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The role of family health climate in physical activity and sedentary behaviour in primary care patients with diabetes – a cross-sectional study

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Abstract

Background The shared perceptions and cognitions of a family toward health such as exercise are termed the family health climate (FHC), and they may influence individual physical activity levels. This study aimed to examine the associations between the FHC and physical activity and sedentary behaviour in adult patients with diabetes while accounting for sociodemographic factors and self-determined motivation.

Methods This cross-sectional study was conducted at a polyclinic in Singapore. The participants completed anonymized, self-administered questionnaires that collected data on sociodemographic variables, family health climate for physical activity (FHC-PA), self-reported physical activity and sedentary behaviour (Global Physical Activity Questionnaire), and self-determined motivation (Behavioural Regulation in Exercise Questionnaire-2). The data were analysed descriptively, and logistic regression was performed to examine the sociodemographic, FHC and motivational covariates of physical activity and sedentary behaviour.

Results A total of 345 participants were included in the analysis. The majority were male (60.3%), Chinese (67.5%), and working (72.8%). The mean age was 61.56 (SD 10.71) years. A minority of the participants had sufficient physical activity (41.2%), and most were sedentary (62%). After we adjusted for sociodemographic factors and self-determined motivation, the FHC-PA score and its subdomains were not associated with physical activity levels ($p > 0.05$) or sedentary behaviour ($p > 0.05$). Those with higher identified regulation scores had higher odds of being sufficiently active, whereas those with higher external regulation scores, from larger households and who were employed had lower odds of sufficient physical activity. Higher degrees of autonomous motivation were associated with reduced sedentary behaviour, whereas being employed was associated with increased sedentary behaviour.

Conclusion The FHC-PA, in the presence of self-determined motivation and sociodemographic factors, was not associated with the individual physical activity levels of adults with diabetes. Further studies can be conducted to determine whether it plays a mediating role. As identified regulation was associated with both physical activity and sedentary behaviour, interventions can be mapped to target this motivational domain.

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Keywords Family health climate and self-determined motivation, Family health climate, Self-determination theory, Motivation, Physical activity, Sedentary behaviour, Type 2 diabetes mellitus

Background

Diabetes is a major public health concern in Singapore, with a prevalence of 8.5% among adults aged 18–74 years from 2021 to 2022 [1]. This has led to considerable economic burden [2] resulting from the loss of life years due to poor health from diabetes-related complications and mortality [3].

The beneficial effects of regular physical activity on glycaemic control [4], insulin sensitivity [5], microvascular complications [6] and cardiovascular outcomes and mortality [7, 8] in patients with diabetes are well described. Incrementally higher physical activity levels are associated with reduced cardiovascular morbidity and mortality in patients with type 2 diabetes mellitus [8]. This dose-response association is evident even in lower levels of physical activity [6]. This increases the need for regular promotion of physical activity, particularly for inactive patients, aiming to reach guideline-recommended levels.

Similarly, increased sedentary time is associated in a dose-response manner with premature mortality in patients with diabetes [9]. Reducing time spent in sedentary behaviour has been shown to reduce all-cause mortality [9, 10] and glycaemic control [9], independent of physical activity [11].

Despite the above benefits, various studies have shown that patients with diabetes clock lower levels of physical activity [12, 13] and increased sedentary time [14, 15] compared to the general population. For interventions to increase physical activity and reduce sedentary time in patients with diabetes, understanding how human behaviour is shaped and the role of individual and socioenvironmental factors is imperative.

