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The relationship between lifestyle and metabolic evaluation in women with a history of gestational diabetes

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Abstract:

BACKGROUND: Gestational diabetes is one of the most common metabolic diseases during pregnancy. The risk of a lifestyle role in the prevention of metabolic syndrome in women with a history of gestational diabetes has now been identified. The present study was performed to investigate the relationship between lifestyle and metabolic syndrome in women with a history of gestational diabetes.

MATERIALS AND METHODS: The present study was a retrospective case–control study that was performed on 90 women (45 women with a history of gestational diabetes and 45 women without a history of gestational diabetes) in Kerman health centers 5 years after delivery in 2020. Data were collected using a demographic questionnaire and a standardized Walker lifestyle Health promoting Lifestyle profile II questionnaire. The reference laboratory was also used to perform the experiments. SPSS21 software and Spearman's and Chi-square tests were used to analyze the data.

RESULTS: The mean age was 35.67 in the case group and 34.27 in the control group ($P = 0.230$). Lifestyle did not show any difference between the two groups ($P = 0.058$). However, metabolic evaluation was different in the two groups ($P = 0.030$). Furthermore, the results of Spearman's test to examine the relationship between lifestyle and other variables studied showed that in the case group ($P = 0.075$) and in the control group ($P = 0.819$) there was no relationship between lifestyle and metabolic assessments 5 years after delivery.

CONCLUSIONS: In case group women, it is possible to prevent the progression to type 2 diabetes and disturb the metabolic assessment by teaching a healthy lifestyle and timely follow-up after delivery. A history of gestational diabetes can be one of the causes of type 2 diabetes and metabolic syndrome. Getting training to change your lifestyle during pregnancy and postpartum can reduce the incidence of gestational diabetes and type 2 diabetes. Screening pregnant women during childbirth is a good opportunity to diagnose diabetes early and predict it in the coming years.

Keywords:

Gestational diabetes, lifestyle, metabolic, women

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Introduction

Lifestyle is considered to be a relatively harmonious set of all the behaviors and activities of a certain person during daily life and the basis for understanding the existing cultural conditions and upcoming developments. Lifestyle shows what is going on inside the values in the cultural subsystem.[1] Lifestyle is mentioned as an important element affecting health and today it is associated with cardiovascular disease, obesity, diabetes, and many cancers.[2] Healthy lifestyle consists of six dimensions of stress management, responsibility for health, interpersonal communication, spiritual growth, nutrition, and physical activity.[3] Thus, a healthy lifestyle means behaviors that cause physical, mental, social, sexual, and emotional health of human beings.[4] In Iran,

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due to increasing urbanization, industrialization, and aging population, we are facing an increase in the prevalence of noncommunicable diseases such as cardiovascular disease and diabetes. According to statistics published in Iran, deaths due to chronic diseases are mainly due to the following reasons: smoking (33%), obesity and overweight (24%), inactivity (23%), hypertension (20%), and high cholesterol (20%). All of these cases reflect the effects of lifestyle.[5] Diabetes is one of the most important metabolic and chronic diseases and its symptoms are chronic hyperglycemia and deficiency in carbohydrate, fat, and protein metabolism.[6] The prevalence of this disease in adults in 2010 is estimated at 4.6%, which is equivalent to 285 million people, and by 2030 it will reach 7.7%, or about 439 million people.[7] Gestational diabetes mellitus (GDM) is defined as intolerance to carbohydrates of varying severity that begins in pregnancy or is first diagnosed in pregnancy.[8] The incidence of gestational diabetes is currently increasing and about 1%–14% of pregnant women develop gestational diabetes.[9] Women with a history of gestational diabetes are at least seven times more likely to develop type 2 diabetes in future and are at risk for cardiovascular disease and metabolic syndrome in the years after pregnancy.[10] Diagnosing gestational diabetes and glucose intolerance during pregnancy helps health professionals identify women at risk for type 2 diabetes.[11] Insulin resistance syndrome or metabolic syndrome is a group of risk factors that include waist fat, abdominal obesity, high blood pressure, diabetes, high triglycerides, and low-density lipoprotein (good fat). In metabolic syndrome, all of these conditions occur together and increase the risk of heart disease, stroke, and diabetes.[12] In studies performed 3–11 months after delivery in women with a history of gestational diabetes, triglyceride levels increased and high-density lipoprotein (HDL) cholesterol levels decreased.[13] Gestational diabetes and metabolic syndrome share risk factors. This suggests that women with risk factors for gestational diabetes (overweight during pregnancy, maternal age, and family history of type 2 diabetes) may be at greater risk for developing subsequent metabolic syndrome, even if they do not have gestational diabetes.[14,15]

