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Original article

Hypoglycemia avoidance behaviour in active Qatari adults with type 1 diabetes under blood glucose monitoring device

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ABSTRACT

Aims: The present study aimed to explore the relationship between fear of hypoglycemia and exercise management strategies in active Qatari adults with T1D during the COVID-19 pandemic, and to explore the potential role of continuous glucose monitoring (CGM) devices in promoting safe physical activity practices.
Methods: Participants completed the Hypoglycemia Fear Survey (HFS) questionnaire and the International Physical Activity Questionnaire (IPAQ). Out of the 102 participants, 41 were considered "active" and under CGM and were included in the analysis.
Results: Multiple linear regression analysis revealed a significant positive correlation between the behavior dimension of the HFS scores and both vigorous physical activity and MET-minutes per week (R^2 adj. = 0.055; $\beta = 0.56$; $p = 0.05$ and R^2 adj. = 0.039; $\beta = 0.38$; $p = 0.04$). The results showed a significant positive association between HbA1c levels and the behavior dimension of the HFS ($R = 0.39$, $p = 0.005$), as well as between the number of episodes of severe hypoglycemia and the behavior dimension ($R = 0.46$, $p = 0.042$).
Conclusion: These findings highlight the need for effective strategies to manage fear of hypoglycemia and promote physical activity in individuals with T1D. The use of CGM devices may provide added safety to physical activity practices by reducing the risk of hypoglycemia.

1. Introduction

Type 1 diabetes (T1D) individuals face multiple challenges, one of which is the fear of hypoglycemia, which can impact their physical activity adherence and reduce exercise patterns. Fear of hypoglycemia is known to be a prominent barrier to physical activity in adults and youth of both genders with T1D [1–3]. Moreover, regular exercise is considered a potential factor that can improve the overall health status of T1D individuals; however, those who exercise often face difficulties in managing their glycemic levels, primarily manifested by numerous hypoglycemia episodes [1,2,4]. Hypoglycemia episodes have been found to be significantly associated with physical activity participation [5].

Managing hypoglycemia episodes is crucial for T1D individuals to engage in regular physical activity, and appropriate behavioral management is required to overcome this challenge [5]. Roberts et al. [3] reported that a higher physical activity level was associated with increased reported exercise-specific hypoglycemia avoidance behavior, and low levels of knowledge and lack of confidence around managing diabetes around exercise were the most notable diabetes-specific barriers to exercise [1,2]. To address these challenges, it is important to focus on improving behavioral management and controlling glycemic levels in T1D individuals engaging in physical activity [4]. Exercise management for young people with T1D is complex and one approach does not fit all. Many factors influence an individual's glycemic response to exercise including the type, intensity, and duration of the activity, the amount of insulin on board, and the person's stress/anxiety levels [2].

Active youth report employing strategies to reduce hypoglycemia risk with exercise, and whether fear of hypoglycemia impacts exercise management behaviors in an adaptive or maladaptive manner is still an exploratory area of study [6]. One explanation for the association between higher physical activity levels and increased hypoglycemia avoidance behavior could be that those who are most physically active are more aware of the risks of hypoglycemia and have more experience in avoiding it [3]. In addition, glucose blood monitoring may also be a benefit to help individuals with type 1 diabetes manage their blood sugar levels during physical activity [7].

However, in the context of the recent COVID-19 pandemic, daily routines underwent drastic changes. The heightened stress and fears associated with the virus not only disrupted blood sugar management for these individuals but also influenced their decisions related to exercise and medical care [8–11]. Encouragingly, research indicates that those utilizing continuous glucose monitoring (CGM) during these challenging times exhibited better blood glucose management and experienced fewer hypoglycemic incidents [12,13].

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In conclusion, fear of hypoglycemia and its avoidance behavior can significantly influence physical activity adherence in individuals with type 1 diabetes, and the COVID-19 pandemic may have exacerbated these concerns. However, the use of CGM devices may provide added safety to physical activity practices by reducing the risk of hypoglycemia. Further research is needed to identify effective strategies for behavioral management and glycemic control to prevent hypoglycemia and promote physical activity in Qatari adults with type 1 diabetes during the pandemic. The aim of the present work is to explore the relationship between fear of hypoglycemia and exercise management strategies in active Qatari adults with type 1 diabetes during the COVID-19 pandemic, and to explore the potential role of CGM devices in promoting safe physical activity practices.