Motivation is an important determinant of physical activity [16], including among patients with diabetes mellitus [17]. The 5-stage self-determination theory [18] is a commonly used framework for examining the relationship between motivation and physical activity. The theory describes motivation as a continuum of 5 stages from amotivation to intrinsic motivation, with each stage ascending to a more autonomous and self-determined quality of motivation [18]. Intrinsic motivation is the most autonomous form of motivation, in which the behaviour is done out of inherent interest and enjoyment [19]. Identified regulation arises somewhat internally and is regulated by how the individual values and places importance on the behaviour rather than inherent interest [18]. Introjected regulation is controlled by internal rewards and punishments, for instance, performing a behaviour to avoid guilt and anxiety or for ego-enhancement [18]. External regulation is derived entirely externally and is driven by external rewards and punishments [16]. The quality of motivation, not just its degree, is positively associated with exercise [19]. Motivation towards physical activity also influences sedentary behaviour. Having higher intrinsic and identified motivation towards physical activity is protective of sedentary behaviour [20].

However, the social contexts within which behaviours develop also play a crucial role. An important setting is the family environment. Studies have demonstrated spousal concordance in health behaviour, such as physical activity participation [21], and even the risk of developing type 2 diabetes [22, 23]. In terms of sedentary behaviour, perceiving greater social support and norms for sedentary behaviour is associated with increased sedentary time [20]. These studies suggest the potential influence of a shared family environment on health behaviour and outcomes. At the population level, the family unit has been shown to contribute substantially to individual health status [24].

The shared perceptions and cognitions of a family toward a healthy lifestyle were first described as the family health climate (FHC) by Niermann et al. in 2014 [25]. The FHC was based on Bandura's social cognitive theory [26], in which environmental and individual determinants are reciprocally interrelated, and both affect health behaviour. Within a family, the climate with respect to a healthy lifestyle is characterized by day-to-day interactions about physical activity, food choices or preparation, and attitudes towards health and disease. These daily interactions provide a reference for individuals and influence their choices and behaviours. Thus, the FHC-physical activity (FHC-PA) scale was developed [25] to measure this family-level attribute as perceived by the individual. It has been validated in various populations [27, 28]. The perception of the FHC-PA of one family member is related to the cognitive, motivational, and behavioural variables of another family member [25], as demonstrated by the concordance of FHC-PA responses among dyads of the same household (parent–child, couples, siblings, etc.) [27].

In adolescents, a positive FHC-PA (a family that discusses and engages in physical activity regularly) is associated with increased individual physical activity levels [29]. While the role of the family in health promotion has been extensively studied in the context of parent−child relationships, few studies have examined adults. One study in Singapore showed that the FHC-PA is associated with an individual's amount of recreational physical activity [27]. In adults with diabetes, the influence of the

FHC on individual physical activity levels and sedentary behaviour is unknown, especially in the presence of other known corelates of physical activity, such as motivation.

Given the lower levels of physical activity and greater sedentary time in patients with diabetes [12–15] in whom cardiovascular risk is already elevated, it is of interest to understand the influence of the family environment on physical activity and sedentary behaviour at the socioenvironmental level. This can facilitate the design of public health strategies and interventions to both increase physical activity participation and reduce sedentary behaviour [30]. A multilevel ecological approach involving individual- and family-level interventions may be more likely to enact behaviour change.

Therefore, this study aimed to examine the associations between the family health climate and physical activity and sedentary behaviour in patients with diabetes while accounting for sociodemographic and motivational factors. It is hypothesized that a positive family health climate and higher degrees of self-determined motivation are associated with higher physical activity levels among patients with diabetes.

Methods

Sample and procedure

This cross-sectional study was conducted at a polyclinic in Singapore from June to October 2023. Participants were eligible if they (a) were aged 21 and above, (b) had diabetes, (c) were living with a family member in the same household, and (d) were able to read and understand English. The participants were selected by convenience sampling, and they completed an anonymized, self-administered questionnaire in English. The questionnaire consisted of four sections that collected data on sociodemographic variables, family health climate, self-reported physical activity levels and sedentary behaviour, and the degree of intrinsic motivation.

This study was performed in accordance with the Declaration of Helsinki. Ethical approval was obtained from the National Healthcare Group Domain Specific Review Board (reference number: 2023/00115), and the need for participant consent was waived as the study involved questionnaires without identifiers.