In Iran, large and rapid changes in lifestyle and increasing obesity and the prevalence of diseases such as hypertension and hyperlipidemia have increased the risk of developing type 2 diabetes.[16] In addition, regarding the important factors that increase diabetes in Iran, we can mention the increase of urbanization, aging and increasing life expectancy, change in diet, decrease in physical activity, and change in lifestyle in general.[17] Diabetes is one of the chronic diseases. The cause of most chronic diseases is an unhealthy lifestyle. Because the source of these diseases is the lifestyle and behavior of the individual that can be changed and corrected should be considered.[3] Studies have shown that a combination of several healthy lifestyle criteria reduces the risk of diabetes by up to 90%. These healthy lifestyle criteria include use of diets high in fiber and unsaturated fats, maintaining a body mass index of 25 or less, consuming foods low in saturated fats and sugars, and regular exercise.[18] In addition, women with previous GDM are advised to undergo lifestyle interventions to prevent progression to overt diabetes.[19] In the study, Behboudi-Gandevani *et al*. followed women with a history of gestational diabetes for 12 years and compared them with women without a history of gestational diabetes. The results of this study showed that in women with a history of gestational diabetes, the profiles of lipids including total cholesterol, triglycerides, low-density lipoprotein cholesterol, and HDL cholesterol increased. As a result, all women were advised to make the necessary corrections after pregnancy to have a healthy life.[20-24]

There are few studies on lifestyle in women with gestational diabetes in the after delivery period and its relationship with metabolic assessment. Therefore, this study investigated the relationship between lifestyle and metabolic assessment in women with a history of gestational diabetes.

Materials and Methods

Study design and setting

This study was a retrospective study with a case–control group that was conducted in 2020 in Kerman.

Study participants and sampling

The statistical population of this study consisted of women who had completed their pregnancy 5 years ago and referred to health centers for child vaccination courses and periodic evaluation care (using the Sib system and maternity care offices). The sampling method was simple and randomly classified. According to Tanczer's (2017) study in which the fasting blood sugar (FBS) of mothers with a history of gestational diabetes was 5.7 ± 1.1 mmol/L and in women without a history of gestational diabetes was 5.2 ± 0.4, the sample size in each group was calculated to be at least 45 (21). Inclusion criteria were written consent to participate in the study, definitive diagnosis of gestational diabetes, literacy, living in Kerman. Exclusion criteria were unwillingness to participate in the study, cancellation of further study.

Data collection tool and technique

First, 10 bases were randomly selected (in general, there are 10 urban health centers in the city of Kerman, which, considering the number of bases covered, the number of centers is 49. Therefore, in order to cover all areas of the city, a base was selected by lot from each

center). At these centers, 45 women with gestational diabetes were considered as the case group. Forty-five women with no history of gestational diabetes were included in the control group. First, written consent was completed by the participants. Then, the demographic information questionnaire and lifestyle questionnaire were completed. After completing the questionnaires, clinical evaluation (measurement of blood pressure and waist circumference) and metabolic tests (FBS, HDL, triglycerides, cholesterol, and Vitamin D3) were performed. For clinical trials, a laboratory was considered as a reference in Kerman. A mercury sphygmomanometer with a suitable arm was used to measure blood pressure. The correct method of measuring blood pressure was in accordance with the standards of the World Health Organization. In this way, blood pressure was measured twice in a sitting position from the right hand with a time interval of 10 min and the mean measurement was determined as the final blood pressure. A cloth meter was used to measure waist circumference. The meter was placed on the top of the iliac crest and then the size was recorded. For paraclinical experiments, first coordination was done with the reference laboratory, then 10 women from the case and control groups came to the laboratory daily in the morning on an empty stomach and with a light dinner. As a result, paraclinical tests were completed after 10 days.

