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Physical activity in type II diabetes

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ABSTRACT

INTRODUCTION AND AIM OF WORK

A factor significantly influencing the risk of lifestyle diseases, including diabetes, is physical activity. The last decades have been characterized by reduced physical activity in developed countries. This is associated with deteriorating population health and the risk of developing type 2 diabetes. Appropriately tailored physical effort is essential for the proper functioning of the body.

MATERIALS AND METHODS

The aim of the study is to compare the physical activity levels among individuals with diabetes. To achieve this goal, a survey was created and subsequently distributed via social media (Telegram platform) in August 2023.

RESULTS

A total of 101 surveys were collected, with the average age of respondents being 34 years old. Among the respondents, 25 individuals (24.75%) had diabetes, while the rest did not have the condition. Out of the participants, 46 respondents indicated a family history of diabetes. Diabetes was statistically significantly associated with a family history of diabetes ($p=0.037$). Furthermore, the diabetes group exhibited a higher frequency of overweight and obesity ($p=0.027$). The respondents' body weight was positively correlated with both the frequency of food intake ($r=0.31$, $p=0.011$) and negatively correlated with the frequency of exercise ($r=-0.22$, $p=0.046$).

CONCLUSIONS

The gathered results confirm the familial nature of diabetes occurrence. They also highlight the significant role of exercise in maintaining body weight, as well as the importance of diet.

KEY WORDS: diabetes, physical activity, physical effort, cardiovascular system, obesity, malnutrition

Introduction

Physical activity significantly influences the occurrence of diabetes. In recent decades, there has been a downward trend in physical activity in developed countries (1). This unfavorable trend is directly related to the deteriorating health status of the population and, consequently, an increased risk of developing type 2 diabetes. In recent years, there has also been an increased susceptibility to type 2 diabetes in children (2). Appropriately adjusted physical activity becomes an essential element ensuring the proper functioning of the human body.

Physical effort, tailored to individual capabilities and the body's needs, plays a crucial role in preventing many diseases, including diabetes. Regular physical activity helps maintain a healthy body weight by regulating the metabolism of fats (3) and carbohydrates (4). Moreover, regular exercise increases tissue sensitivity to insulin, helping to maintain a stable blood glucose level. This is particularly important in the context of type 2 diabetes, where one of the problems is the disturbed regulation of glucose levels.

The Effect of Physical Activity on Diabetes Control

During physical activity, skeletal muscles increase glucose uptake independently of insulin. Under the influence of hormones regulating glucose levels, as well as the release and mobilization of free fatty acids, blood glucose concentration is controlled (5,6). In the case of diabetes or insulin resistance, this balance may be disrupted. After each bout of physical activity, there is an increase in insulin sensitivity, which can last for a period ranging from 2 to 72 hours. However, the decrease in blood glucose levels is associated with the duration and intensity of physical activity (7, 8, 9). Regular exercise strengthens the function of beta cells, making the body more sensitive to insulin (10,11). Better control of blood sugar levels is a key goal in diabetes management. Thanks to regular exercise and increased insulin sensitivity, the body can better maintain an appropriate glucose level, which is crucial for individuals with diabetes. Additionally, exercise can have a positive impact on the cardiovascular system, reducing the risk of heart disease and strokes. Engaging in regular exercise or physical activities has multiple

benefits. It helps better control diabetes, improves overall health, and reduces the risk of many diseases, contributing to a better quality of life and increased longevity.

Effects of Exercise in the Context of Diabetes Management

Short-term aerobic exercise improves insulin sensitivity in adults with type 2 diabetes, simultaneously providing benefits in mitochondrial function (12). In individuals with obesity and type 2 diabetes, short-term aerobic exercise contributes to the overall improvement of insulin sensitivity by increasing peripheral insulin sensitivity more than hepatic insulin sensitivity (13). Regular exercise also leads to increased insulin sensitivity, improvement in lipid profile, blood pressure reduction, favorable changes in other metabolic indicators, and enhanced physical fitness, even without the necessity of weight loss (14).

Typically, in adults with type 2 diabetes, resistance training often results in improved endurance, bone mineral density, blood pressure, lipid profile, skeletal muscle mass, and insulin sensitivity (15). The latest meta-analysis of studies on resistance training indicates that high-intensity exercise is more beneficial than low or moderate-intensity training in terms of overall glucose control and insulin regulation in adults with type 2 diabetes (16).