Sociodemographic variables

Data were collected on gender, age, ethnicity, marital status, highest education level, current work status, monthly personal income, type of dwelling and number of household members (excluding nonfamily members such as domestic helpers, tenants, landlords, etc.).

Family health climate – physical activity (FHC-PA)

The original FHC-PA (Niermann et al.) [25] was validated in Singapore with some modifications, leading to a modified version [27] that was used in this study. The modified FHC-PA scale consists of 11 items across 3 domains - value (4 items), cohesion (4 items), and information (3 items) - which reflect the participant's perception of the family's emphasis on being physically active together, the family's engagement in physical activities together and the level of enjoyment in such activities, and the extent to which the family searches for and shares information related to exercise. Each item is scored on a four-point Likert scale from 0 = 'Strongly Disagree' to 3 = 'Strongly Agree'. Higher total scores reflect a more positive FHC. The total FHC-PA scores thus range from 0 to a maximum of 33. For each domain of value, cohesion, and information, the mean scores range from 0 to 3.

Self-determined motivation to exercise

The Behavioural Regulation in Exercise Questionnaire-2 (BREQ-2) measures the level of self-determined motivation with respect to exercise [31] and it has been utilised in various healthcare settings and populations, including in Singapore [32]. The BREQ-2 consists of 19 items over 5 subscales that correspond to a stage of the self-determination continuum (Deci and Ryan, 1991): (i) amotivation (4 items), (ii) external regulation (4 items), (iii) introjected regulation (3 items), (iv) identified regulation (4 items) and (v) intrinsic motivation (4 items), with each stage ascending to a more autonomous and self-determined quality of motivation from the previous stage. Each item is scored on a 5-point Likert scale, from 0 = 'Not true for me' to 4 = 'Very true for me'. The BREQ-2 is assessed as a summation of the mean scores of each subscale, which ranges between 0 and 4.

Physical activity and sedentary behaviour

The Global Physical Activity Questionnaire (GPAQ) is a 16-item scale developed by the World Health Organization (WHO) in 2014 to measure levels of physical activity and sedentary behaviour [33]. The questionnaire assesses the duration and frequency of vigorous and moderate-intensity activities across three domains (work, transport, or leisure) during a typical week. It also assesses the time spent in sedentary behaviour on a typical day. The participants were then classified into two groups based on the 2020 WHO guidelines on physical activity and sedentary behaviour [34].

a) Sufficiently active: (i) had at least 150 min of moderate-intensity physical activity, OR (ii) 75 min of vigorous-intensity physical activity, OR (iii) an equivalent combination of moderate- and vigorous-intensity physical activity, all of which would amount to a minimum of 600 metabolic equivalent of task (MET) minutes per week.

b) Inactive: participants who did not meet the above criteria.

Sedentary behaviour was dichotomized into 'sedentary' and 'not sedentary' based on a cut-off for time spent in sedentary behaviour of ≥7 h and <7 h per day, as derived from a meta-analysis that revealed the risk of all-cause mortality increased significantly beyond 7 h [35].

In Singapore, the GPAQ demonstrated fair–to-moderate correlations with accelerometer-measured levels of physical activity across all three domains [36]. The self-administered GPAQ was also shown to be as correlated as the interviewer-administered version with accelerometer measurements [36]. The GPAQ was also used in Singapore's annual National Population Health Survey [37].

Sample size

The sample size was calculated based on the findings of Ho et al., who reported that FHC-PA was significantly associated with an individual's amount of leisure-time physical activity, where $r=0.16$ ($p<0.001$) [27]. With a 2-sided alpha level of 0.05 and a power of 0.8, the number of subjects required to observe an association is 305. Based on the available literature, the non-response rate for self-administered health questionnaires can be up to 20% [38]. As our questionnaire was self-administered and 46 items long, we anticipated for a non-response rate of up to 20%. Thus we inflated our final sample size by 20% to 366 to buffer for missing or incomplete data.