The questionnaire used in this study was a standardized lifestyle questionnaire that was measured by Likert scale. The Health Promoting Lifestyle Questionnaire has 52 questions and its purpose is to measure health-promoting behaviors (nutrition, exercise, health responsibility, stress management, interpersonal support, and self-fulfillment). Answering questions is in the Likert range (never = 1, sometimes = 2, often = 3, and always = 4). The Health Promoting Lifestyle Questionnaire has six dimensions (nutrition, exercise, health responsibility, stress management, interpersonal support, and self-fulfillment). To get points for each dimension, the sum of the points of the questions related to that dimension is added together. To get the total score of the questionnaire, the total score of all the questions is added together. The validity and reliability of this questionnaire has been confirmed in the study of Mohammadi Zeidi *et al*.[23] In this study, a retest test was used to confirm the reliability. Reliability was confirmed by Cronbach's α 0.86. Demographic characteristics questionnaire consisted of 21 questions, the reliability of which was confirmed with an alpha of 0.84.

Ethical consideration

Initially, written consent was obtained from all participants in the research. Participants could withdraw at any stage of the research. This study did not endanger the participants' health. The information obtained from the participants was confidential. The information obtained from the study was presented to the participants at the end of the study. This research was approved by the Vice-Chancellor of Ethics Committee of Kerman University of Medical Sciences (with the code IR.KMU.REC.1399.425).

Data management and statistical analyses

Information was encrypted and entered into SPSS (Version 21) software (IBM, SPSS Inc., Chicago, Illinois, USA). Then, Pearson's and Chi-square statistics were used to test the hypotheses. P <0.05 was considered statistically significant.

Results

Table 1 shows the mean and standard deviation of demographic variables and their significance by case group (pregnant women with a history of gestational diabetes) and control (pregnant women with no history of gestational diabetes). According to this table, the variables of age, duration of marriage, number of children, and number of pregnancies in the case and control groups did not differ ($P > 0.05$).

In this study, the two case and control groups were not different in terms of their education, spouse education, occupation, and spouse occupation. Most of the educated people in both groups had postgraduate and bachelor's degrees and the lowest frequency in both groups had primary education and literacy. In this study, homemakers had the highest frequency in both groups. In the spouse job variable, in the case group, the highest frequency was related to freelance work and in the control group, the number of people with employee jobs was more than other jobs.

Table 2 shows the frequency comparison of case and control groups for variables related to place of delivery, history of diabetes in previous pregnancies, family history of diabetes and other cases, as well as their significance by case and control groups. According to this table, the variables of history of diabetes in previous pregnancy, family history of diabetes, history of insulin use in recent pregnancy, follow-up of postpartum diabetes, history of disease other than diabetes, and time of diagnosis of diabetes were different in the two groups ($P < 0.05$). The two groups were not different in terms of delivery and breastfeeding variables after the last pregnancy ($P > 0.05$).

Table 3 shows the mean and standard deviation of laboratory variables by case and control groups. According to the findings of this table, the variables of blood pressure, waist circumference and HDL are not

Table 1: Mean and standard deviation of demographic variables and their significance

Variable	Group		Mean		SD		Middle		*P* Mann-Whitney U
	Case	Control	Case	Control	Case	Control	Case	Control	
Age (years)	45	44	35.67	34.27	5.205	5.78	35	34	0.230
Duration of marriage (years)	45	45	12.87	11.51	5.075	4.96	12	10	0.111
Number of children	45	45	2.11	1.98	0.775	0.69	2	2	0.415
Gravida	45	45	2.49	2.47	1.079	1.014	2	2	0.912

SD=Standard deviation

Table 2: Results of Chi-square test (χ^2) to compare the frequency of demographic variables related to fertility and diabetes records of the two case and control groups according to different classes