2. Methods

2.1. Participants and study design

The study recruited participants with type 1 diabetes who were at least 18 years old and Qatari citizens, and who could understand either English or Arabic language. Exclusion criteria included uncontrolled diabetes, comorbidities that prevented exercise, ongoing COVID-19 infection, and cognitive impairments. The study was approved by the Qatar University Institutional Review Board *(QU-IRB) (QU-IRB 1559-E/21)*, and participants were invited to participate in the study through an electronic survey that was distributed via various platforms, including email announcements to the Qatar University community (students, faculty members, and administrators). Out of the 112 individuals who responded to the survey, 102 met the inclusion criteria and agreed to participate in the study by signing an informed consent form [14].

Participants completed two questionnaires: the International Physical Activity Questionnaire (IPAQ) and the Hypoglycemia Fear Survey (HFS) questionnaire. The study also collected anthropometric data such as body weight and height, insulin administration method, and the most recent glycated hemoglobin level. For the purpose of the present work we have selected only active participants under continuous glucose monitoring (CGM) (n = 41, see Fig. 1).

2.2. Measures

In this study, we have employed two validated survey tools to assess fear of hypoglycemia and physical activity levels in Qatari adults with type 1 diabetes. The Hypoglycemia Fear Survey (HFS) was used to measure fear of hypoglycemia, with both worry and behavior subscales. Participants rated each item on a scale of 0 to 4, with higher scores indicating greater fear. The HFS is a well-established tool for assessing hypoglycemia fear and has been used in previous research [15,16].

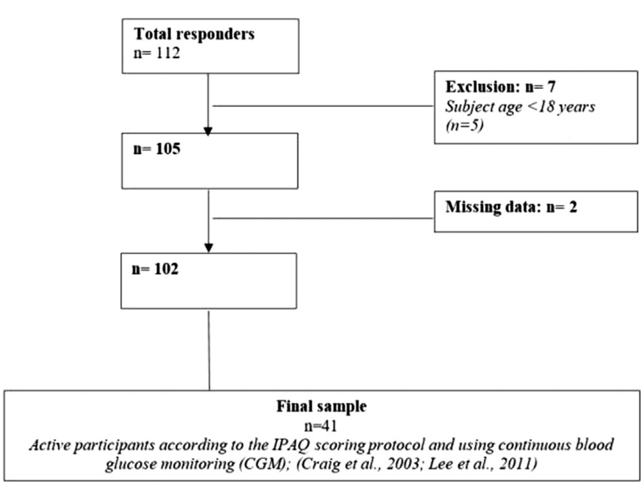

Fig. 1. Study design flowchart.

In addition to the HFS, the International Physical Activity Questionnaire (IPAQ) has been used to assess physical activity levels. The IPAQ is a widely used tool for assessing physical activity and sitting time in daily life. It estimates the total physical activity in minutes per week and the time spent sitting by asking questions about the type and intensity of physical activity people engage in. The data from each item are summed to estimate the total amount of time engaged in physical activity per week [17,18]. The IPAQ has been validated in various populations and is considered a reliable and valid tool for assessing physical activity levels [17,18]. For the purpose of the present work, we have selected only "active" participants. In fact, according to the IPAQ scoring protocol, individuals who engaged in at least 600 metabolic equivalent (MET) minutes per week of physical activity were considered "active". MET is a unit of measurement for physical activity, and 1 MET is equivalent to the energy expenditure of sitting quietly. Thus, 600 MET minutes per week is equivalent to 150 min per week of moderate-intensity activity (e.g., brisk walking) or 75 min per week of vigorous-intensity activity (e.g., running). Therefore, participants who reported engaging in at least 600 MET minutes per week of physical activity were included in the analysis.