The combination of aerobic and resistance training as an intervention may yield greater benefits than each type of training alone. Combined training showed a significant improvement in glycated hemoglobin levels compared to the control group that did not exercise, while neither resistance nor aerobic training alone induced significant changes (17).

Higher-intensity aerobic exercise is generally considered more beneficial than lower-intensity exercise (18). High-intensity interval training results in a significant improvement in physical fitness, reduction in glycated hemoglobin levels, and body mass index (BMI) in adults with type 2 diabetes. Additionally, an increase in insulin sensitivity and improvement in beta cell function are observed in adults with type 2 diabetes engaging in high-intensity interval training (19). Individuals with type 2

diabetes who want to control glucose levels through high-intensity interval training should carefully observe how their bodies respond to the training, as prolonged and intense exertion may lead to adverse effects such as transient hyperglycemia post-exercise, making monitoring essential.

Other types of physical activity bring different benefits, and their impact on blood sugar levels is less straightforward. For example, yoga may lead to improvements in glycosylated hemoglobin levels, lipid profile, and body composition in adults with type 2 diabetes (20). On the other hand, Tai Chi may contribute to improvements in glucose management, balance, neuropathic symptoms, and certain aspects of quality of life (21). Further research is necessary to fully understand the potential benefits of yoga and Tai Chi for individuals with type 2 diabetes.

Materials and Methods:

To assess the issue, we created a survey evaluating age, dietary habits, and the frequency of infections. The survey consisted of 10 questions in total. The questionnaire was created using Microsoft Forms and shared through Telegram groups between August 15 and 23, 2023. We collected a total of 101 responses. Each participant was informed about the study, provided with participation rules, and informed about the option to withdraw at any time.

The questionnaire included the following questions: age, current body weight, self-assessment of physical activity, frequency of food intake, whether the participant has type 2 diabetes, whether diabetes is present in the family, whether the participant's occupation involves physical activity, how much time is spent on exercise, and how often unhealthy food is consumed. All questions except for age were single-choice questions.

Statistical Analysis:

The data were analyzed using Excel, and statistical formulas were calculated using the Statistica program. The normality of the distribution of continuous variables

was assessed using the Shapiro-Wilk test. Ordinal variables are presented using absolute numbers and corresponding percentage values. Spearman's rho non-parametric correlation test was used to determine the relationships between factors. The U-Mann-Whitney test was used to compare two groups, and the Kruskal-Wallis test was used for comparisons involving more than two groups. The Chi² test without continuity correction was used to compare binary data (presence/absence of diabetes vs. presence/absence of diabetes in the family). The same test was applied to compare whether diabetes is more common in individuals with excess body weight. A p-value below 0.05 was considered statistically significant.

Results:

A total of 101 surveys were collected. The average age of the respondents was 34 years. All collected responses were from male participants. The youngest participant in the study was 21 years old, while the oldest was 59 years old. Details of responses regarding questions about body weight, current physical activity, and the frequency of diagnosed diabetes are presented in Graph 1, Graph 2, and Graph 3.