Variable	Classes	Groups		χ^2	*P*
		Case	Control		
Place of delivery	Public hospital	33	26	2.41	0.12
	Private hospital	12	19		
History of diabetes in a previous pregnancy	Yes	29	0	48.02	<0.001
	No	12	45		
Family history of diabetes	Yes	35	16	14.85	<0.001
	No	10	27		
History of insulin use in recent pregnancy	Yes	36	2	51.76	<0.001
	No	9	42		
Breastfeeding after the last pregnancy	Breast milk	30	38	5.73	0.057
	Formula	7	1		
	Breast milk and formula	8	6		
Follow-up of after delivery diabetes	Yes	26	3	21.92	<0.001
	No	15	29		
History of a disease other than diabetes	Yes	21	12	3.92	0.048
	No	23	32		
Time to diagnose diabetes	Before the last pregnancy	12	0	15.82	<0.001
	During the last pregnancy	33	2		
	After the last pregnancy	0	1		

Table 3: Mean and standard deviation of laboratory variables and their significance

Variable	Group		Mean		SD		Middle		*P* Mann-Whitney U
	Case	Control	Case	Control	Case	Control	Case	Control	
TG	45	45	148.71	106.56	140.06	56.05	108	90	0.037
HDL	44	45	31.09	37.76	5.62	28.39	31	35	0.056
FBS	45	45	120.44	91.67	49.34	6.63	104	91	0.001
Waist circumference	44	45	97.89	97.64	11.19	12.84	96	96	0.815
Blood pressure (systolic)	45	45	114.00	114.76	11.88	13.78	111	112	0.968
Blood pressure (diastolic)	45	45	76.40	76.73	8.98	10.09	77	77	0.945

TG=Triglyceride, HDL=High-density lipoprotein, FBS=Fasting blood sugar, SD=Standard deviation

different in the two groups ($P > 0.05$). However, blood sugar and triglyceride ($P < 0.05$) are different in the two groups.

Table 4 shows the mean and standard deviation of lifestyle variables and their significance in the two groups. According to this table, exercise ($P = 0.027$), responsibility for health ($P = 0.011$), and stress management ($P = 0.039$)) are different in two groups and the variables of nutrition, interpersonal support, maintaining relationships with feelings of closeness and self-fulfillment ($P > 0/05$) is not different in the two groups.

Table 5 shows the mean and standard deviation of lifestyle variables and their metabolic evaluation and significance. According to the results of this table, lifestyle is not different in case and control groups ($P = 0.058$). However, metabolic evaluation is different in the two groups ($P = 0.030$).

The results of Spearman's test to examine the relationship between lifestyle and other variables studied showed that there is no relationship between lifestyle and metabolic evaluation 5 years after delivery in the case group ($P = 0.075$) and the control group ($P = 0.819$).

Table 4: Mean and standard deviation of lifestyle variables and their significance

Variable	Group		Mean		SD		Middle		*P* Mann-Whitney U
	Case	Control	Case	Control	Case	Control	Case	Control	
Nutrition	45	45	21.40	22.40	4.52	4.08	21	24	0.176
Exercise	45	45	13.96	16.49	5.07	5.96	13	15	0.027
Health responsibility	45	45	25.00	28.36	6.20	6.03	23	28	0.011
stress management	45	45	10.11	11.04	2.74	2.24	9	11	0.039
Interpersonal support, maintaining relationships with a sense of closeness	45	45	25.56	26.11	5.49	5.18	26	26	0.557
Self-actualization	45	45	27.31	24.56	6.04	5.14	23	24	0.507

SD=Standard deviation

Table 5: Mean and standard deviation of lifestyle variables and metabolic and significant evaluation

Variable	Group	Number	Mean	SD	Middle	*P* Mann-Whitney U
Lifestyle	Case	45	119.73	21.097	122	0.058
	Control	45	128.96	20.243	129	
Metabolic evaluation	Case	44	589.52	179.88	539	0.030
	Control	45	525.12	71.97	506	

SD=Standard deviation

Discussion

This retrospective study was performed to investigate the relationship between lifestyle and metabolic assessment in women with a history of gestational diabetes in Kerman.

In the present study, no significant difference was observed between case and control groups in terms of lifestyle. Lifestyle in this study was not significantly different between the two groups, but in terms of nutrition and physical activity, the control group was in a better position, and this highlights the need to improve lifestyle, i.e., proper nutrition, mobility and physical activity in the case group to prevent the onset of type 2 diabetes and subsequent metabolic syndrome.