2.3. Statistical analysis

The analyses were performed using SPSS v. 21 software. Descriptive statistics were calculated for participant characteristics, including mean, standard deviation, and median. Normality was tested using the Kolmogorov−Smirnov test. Pearson correlations were used to assess the association between physical activity level and hypoglycemia avoidance score, HbA1c, and rate of hypoglycemia. Multiple linear regression was used to model the mean outcomes for each exposure of interest. A value of $p < 0.05$ was set as the level of statistical significance. The results were presented as beta coefficients (β), adjusted R-squared values, and p-values.

3. Results

Our participants' characteristics are presented in Table 1. Forty-one were s enrolled and completed the required questionnaires and were included in the analysis (Fig. 1). The participants had a mean BMI of 24.7 kg/m2, which is within the healthy weight range. HbA1c level was 6.8%, indicating good glycemic control. Additionally, 61% of the participants had experienced severe hypoglycemia in the past 12 months, and 36% reported being infected by COVID-19. The self-reported physical activity information showed that the participants engaged in a mean of 260 min per week of moderate physical activity and 91 min per week of vigorous physical activity, resulting in a mean of 2014 MET-minutes per week. The participants reported a mean total screen time of 4.6 hours per day, with a mean of 4.11 days per week (Table 1). The hypoglycemia fear survey scores showed a mean of 2.08 for the behavior subscale (HFS-B) and a mean of 3.09 for the worry subscale (HFS-W).

The Table 2 reported a significant association between VPA and HFS scores (β = 0.56, p = 0.05), indicating that individuals who engaged in more VPA tended to have higher scores on the behaviour dimension of the HFS. A similar pattern was observed for MET-minutes per week, with a significant relationship between this type of exercise and HFS scores (β = 0.38, p = 0.04). For the worry dimension of the HFS, the analysis revealed no significant relationship between MPA and HFS scores (β = 0.06, p = 0.55), nor between VPA and HFS scores (β = 0.07, p = 0.57). Similarly, there was no significant relationship between MET-minutes per week and HFS scores (β = 0.07, p = 0.66).

Table 1
Participant characteristics.

	Mean
Age *(years)* Median (Q1-Q3)	21 (18–26)
Duration of diabetes in years Median (Q1-Q3)	15(10–18)
Weight (kg)	71.2 ± 3.7
Height (cm)	171 ± 4.8
BMI (kg.m^{-2})	24.7 ± 3.3
HbA1c (%)	6.8 ± 2.1
Number of episodes of severe hypoglycemia in past 12 months	61%
Infected by COVID-19 (%)	36%
Self-reported PA and screen time information	
Total screen time·day^{-1} *(h)* (TV, video games, computer)	4.6 ± 2.11
Days/week of PA (d)	4.11 ± 2.24
Minutes/week of MPA (min)	260 ± 99
Minutes/week of VPA (min)	91 ± 18
MET-minutes/week	2014 ± 355
Hypoglycemia fear survey scores	
HFS-B	2.08 (0.33)
HFS-W	3.09 (1.019)

Values are mean (standard deviation). Q1: First quartile; Q3: Third quartile; BMI: body mass index; HbA1c: glycated haemoglobin; PA: physical activity; MPA: moderate physical activity; VPA: vigorous physical activity; MET: metabolic equivalent; h: hour; min: minute; HFS-B: hypoglycemia fear survey-behaviour; HFS-W: hypoglycemia fear survey-worry.

Table 2
Linear regression results showing the association of HFS scores with amount of exercise.

Type of scale	Minutes/week of MPA (min)	Minutes/week of VPA (min)	MET-minutes/week
Behaviour	R^2 adj. = 0.53; β = 0.03; p = 0.44	R^2 adj. = 0.055; β = 0.56; p = 0.05*	R^2 adj. = 0.039; β = 0.38; p = 0.04*
Worry	R^2 adj. = 0.48; β = 0.06; p = 0.55	R^2 adj. = 0.88; β = 0.07; p = 0.57	R^2 adj. = 0.81; β = 0.07; p = 0.66

* denotes significant relationship

Table 3
Correlation between behaviour and worry scores and clinical variables.