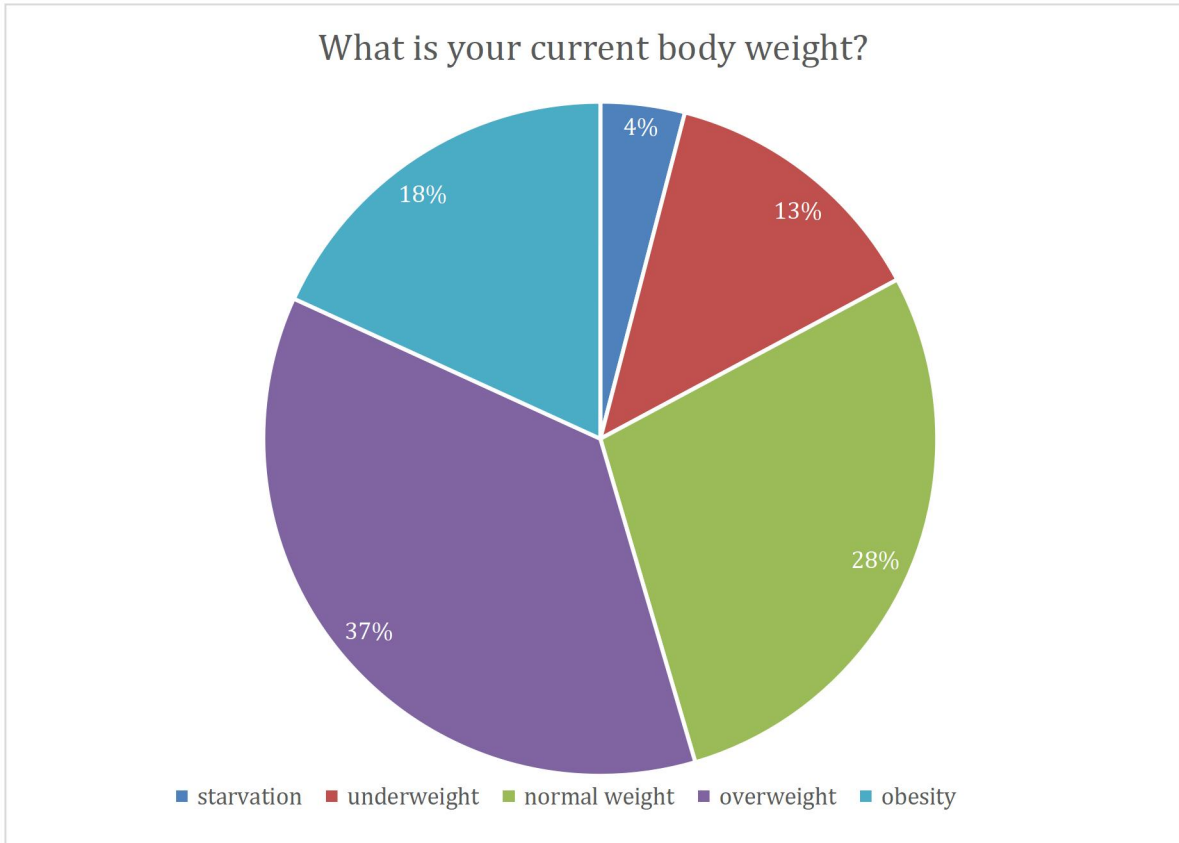


Figure 1.

