculate that this discrepancy can be attributed to the increasing trend

Figure 3 Postprandial blood glucose levels. The 2-h glucose levels after lunch (A) and dinner (B) were significantly lower in the intervention group. *, P<0.05.

Figure 4 Weight gain comparison. The intervention group had lower average weight increase than the control group. *, P<0.05.
Figure 5 Maternal outcome comparison. (A) No difference was found between the two groups in the incidence of cesarean section. The intervention group had better outcomes regarding (B) gestational hypertension, (C) preterm labor, and (D) premature rupture of membranes.

Figure 6 Neonatal outcome comparison. The intervention group had healthier neonates, with a lower incidence of (A) hypoglycemia of newborn and (B) macrosomia, and lower (C) neonatal birth weights.
of cesarean section among Chinese women. Spontaneous delivery in patients with GDM may result in unexpected adverse events, such as premature rupture of membranes, dystocia, and even death. In contrast, cesarean section provides more safety, less pain, and healthier babies. Therefore, an overwhelming number of patients prefer cesarean section, even in the absence of corresponding indications. This may have led to the different results in our study.

Conclusions

The 12h-HNC enabled better control of blood glucose levels and lower average weight increase after a trial on 300 patients with GDM. Therefore, this comprehensive intervention has broad prospects for future use to reduce complications and improve the maternal and neonatal outcomes in pregnant women with GDM.

Acknowledgments

Funding: None.

Footnote

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at http://dx.doi.org/10.21037/apm.2020.03.16). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. This study complied with the Declaration of Helsinki and was approved by Ethics Committees of the Fourth Hospital of Shijiazhuang (No. 20200001). All patients provided written informed consent.

Open Access Statement: This is an Open Access article distributed in accordance with the Creative Commons Attribution-NonCommercial-NoDerivs 4.0 International License (CC BY-NC-ND 4.0), which permits the non-commercial replication and distribution of the article with the strict proviso that no changes or edits are made and the original work is properly cited (including links to both the formal publication through the relevant DOI and the license). See: https://creativecommons.org/licenses/by-nc-nd/4.0/.

References