Type of scale	*Behaviour scales*	*Worry scale*
BMI (kg.m^{-2})	R = 0.24, P = 0.61	R = 0.52, P = 0.63
HbA1c (%)	R = 0.39, P = 0.005*	R = 0.38, P = 0.41
Number of episodes of severe hypoglycemia in past 12 months	R = 0.46, P = 0.042*	R = 0.33, P = 0.72
BMI (kg.m^{-2})	R = 0.18, P = 0.52	R = 0.29 P = 0.22

* denotes significant relationship

Table 3 presents the correlation coefficients between the behaviour and worry dimensions of the HFS and several clinical variables. For the behaviour dimension, there was a significant positive correlation with HbA1c (R = 0.39, P = 0.005), indicating that individuals who had higher levels of HbA1c tended to score higher on the behaviour dimension of the HFS. There was also a significant positive correlation between the number of episodes of severe hypoglycemia in the past 12 months and the behaviour dimension of the HFS (R = 0.46, P = 0.042), suggesting that individuals who had experienced more severe hypoglycemia tended to score higher on the behaviour dimension.

4. Discussion

The present study aimed to investigate the relationship between fear of hypoglycemia and exercise management strategies in active Qatari adults with type 1 diabetes during the COVID-19 pandemic, and to explore the potential role of CGM devices in promoting safe physical activity practices. Our findings suggest that individuals who engage in more vigorous physical activity (VPA) and metabolic equivalent (MET)-minutes per week may have higher scores on the behaviour dimension of the Hypoglycemia Fear Survey (HFS), indicating greater fear of hypoglycemia. This finding is consistent with previous studies that have identified fear of hypoglycemia as a significant barrier to physical activity in individuals with type 1 diabetes [1,2,14].

In accordance with previous studies [15,19], our results indicate that individuals with higher HbA1c levels and more severe hypoglycemia episodes in the past 12 months tended to have higher scores on the behaviour dimension of the HFS, suggesting greater fear of hypoglycemia. This finding highlights the importance of glycemic control in reducing fear of hypoglycemia and promoting physical activity adherence in individuals with type 1 diabetes. One possible explanation for these results is that individuals with higher HbA1c levels and more severe hypoglycemia episodes may have experienced negative consequences of hypoglycemia, such as impaired cognitive function or accidents, which could lead to greater fear of hypoglycemia and reduced physical activity. Another possible explanation is that individuals with higher HbA1c levels and more severe hypoglycemia episodes may have received more intensive diabetes management, which could lead to greater awareness of hypoglycemia and greater fear of hypoglycemia. Moreover, the results indicate that fear of hypoglycemia may impact exercise management behavior more than worry about hypoglycemia. This finding is consistent with previous studies that have reported that fear of hypoglycemia is a primary and specific barrier to physical activity in individuals with type 1 diabetes [1,2,3,14].

Other influential barrier to physical activity patterns and glycemic control has been currently highlighted is the COVID-19 pandemic [14]. In fact, COVID-19 pandemic has significantly affected stress levels, anxiety, and physical activity patterns, impacting the management of type 1 diabetes and fears of hypoglycemia during exercise [8,9,14]. Studies found both reduced physical activity and increased sedentary behavior due to pandemic-related measures [20], as well as heightened psychological distress [21]. Further investigation is essential to understand the pandemic's effect on hypoglycemia fears in those with type 1 diabetes using CGM devices

In the present work no significant relationship was found between the worry dimension of the HFS and physical activity levels, indicating that fear of hypoglycemia may impact exercise management behavior more than worry about hypoglycemia. This finding is consistent with the results reported by Campbell et al. [6], who found that active youth with type 1 diabetes reported employing strategies to reduce hypoglycemia risk with exercise, and that fear of hypoglycemia impacted exercise management behaviors in an adaptive manner. Moreover, no significant relationship between screen time and fear of hypoglycemia which is inconsistent with previous studies that have reported a significant association between screen time and glycemic control in individuals with type 1 diabetes [22,23]. However, it is important to note that our sample size was relatively small, and further research is needed to explore the potential impact of screen time on fear of hypoglycemia and physical activity in individuals with type 1 diabetes.