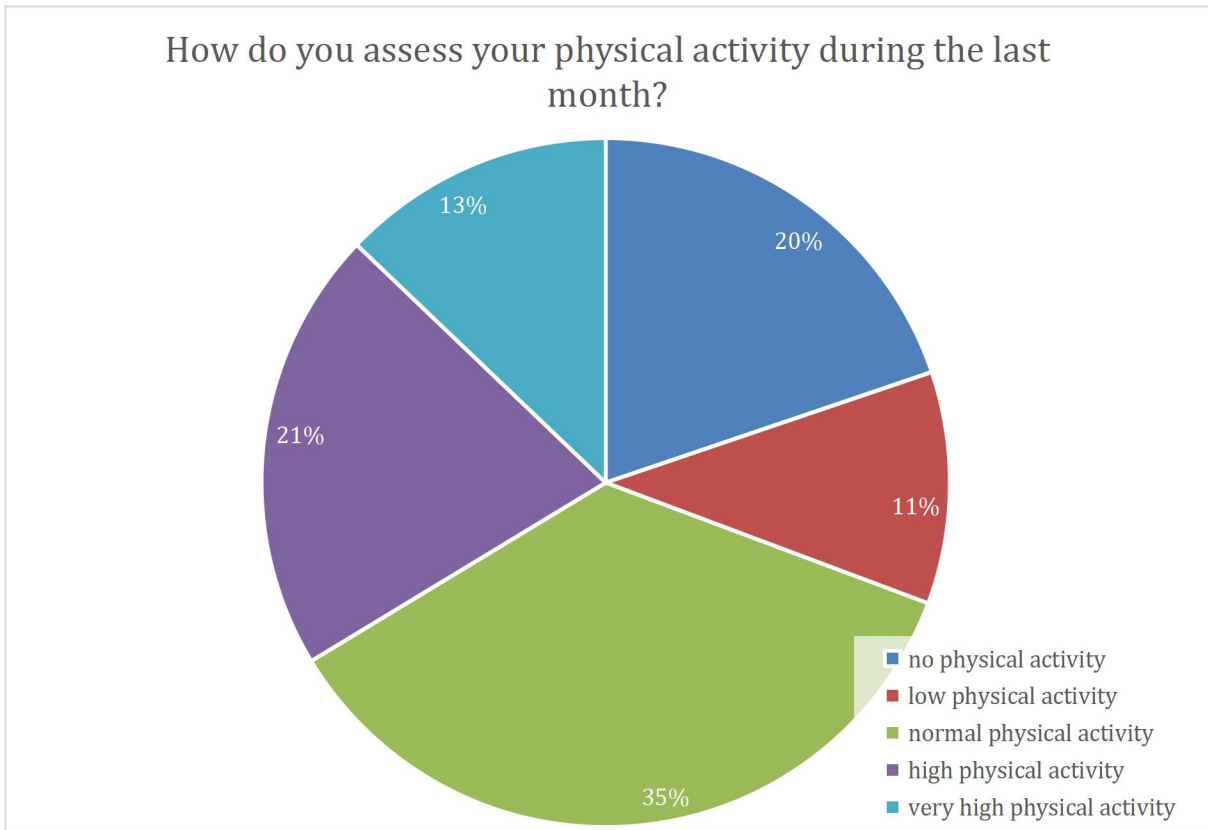


Figure 2.