In a 2015 study by Persson *et al*., in Sweden, the researchers concluded that there was a significant difference between women with normal pregnancies and pregnant women with gestational diabetes in terms of lifestyle and health status approximately 4 years after delivery,[25] which is not in line with our study in terms of lifestyle. Of course, this can be justified given the living conditions in the two countries. The study found that irregular eating habits, lack of proper physical activity, overweight or obesity, and regular medication use were all associated with poorer self-care in follow-up cases. In this study, in terms of number of pregnancies and number of children born, no difference was observed between women with normal pregnancies and women with a history of gestational diabetes, and these cases do not seem to affect lifestyle and are equal to our study. Of course, according to the living conditions in the two countries, some differences can be explained by our study. Women in Sweden receive lifestyle education during pregnancy. The study covered all geographical areas of Sweden, had 444 participants, and was born outside Sweden with poor self-care. In the present study, only one region and only women living in Kerman and Iranians participated in the study. In addition, differences in the number of participants may have affected the difference in results, our study had 90 participants. No training on gestational diabetes and its follow-up was provided to women during pregnancy and after delivery. It has also been suggested that during the years following pregnancy and childbirth, some women's experiences may affect their lifestyle and health status. For example, women may assess their living conditions under the influence of physical symptoms and emotional problems that affect daily life as well as family functioning, relationship with partner and balancing maternal and work responsibilities.[26] It should be noted that the women in the case group in our study did not receive any training on postpartum follow-up. Also in a study by Tänczer *et al*. in Canada, women with a history of gestational diabetes were less active 3 years after delivery.[27] In our study, this issue was also present in the group with a history of gestational diabetes. In a 2018 meta-analysis entitled "Lifestyle Intervention to Prevent Diabetes in Women with Pregnancy Diabetes," Goveia *et al*., showed that postpartum lifestyle intervention is effective in women with a history of gestational diabetes. They stated that lifestyle changes reduce the risk of diabetes and its complications by 25%.[28] The next finding in this study was that there was no relationship between lifestyle and metabolic evaluation 5 years after delivery in both case and control groups. However, in the comparison of the two groups, the metabolic evaluation was significantly different and as expected, in the case group with a history of gestational diabetes, 5 years after delivery, the metabolic syndrome was higher than the

control group. This result can be justified considering the common risk factors of diabetes and metabolic syndrome. Therefore, comparing blood sugar levels in the two groups shows that type 2 diabetes is more likely to occur in the case group.

A study by Ion Shen, *et al*. Showed that women with gestational diabetes are at risk for metabolic syndrome in the future. They also stated that lifestyle interventions prevent type 2 diabetes and metabolic syndrome.[29]

A study by Javid *et al*., was conducted in 2015 entitled "Comparison of lifestyle of healthy and diabetic pregnant women in Shahid Beheshti University." The results showed that the lifestyle of women with gestational diabetes is different from that of healthy pregnant women. Diet and physical activity and self-care during pregnancy were more desirable in healthy pregnant women than in pregnant women with gestational diabetes. These results indicate the need to pay attention to these cases in women with a history of gestational diabetes, and by increasing awareness and education of pregnant women about healthy lifestyles and interventions related to improving lifestyle can prevent the complications of gestational diabetes.[30] In this study, there was no significant difference between the lifestyle of diabetic and non-diabetic pregnant women during pregnancy in terms of demographic variables such as age, number of pregnancies, and economic factors such as education level, spouse education level, occupation and spouse occupation. Carr *et al*. (2006) concluded in their study that women with a history of gestational diabetes had a higher risk of cardiovascular disorders, metabolic syndrome and chronic diabetes than the control group.[31] In this regard, in our study, in the group with a history of gestational diabetes, metabolic assessment was impaired and blood sugar was significantly different in the two groups. It can be concluded that gestational diabetes leads to impaired metabolic evaluation and predicts the risk of type 2 diabetes in the future.