Statistical analysis

All statistical analyses were conducted using IBM SPSS® Version 29. Descriptive statistics were calculated to summarize the demographic and clinical characteristics of the participants. Continuous variables were reported as means with standard deviations (SDs), while categorical variables were expressed as frequencies and percentages. The two outcome variables of physical activity and sedentary behaviour were binary and categorised as:

a) Physical activity levels: sufficiently active (meeting WHO physical activity guidelines) or inactive.
b) Sedentary behaviour: sedentary (≥7 h per day of sedentary time) or not sedentary (<7 h per day).

The independent variables included sociodemographic variables (gender, age, ethnicity, marital status, education level, work status, dwelling type, and number of household members), FHC-PA (domains of value, cohesion, and information), and self-motivation (domains of amotivation, external regulation, introjected regulation, identified regulation and intrinsic motivation).

As the data were not normally distributed, Mann-Whitney *U* test was used to examine the correlations between FHC-PA domains and BREQ domains with physical activity and sedentary behaviour. Additionally, Spearman's rho was used to evaluate the correlation between FHC-PA and physical activity levels in terms of MET minutes per week.

Multiple logistic regression analysis was used to examine the associations between family health climate and the two outcomes of physical activity and sedentary behaviour while adjusting for sociodemographic variables and self-determined motivation. Adjusted odds ratios (OR) with 95% confidence intervals (CI) were calculated for all independent variables. Statistical significance was set at a p value of <0.05.

Multicollinearity among independent variables was assessed using the Variance Inflation Factor (VIF).

Results

A total of 366 questionnaires were distributed, 365 of which were returned (response rate of 99.7%). Of these, 20 questionnaires were incomplete and excluded to allow for complete case analysis of the remaining 345.

Sociodemographic characteristics

There were nearly twice as many male participants as females (60.3% vs. 39.7%). Slightly more than half the population (56.8%) were aged below 65 years, with the remaining (43.2%) comprised older adults aged 65 years and above. The majority of the participants were Chinese (67.5%), with a third being non-Chinese (Malay, Indian or others). The participants were predominantly married or cohabitating (80.6%). In terms of education level, there were equal proportions of participants with 'A' level qualifications and above (37.1%) and with 'O'/ 'N' level or equivalent qualifications (37.1%). Those with a primary school education or less composed the minority (25.8%). Most participants (59.7%) lived in four- to five-room HDB flats or executive condominiums, and the mean number of household members was 3.63 (SD 1.59). The detailed sociodemographic characteristics are presented in Table 1.

Family health climate for physical activity (FHC-PA) and self-determined motivation to exercise

The mean total FHC-PA score of our participants was 25.82 (SD 8.78), out of a maximum score of 33, whereas the mean scores for each domain of value, cohesion and information were 2.56 (SD 0.87), 2.35 (SD 0.90) and 2.06 (SD 0.89), respectively. The mean scores for the BREQ-2 factors of amotivation, external regulation, introjected regulation, identified regulation and intrinsic regulation were 1.14 (SD 0.94), 1.1 (SD 0.88), 1.23 (SD 1.00), 2.04 (SD 1.08), and 1.80 (SD 1.10), respectively. The results are presented in Table 1.