To conclude, fear of hypoglycemia may impact exercise management behavior more than worry about hypoglycemia in active Qatari adults with type 1 diabetes during the COVID-19 pandemic. Specifically, individuals who engage in more VPA and MET-minutes per week may have higher scores on the behavior dimension of the HFS, indicating greater fear of hypoglycemia. In addition, individuals with higher HbA1c levels and more severe hypoglycemia episodes in the past 12 months tended to have higher scores on the behavior dimension of the HFS, suggesting greater fear of hypoglycemia. These findings highlight the importance of addressing fear of hypoglycemia and promoting safe physical activity practices in individuals with type 1 diabetes. Furthermore, the use of CGM devices may provide added safety to physical activity practices by reducing the risk of hypoglycemia. This underscores the importance of promoting the use of CGM devices and other effective strategies for behavioral management and glycemic control to prevent hypoglycemia and promote physical activity in individuals with type 1 diabetes during the pandemic. Future research should focus on identifying effective interventions to address fear of hypoglycemia and promote physical activity in this population during the pandemic.

Overall, our study contributes to the growing body of literature on the relationship between fear of hypoglycemia, physical activity, and diabetes management, and highlights the potential role of CGM devices in promoting safe physical activity practices.

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Declaration of Competing Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest. GJ and SH contributed to the conception and design of the study and to the data collection; GJ performed data analysis and interpretation; GJ drafted the manuscript, GJ and SH revised, read and approved the submitted version.

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References

[1] Brazeau AS, Rabasa-Lhoret R, Strychar I, Mircescu H. Exercise management for young people with type 1 diabetes. Front Endocrinol 2019;10:1–12. doi: 10.3389/fendo.2019.00326.

[2] Brazeau AS, Rabasa-Lhoret R, Strychar I, Mircescu H. Exercise-induced hypoglycaemia in type 1 diabetes. Exp Physiol 2019;104(7):1007–19. doi: 10.1113/EP088219.

[3] Roberts L, James LJ, Shirreffs SM, Kriemler S. Hypoglycaemia avoidance and exercise in type 1 diabetes: a narrative review. Int J Sport Nutr Exerc Metab 2019;29(5):561–8. doi: 10.1123/ijsnem.2018-0254.

[4] Galassetti P, Riddell MC. Exercise, hypoglycemia, and type 1 diabetes - PMC. Front Endocrinol 2013;4:1–8. doi: 10.3389/fendo.2013.00037.

[5] Jabbour G, Henderson M, Mathieu ME, Bougie K, Rabasa-Lhoret R, Weisman A. Association between exercise and hypoglycemia risk in type 1 diabetes: a systematic review and meta-analysis. Diabetes Obes Metab 2020;22(5):727–35. doi: 10.1111/dom.13923.

[6] Campbell MD, Walker M, Trenell MI, Stevenson EJ, Turner D, Bracken RM, Shaw JA, West DJ. Hypoglycaemia avoidance behaviour and exercise levels in young people with type 1 diabetes. Diabetic Med 2017;34(5):698–702. doi: 10.1111/dme.13298.

[7] Houlder SK, Yardley JE. Continuous glucose monitoring and exercise in type 1 diabetes: past, present and future. Biosensors 2018;8(3):73. doi: 10.3390/bios8030073.

[8] Yardley JE, Kenny GP, Perkins BA, Riddell MC, Malcolm J, Boulay P. Effects of performing resistance exercise before versus after aerobic exercise on glycemia in type 1 diabetes. Diabetes Care 2020;43(11):2788–95. doi: 10.2337/dc20-1105.

[9] O'Mahoney LL, Highton PJ, Kudlek L, Morgan J, Lynch R, Schofield E, Sreejith N, Kapur A, Otunla A, Kerneis S, James O, Rees K, Curtis F, Khunti K, Hartmann-Boyce J. The impact of the COVID-19 pandemic on glycaemic control in people with diabetes: a systematic review and meta-analysis. Diabetes Obes Metab 2022;24(9):1850–60. doi: 10.1111/dom.14771.