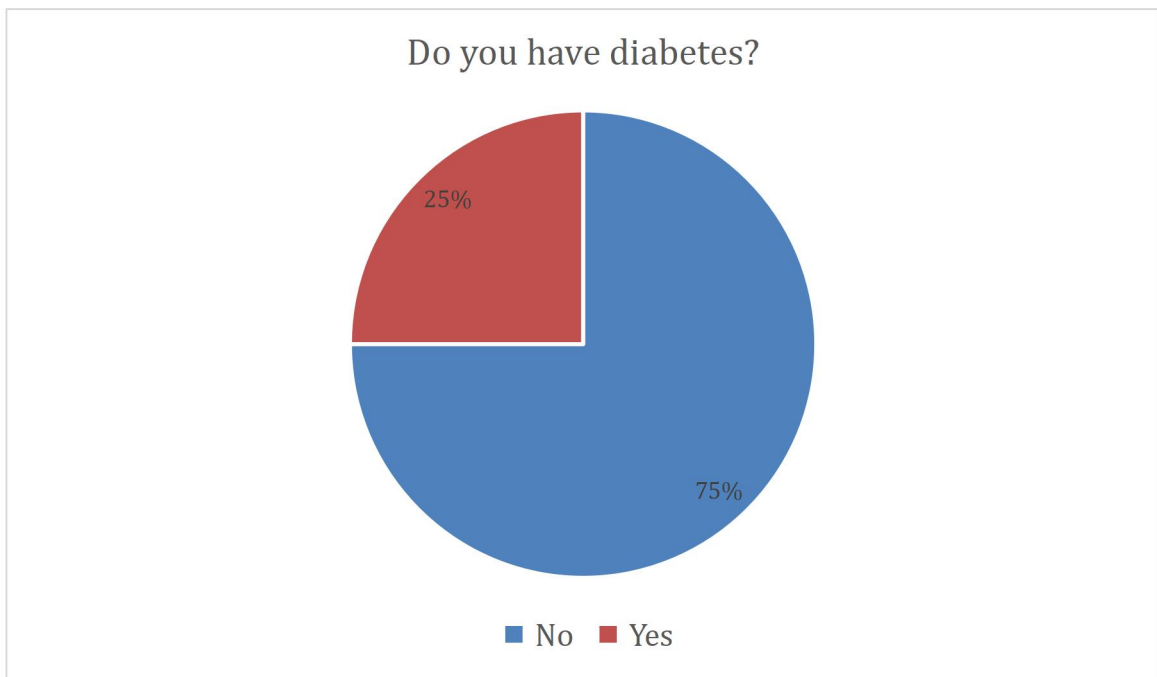


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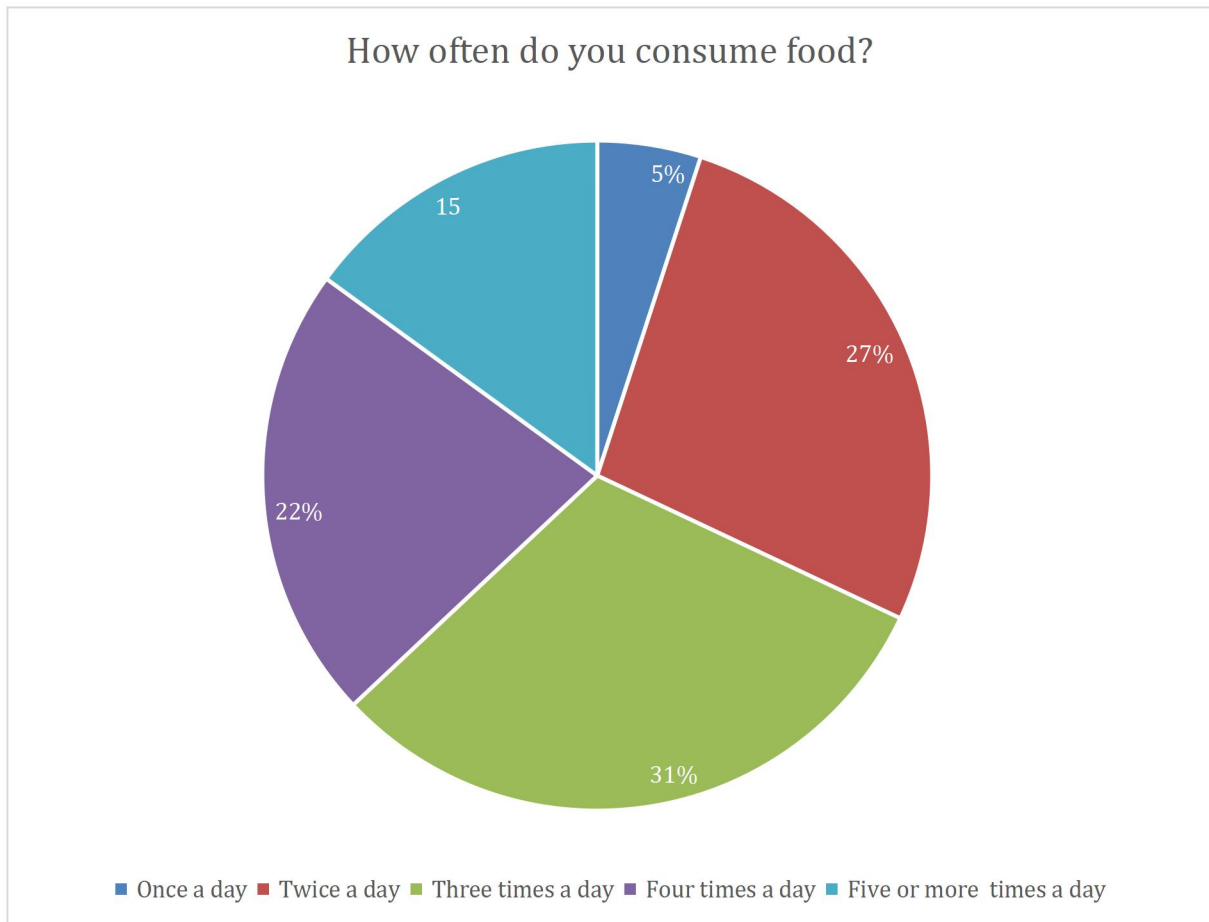


Figure 4.

Furthermore, in the question regarding whether diabetes is present in the family, 46 respondents (45.54%) provided a positive response, while 55 individuals (54.46%) denied the presence of diabetes in their family.

Regarding the adoption of a vegetarian diet, 9 participants (9.58%) indicated adherence to a vegetarian diet, while 85 individuals (90.42%) did not follow a vegetarian diet.

As for occupational physical activity, responses were closely distributed. The highest number of respondents, 25 individuals (24.75%), reported no physical activity at work. Low and moderate levels of physical activity at work were reported by 18 and 19 individuals, respectively (17.82% and 18.81%). High

occupational physical activity was rated by 27 respondents (26.73%). Very high occupational physical activity was reported by the fewest, only 12 individuals (11.88%).

