COMMENTARY

Personalizing Physical Activity for Glucose Control Among Individuals With Type 2 Diabetes: Are We There Yet?

Cuilin Zhang[1,2,3,4] *and Jiaxi Yang*[1,2,3]

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Type 2 diabetes continues to be a major global pandemic. Despite tremendous efforts in prevention and treatment, it is projected that by 2050, type 2 diabetes will affect 1.3 billion people worldwide (1). Alarmingly, at the time of diagnosis, most affected individuals may have already developed complications such as cardiovascular disease, nerve damage, and kidney and eye diseases (2). Glycemic control is crucial for lowering the risks of these complications and of mortality and for improving general well-being for individuals living with type 2 diabetes (3–6). HbA_{1c} is a key parameter for assessing glycemic control (7). A 1% absolute decrease in HbA_{1c} is associated with a 15–20% reduction in cardiovascular complications (8), a 37% reduction in microvascular complications, and a 21% reduction in diabetes-related death (9). Engaging in a healthy lifestyle, including physical activity, is recommended as a strategy for glycemic management in affected individuals. The American Diabetes Association (ADA) and the World Health Organization recommend 150–300 min of moderate-intensity aerobic physical activity or 75–150 min of vigorous-intensity aerobic physical activity per week plus strength/resistance training two or more times a week for adults living with diabetes (10).

Accumulating evidence from randomized controlled trials (RCTs) of individuals with type 2 diabetes supports the claim that physical activity can lower HbA_{1c} values and improve other glycemic parameters (e.g., fasting blood glucose, insulin, and HOMA of insulin resistance) (11). Different types of physical activities (aerobic exercise and strength) with varying intensities appear to be effective in reducing HbA_{1c} (12–14) in these individuals. However, the dose-response relationship of physical activity on HbA_{1c} among individuals with type 2 diabetes remains unclear, and the recommended dose and types of physical activity outlined in the guidelines need to be verified.

Treating individuals with type 2 diabetes as one homogenous group can be problematic. Glycemic control status, for example, may vary among individuals. As shown in previous studies, individuals with different baseline HbA_{1c} values presented varying HbA_{1c} responses despite receiving the same physical activity intervention (15). Furthermore, offering a range of physical activity types accommodates individuals with various personal preferences, physical fitness levels, and access to health facilities. Accounting for baseline glycemic status and how different types of physical activities may affect glycemic control can help to improve personalized physical activity recommendations and the level of detail in the guidelines for individuals with type 2 diabetes.

In this issue of *Diabetes Care*, Gallardo-Gómez et al. (16) conducted a systematic review and meta-analysis of RCTs to examine the dose-response relationship between physical activity, measured in metabolic equivalents of task per week (METs-min/week), and HbA_{1c} in individuals with type 2 diabetes and to identify the optimal dose of physical activity according to baseline glycemic control. In addition, they examined different types of physical activity (i.e., cycling, high-intensity interval training, mind-body activities, mixed aerobic exercises, and multicomponent exercise based on a combination of strength and aerobic activities). Baseline glycemic control was defined by baseline HbA_{1c} according to the following ADA guidelines (17): prediabetes (less than 6.5%; 48 mmol/mol), controlled type 2 diabetes (between 6.5% and 7.0%; between 48 mmol/mol and 53 mmol/mol), uncontrolled type 2 diabetes (between 7.0 and 8.0%; between 53 mmol/mol and 64 mmol/mol), and severe uncontrolled type 2 diabetes (more than 8.0%; 64 mmol/mol). Change in HbA_{1c} before and after intervention was evaluated as the primary outcome.

After applying inclusion criteria (RCTs involving participants with type 2 diabetes

[1]*Global Centre for Asian Women's Health, Yong Loo Lin School of Medicine, National University of Singapore, Singapore*
[2]*Department of Obstetrics and Gynaecology, Yong Loo Lin School of Medicine, National University of Singapore, Singapore*
[3]*Bia-Echo Asia Centre for Reproductive Longevity & Equality (ACRLE), Yong Loo Lin School of Medicine, National University of Singapore, Singapore*
[4]*Department of Nutrition, Harvard T.H. Chan School of Public Health, Boston, MA*

Corresponding author: Cuilin Zhang, obgzc@nus.edu.sg

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who used any type of physical activity as an intervention), this systematic review included 126 RCTs with a total of 6,718 participants. The mean age was 58 years, and the intervention duration ranged between 4 and 96 weeks (16). This review reported a nonlinear relationship between the dose of physical activity and the change in HbA_{1c}, with the optimal dose identified as 1,100 METs-min/week across all the ADA glycemic categories: at 1,100 METs-min/week versus usual care, the change in HbA_{1c} was −0.38% to −0.24% in prediabetes, −0.47% to −0.40% in controlled diabetes, −0.64% to −0.49% in uncontrolled diabetes, and −1.02% to −0.66% in severe uncontrolled diabetes. The minimal doses of physical activity needed to move across two adjacent ADA categories were estimated (Table 1). The optimal dose was found to be 1,100 METs-min/week for all types of physical activities. Importantly, the authors noted how 1,100 METs-min/week can be translated into various durations of different physical activity types (Table 1) (16).