Table 1 Sociodemographic characteristics of participants and their level of self-determined motivation, family health climate, physical activity, and sedentary behaviour

	N	%
Gender		
Female	137	39.7
Male	208	60.3
Age, Mean (SD)	61.56 (10.71)	
Below 65 years	196	56.8
65 year and above	149	43.2
Ethnicity		
Chinese	233	67.5
Non-Chinese [a]	112	32.5
Marital Status		
Married/Cohabitating	278	80.6
Single/Divorced/Separated/Widowed	67	19.4
Education Level		
Primary and below	89	25.8
N level/O level/NTC 3	128	37.1
A level and above	128	37.1
Work Status		
Working	251	72.8
Not working [b]	94	27.2
Dwelling Type		
1–3 Room HDB	100	29.0
4–5 Room HDB/ hybrid [c]	206	59.7
Private property [d]	39	11.3
No. of Household members, Mean (SD)	3.63 (1.59)	
Global Physical Activity Questionnaire - Level of Physical Activity		
Sufficiently active	142	41.2
Inactive	203	58.8
Global Physical Activity Questionnaire - Sedentary Behaviour		
Sedentary	214	62.0
Not Sedentary	131	38.0
Family Health Climate - Physical Activity Questionnaire		
Value	2.56 (0.87)	
Cohesion	2.35 (0.90)	
Information	2.06 (0.89)	
Total	25.82 (8.78)	
Behavioural Regulation in Exercise Questionnaire		
Amotivation	1.14 (0.94)	
External Regulation	1.1 (0.88)	
Introjected Regulation	1.23 (1.00)	
Identified Regulation	2.04 (1.08)	
Intrinsic Regulation	1.8 (1.10)	

[a] Malays, Indians, Eurasians, Others

[b] Unemployed, student, housewife, retiree

[c] Executive condominium/HUDC

[d] Condominium/Private Apartment/Landed Property

Physical activity levels and sedentary behaviour of participants

41.2% of the participants were sufficiently active, with a mean MET minutes per week of 4249.01 (SD 6076.86) minutes. Among the inactive participants, 77.3% did not meet the minimum amount of 10 min per day of moderate-intensity physical activity across all domains of work, transport, or leisure. The mean MET minutes per week for inactive participants was 71.33 (SD 145.83) minutes. 62% of the participants were sedentary, i.e., spent more than 7 h of time awake lying or sitting down.

Associations between FHC-PA and motivation with physical activity and sedentary behaviour

Higher FHC-PA total scores and domain-specific scores were associated with higher physical activity levels, as measured by MET-minutes per week ($p < 0.001$) and as categorized by the 2020 WHO physical activity recommendations ($p < 0.001$). Similarly, higher motivation scores were associated with higher physical activity levels ($p < 0.05$). Conversely, lower FHC-PA scores and lower motivation scores were also associated with sedentary behaviour ($p < 0.05$), except for external regulation. Refer to Table 2.

The association between FHC-PA and physical activity was further analysed by multiple logistic regression, adjusting for sociodemographic variables and self-determined motivation. The model was statistically significant, $\chi2$ (18, $N = 345$) = 196.91, $p < 0.001$, indicating the ability to distinguish between respondents who were sufficiently active and inactive. The model explained about 58.6% (Nagelkerke R^2) of the variance in the level of physical activity, and correctly classified 83.2% of the cases.

The FHC-PA and its domains were not associated with physical activity after adjustment. (value domain OR = 1.75, 95% CI [0.86, 3.56], $p = 0.13$; cohesion domain OR 1.13, 95% CI [0.60, 2.10], $p = 0.71$; information domain OR = 1.10, 95% CI [0.66, 1.82], $p = 0.72$). Instead, external regulation and identified regulation remained significantly associated with physical activity. Those with higher identified regulation scores had higher odds of being sufficiently active (OR = 2.07, 95% CI [1.18, 3.66], $p = 0.01$), and those with higher external regulation scores had lower odds of being sufficiently active (OR = 0.49, 95% CI [0.29, 0.84], $p = 0.01$). Additionally, participants from larger households and those who were working had lower odds of sufficient physical activity (OR = 0.76, 95% CI [0.61, 0.96, $p = 0.02$) and (OR = 0.41, 95% CI [0.19, 0.88], $p = 0.02$). The results are presented in Table 3.