In this regard, Niyafar *et al*., reported that 6 weeks after delivery, the history of gestational diabetes in previous pregnancies is an important risk factor for gestational diabetes as well as the incidence of postpartum diabetes. This rate is reported to be 20%–50% in Asians and 50%–84% in Americans.[32] Vilmi-Kerälä *et al*., reported that the risk of metabolic syndrome after gestational diabetes was 2.4 times higher than normal pregnancy,[33] which is consistent with our study (metabolic assessment disorder in the case group). A regular survey conducted in 2014 by Xu *et al*., found that women with gestational diabetes were almost four times more likely to develop metabolic syndrome in the future than women with normal pregnancies. This meta-analysis also concludes that the diagnosis of gestational diabetes may act as a precursor or signal of various metabolic diseases in the near future.[10] Rautio *et al*., in Finland conducted a study entitled "Lifestyle Intervention in the Prevention of Type 2 Diabetes in Women with a History of Gestational Diabetes" on 115 women with a history of gestational diabetes and 150 women without a history of gestational diabetes. The follow-up period was one year after delivery. The results showed that lifestyle intervention did not make a difference in the risk of metabolic syndrome between women with and without a history of pregnancy.[34] However, it should be noted that women with a history of gestational diabetes may receive lifestyle counseling sooner and be led to a healthier lifestyle due to the diagnosis of gestational diabetes during pregnancy. In Finland, almost all pregnant women go to maternity welfare clinics about 12–15 times for free counseling and health care. Women with gestational diabetes are treated more severely, and most receive dietary and other lifestyle advice.[34-36] But in Iran, the maximum number of referrals during pregnancy is 8 times and there is almost no after delivery follow-up program for women with a history of gestational diabetes. One of the common risk factors between gestational diabetes and metabolic syndrome is a family history of diabetes.[10] Due to the fact that in our case study, the family history of diabetes was more observed in the case group, so as expected, the metabolic assessment of the two groups was different and the case group was worse in terms of metabolic assessments. In this regard, Puhkala *et al*. (2013) in their study in one-year follow-up showed that 10%–25% of women with gestational diabetes show metabolic syndrome up to 12 months immediately after delivery.[15] Also, a regular study conducted in 2014 by Xu *et al*. Found that women with gestational diabetes were almost four times more likely to develop metabolic syndrome in the future than women who had a normal pregnancy.[10] It should be noted that most studies on the development of metabolic syndrome after gestational diabetes are consistent with our study. However, other limited studies have shown conflicting results and found no association between metabolic syndrome and gestational diabetes.[37-39] Puhkala *et al*. Showed that an increased risk of gestational diabetes was not associated with a higher prevalence of metabolic syndrome 7 years after delivery. Also, there are some factors that may change the risk of developing metabolic syndrome after gestational diabetes. For example, in the meta-analysis of Xu *et al*., the variables of study type, maternal age, gestational diabetes criteria, metabolic syndrome criteria, number of random samples and mean year of follow-up failed to indicate the possibility of developing metabolic syndrome in women with a history of gestational diabetes.

However, when ethnicity was used as a subgroup factor, the result was significantly different. After gestational diabetes, Caucasian women were significantly more

likely to develop metabolic syndrome than Asian women.[10] Therefore, the correct time of gestational diabetes diagnosis and follow-up (during pregnancy and childbirth) should be determined for women with gestational diabetes to reduce the risk of metabolic syndrome and thus reduce the risk of type 2 diabetes and cardiovascular disease.[10] Rafii *et al*. Showed that inadequate education is a barrier to screening for postpartum diabetes.[38] This is consistent with other studies that have highlighted the lack of information on postpartum diabetes screening[37-39] and the role of education and necessary interventions in this regard.

This study supports the necessity of postpartum follow-up among women with a history of gestational diabetes. Also in this study, we used a health employee to complete a questionnaire and guide women in the laboratory.

Limitation and suggestion

One of the limitations of this study was that the study population was from women visiting the health centers in Kerman city, and many not be generalizable to women in the province or country. Therefore, it is recommended to conduct similar studies with higher sample size in other parts of Iran.

Conclusions

The results of this study showed that women with a history of gestational diabetes progressed to type 2 diabetes and metabolic syndrome. However, they have not received any training to change their lifestyle during pregnancy and after childbirth. Therefore, by increasing awareness and educating pregnant women during pregnancy and after delivery about a healthy lifestyle, as well as teaching them how to follow up after delivery gestational diabetes, it is possible to prevent progression to type 2 diabetes and metabolic syndrome in the future. Also, among women who experience gestational diabetes during pregnancy, after delivery screening offers a good opportunity to detect diabetes early and predict it in the coming years.

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Conflicts of interest

There are no conflicts of interest.

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