This meta-analysis offers several major strengths. It has a large sample size with good statistical power. It accounted for two important factors, baseline glycemic status and different types of physical activities, when examining the relationship between physical activity and glycemic control. The study provided interpretable results on the optimal doses of physical activity and the minimal doses required to improve glycemic status. The types of physical activities examined in this study (e.g., high-intensity interval training, running, and multicomponent) are more specific and user-friendly than those examined in earlier reviews, making real-world implementation more feasible and allowing individuals to select the one(s) that best matches their preferences and circumstances. However, there are some limitations. As the authors noted, while the optimal dose of physical activity was determined, the duration corresponding to the optimal dose required to achieve those HbA_{1c} reductions cannot be estimated due to heterogeneity between intervention durations and study protocols (16). Further, the reported nonlinear relationship warrants caution in interpretation. Even though the authors described the relationship as J-shaped, it is not a typical J-shaped curve, as the right arm was shorter than the left arm. The shape of the right upper arm (i.e., very high doses of physical activity) may have been determined largely by the limited data points in that region. More RCTs involving physical activity with varying intervention intensities and durations are warranted to better characterize the dose-response relationship and the long-term health effects of physical activity. By excluding RCTs in which participants had an associated severe condition(s), the conclusions of this study cannot be generalized to the broader population of individuals with type 2 diabetes. The dose-response relationship and the feasibility of different physical activities with varying intensity in subgroups of affected individuals with certain medical conditions should be examined in future RCTs.

The optimal dose of physical activity suggested in this review is 1,100 METs-min/week, equivalent to 244 min/week of moderate-intensity aerobic physical activity or 157 min/week of vigorous-intensity aerobic physical activity. This exceeds the current general recommendations of physical activity (16). It also challenges the current recommendations, which may not be sufficient for optimizing glycemic control in individuals with type 2 diabetes. These findings underscore the importance of personalized physical activity for glycemic control among individuals with type 2 diabetes.

Table 1—Study summary

Question or parameter	Finding
What are the current guidelines on recommended physical activity among individuals with type 2 diabetes?	150–300 min/week of moderate-intensity training or 75–150 min/week of vigorous-intensity training plus two or more strength training sessions per week
What is the optimal dose of physical activity for HbA_{1c} reduction in individuals with type 2 diabetes?	1,100 METs-min/week for all baseline glycemic categories[a]
The optimal dose of physical activity (i.e., 1,100 METs-min/week) can be translated into	
Moderate-intensity aerobic physical activity	244 min/week
Vigorous-intensity aerobic physical activity	157 min/week
Moderate-intensity multicomponent activity (aerobic and strength combined)	314 min/week
Vigorous-intensity multicomponent activity	138 min/week
Moderate-intensity strength training	314 min/week
Vigorous-intensity strength training	183 min/week
Moderate-paced brisk walking	256 min/week
Vigorous-paced brisk walking	157 min/week
Minimal dose range required to move across glycemic categories	
Severe uncontrolled diabetes to uncontrolled diabetes	150–810 METs-min/week
Uncontrolled diabetes to controlled diabetes	330–990 METs-min/week
Controlled diabetes to prediabetes	570–900 METs-min/week

[a]The baseline glycemic categories were defined by baseline HbA_{1c} according to ADA guidelines: prediabetes (less than 6.5%; 48 mmol/mol), controlled type 2 diabetes (between 6.5% and 7.0%; between 48 mmol/mol and 53 mmol/mol), uncontrolled type 2 diabetes (between 7.0% and 8.0%; between 53 mmol/mol and 64 mmol/mol), and severe uncontrolled type 2 diabetes (more than 8.0%; more than 64 mmol/mol).

Further, the majority of the RCTs on this topic were conducted in North America or Europe. Countries in North Africa, the Middle East, and Asia are experiencing increasing burdens of diabetes (1) and diabetes-related complications (18,19) due to a shift to Western diets and lifestyle and an increase in obesity. Future studies in populations from these regions are urgently needed to enhance the quality of evidence for improving diabetes care worldwide. In addition, while physical activity promotes health, various types of physical activity have different environmental impacts in terms of their expenditure of energy for food, training facilities, equipment, and transportation (20). More research and efforts to promote sustainable physical activities that are eco-friendly, economically feasible, and acceptable are warranted for building a more sustainable environment and a healthier future. Lastly, it should be noted that certain types of physical activities require professional trainers as well as specific equipment and facilities, where affordability, accessibility, and equity may influence real-world implementation (14). Developing and promoting personalized physical activity for optimal glycemic control and overall health among individuals with diabetes requires multidisciplinary joint efforts from researchers, clinicians, fitness experts, behavioral scientists, and policymakers.

Duality of Interest. No potential conflicts of interest relevant to this article were reported.

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