[10] Aguilar-Farias N, Miranda-Marquez S, Sadarangani KP, Chaput JP, Kuriyan R. Prevalence of physical activity and sedentary behavior among children and adolescents in India: a systematic review and meta-analysis. Int J Environ Res Public Health 2020;17(22):8540. doi: 10.3390/ijerph17228540.

[11] World Health Organization (2023) COVID-19 and noncommunicable diseases. Accessed March 4, 2023. https://www.who.int/teams/noncommunicable-diseases/covid-19-and-noncommunicable-diseases

[12] Capaldo B, Annuzzi G, Creanza A, Giglio C, De Angelis R, Lupoli R, Riccardi G. Blood glucose control during lockdown for COVID-19: CGM metrics in Italian adults with type 1 diabetes. Diabetes Care 2020;43(12):e162–3. doi: 10.2337/dc20-1105.

[13] Battelino T, Danne T, Bergenstal RM, Amiel SA, Beck RW, Biester T, Phillip M. Clinical targets for continuous glucose monitoring data interpretation: recommendations from the international consensus on time in range. Diabetes Care 2020;43(7):1593–603. doi: 10.2337/dci20-0022.

[14] Jabbour G, Hermassi S, Bragazzi N. Impact of the COVID-19 pandemic on the physical activity profile and glycemic control among qatari adults with type 1 diabetes: effect of vaccination status. Front Public Health 2022;10:865. doi: 10.3389/fpubh.2022.754366.

[15] Gonder-Frederick LA, Schmidt KM, Vajda KA, Greear ML. Psychometric properties of the hypoglycemia fear survey-ii for adults with type 1 diabetes. Diabetes Care 2009;32(5):801–6.

[16] Lam AYR, Xin X, Tan WB, et al. Psychometric validation of the hypoglycemia fear survey-II (HFS-II) in Singapore. BMJ Open Diab Res Care 2017;5:e000329 2017. doi: 10.1136/bmjdrc-2016-000329.

[17] Craig CL, Marshall AL, Sjöström M, Bauman AE, Booth ML, Ainsworth BE, Oja P. International physical activity questionnaire: 12-country reliability and validity. Med Sci Sports Exerc 2003;35(8):1381–95.

[18] Lee PH, Macfarlane DJ, Lam TH, Stewart SM. Validity of the international physical activity questionnaire short form (IPAQ-SF): a systematic review. Int J Behav Nutr Phys Act 2011;8(1):115.

[19] Cox DJ, Irvine A, Gonder-Frederick L, Nowacek G, Butterfield J. Fear of hypoglycemia: quantification, validation, and utilization. Diabetes Care 1987;10(5):617–21.

[20] Maphong R, Sriramatr S. Sedentary behavior, physical activity, and health behavior during the COVID-19 pandemic in Bangkok's office workers. Ann Appl Sport Sci 2022:e1159. Press(In Press).

[21] Ringin E, Meyer D, Neill E, Phillipou A, Tan EJ, Toh WL, Sumner PJ, Owen N, Hallgren M, Dunstan DW, Rossell SL, Van Rheenen TE. Psychological-health correlates of physical activity and sedentary behaviour during the COVID pandemic. Ment Heal Phys Act 2022;23:100481 PMID: 36406837. PMCID: PMC9664206. doi: 10.1016/j.mhpa.2022.100481.

[22] Neylon OM, O'Connell MA, Skinner TC, Cameron FJ. Demographic and personal factors associated with metabolic control and self-care in youth with type 1 diabetes: a systematic review. Diabetes Metab Res Rev 2013;29(4):257–72. doi: 10.1002/dmrr.2392.

[23] Wan X, Li Y, Fan H. The associations between screen time-based sedentary behavior and depression: a systematic review and meta-analysis. BMC Public Health 2019;19:1524. doi: 10.1186/s12889-019-7904-9.