In the question about unhealthy eating, only 1 person indicated consuming it once a month (0.99%), 8 several times a month (7.92%), 16 once a week (15.84%). 34 respondents marked the option several times a week (33.66%), 45 every day (45.55%).

The last question concerned the subjective opinion about how much time one dedicates to physical exercise. 16 individuals (15.84%) do not exercise at all, 18 individuals (17.82%) exercise once a week, 26 individuals (25.74%) exercise twice a week, 30 individuals (29.70%) exercise three times a week, and 10 individuals (9.90%) more than three times a week.

In our study group, body weight was significantly correlated with the frequency of exercise ($r = -0.22$, $p = 0.046$), and we also observed a correlation for the frequency of food intake ($r = 0.31$, $p = 0.11$). Interestingly, body weight was not correlated with the intensity of physical activity at work ($p > 0.05$). Additionally, there was no association between body weight and the frequency of consuming unhealthy foods.

Out of 101 participants in the study, 25 individuals were being treated for diabetes. This allowed for the creation of two separate groups, comparing whether diabetes occurs more frequently in the families of those with diabetes compared to those without. Significantly, the frequency was increased in individuals with diabetes ($p = 0.03$).

Similar grouping was done based on the weight of the participants. Among the 101 individuals in the study, a total of 54 individuals (53.47%) had overweight or obesity. The remaining were classified into the group with normal or low body weight. Subsequently, a 2x2 table was created again to examine whether the percentage of individuals with diabetes and overweight is higher than individuals with overweight but without diabetes. Once again, the result obtained was statistically significant ($p = 0.002$).

Discussion

In current literature, the role of diabetes in maintaining a healthy body weight is undisputed (22). Weight reduction in obese patients brings comparable benefits to those resulting from pharmacotherapy (23-24). In our study, the percentage of individuals with diabetes who were overweight was statistically significantly higher than in individuals who were overweight but did not have diabetes. However, the obtained statistical result does not indicate the underlying mechanism, i.e., whether obesity induces diabetes or vice versa, or if it is a bidirectional relationship (25). Current research suggests that this mechanism is bidirectional (26). At the current level of knowledge, attention is drawn not only to the use of appropriate pharmacological treatment such as insulin or metformin but also to appropriately tailored physical activity and diet (27).

It is worth noting that despite a proper diet and a healthy lifestyle, in some cases, diabetes cannot be prevented. This applies to types of the disease associated with a strictly genetic pathomechanism, such as MODY diabetes. The familial occurrence of diabetes and its increased frequency among certain families are particularly significant (28). In our study, diabetes occurred significantly more often in individuals who had a family member with the disease. This emphasizes the significant role of this mechanism, which should not be neglected.

Obesity as a significant factor in the development of diabetes can be mitigated through appropriately tailored physical exercise. For our entire group (including individuals without diabetes), those who exercised more frequently had a significantly lower weight than those who did not exercise or exercised less frequently. This finding is supported by the literature (29, 30). Additionally, a well-chosen diet positively influences body weight.

Conclusions

The obtained results confirm the familial nature of diabetes occurrence. It is also important to highlight the significant role of exercise in maintaining body weight

and the importance of diet in the pathogenesis, development, and treatment of diabetes. The familial occurrence of diabetes is also significant. However, further research is required to confirm this relationship.

Disclosure

Author's contribution

Conceptualization, Martyna Kępczyk, methodology, Aleksandra Kościotek software, Igor Kłak check, Miłosz Ojdana, Kaja Surowiecka; formal analysis, Oliwia Kwasniewska.; investigation, Dawid Kosciotek; resources, Aleksandra Kościotek; data curation, Oliwia Czekaj, writing - rough preparation, Igor Kłak and Dawid Kościotek; writing - review and editing, Miłosz Ojdana and Jakub Misiak; visualization, Jakub Misiak; supervision, Oliwia Czekaj; project administration, Martyna Kępczyk; receiving funding - no specific funding.

All authors have read and agreed with the published version of the manuscript.

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Institutional Review Board Statement

Not applicable – Not required

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

Not applicable

Conflict of interest

The authors deny any conflict of interest

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