Similarly, multiple logistic regression was also conducted to examine the association between FHC-PA and sedentary behaviour while adjusting for sociodemographic variables and self-determined motivation. The model was statistically significant, $\chi2$ (18, $N = 345$) = 142.13, $p < 0.001$, indicating the ability to distinguish between respondents who were sedentary and not sedentary. The model explained approximately 45.9% (Nagelkerke R^2) of the variance in the sedentary behaviour, and correctly classified 78.0% of the cases.

Table 2 Mean scores of the domains of FHC-PA and self-determined motivation across different levels of physical activity and sedentary behaviour

	Physical activity levels					Sedentary behaviour		
	Sufficiently active	Inactive	*p*	MET mins per week		Sedentary	Not sedentary	*p*
	Mean (SD)	Mean (SD)		Correlation coefficient	*p*	Mean (SD)	Mean (SD)	
FHC PA								
Value	3.11 (0.74)	2.18 (0.73)	**< 0.001**	0.464	**< 0.001**	2.31 (0.79)	2.97 (0.83)	**< 0.001**
Cohesion	2.78 (0.87)	2.05 (0.80)	**< 0.001**	0.37	**< 0.001**	2.17 (0.81)	2.65 (0.98)	**< 0.001**
Information	2.34 (0.92)	1.86 (0.82)	**< 0.001**	0.274	**< 0.001**	1.95 (0.83)	2.24 (0.96)	**0.01**
Total Score	30.56 (8.03)	22.50(7.70)	**< 0.001**	0.426	**< 0.001**	23.76 (7.82)	29.19 (9.22)	**< 0.001**
Self-determined Motivation								
Amotivation	0.77 (0.92)	1.39 (0.86)	**< 0.001**	-0.203	**0.01**	1.33 (0.90)	0.82 (0.92)	**< 0.001**
External Regulation	1.00 (0.96)	1.17 (0.81)	**0.02**	-0.041	0.58	1.13 (0.78)	1.05 (1.02)	0.11
Introjected Regulation	1.58 (1.07)	0.99 (0.87)	**< 0.001**	0.187	0.10	1.10 (0.89)	1.45 (1.13)	**0.01**
Identified Regulation	2.81 (0.83)	1.51 (0.90)	**< 0.001**	0.385	**< 0.001**	1.62 (0.96)	2.73 (0.91)	**< 0.001**
Intrinsic Regulation	2.51 (0.96)	1.30 (0.91)	**< 0.001**	0.439	**< 0.001**	1.40 (0.94)	2.45 (1.05)	**< 0.001**

The FHC-PA and its domains were not associated with sedentary behaviour after adjustment (value domain OR = 1.07, 95% CI [0.56, 2.03], $p = 0.84$; cohesion domain OR = 0.96, 95% CI [0.54, 1.69], $p = 0.87$; information domain OR = 0.98, 95% CI [0.63, 1.54], $p = 0.95$). Instead, introjected regulation, identified regulation and intrinsic regulation were associated with sedentary behaviour. Participants with higher introjected regulation scores were more likely to be sedentary (OR = 1.56, 95% CI [1.05, 2.33], $p = 0.03$). Participants with higher identified and intrinsic regulation scores were less likely to be sedentary (OR = 0.35, 95% CI [0.21, 0.59], $p < 0.001$) and (OR = 0.61, 95% CI [0.39, 0.95], $p = 0.03$). The results are presented in Table 3.

Race and working status were significantly associated with sedentary behaviour. Compared with Chinese participants, non-Chinese participants were less likely to be sedentary (OR = 0.47, 95% CI [0.26, 0.88], $p = 0.02$), and participants who were working were more sedentary (OR = 3.77, 95% CI [1.87, 7.62], $p < 0.001$). The results are presented in Table 3. Multicollinearity tests of the independent variables revealed that all VIF values were below 4 indicating no substantial collinearity.

Discussion

The shared family environment is presumed to be an important social context within which health behaviours such as physical activity develop and are perpetuated. This cross-sectional study is the first to explore the direct influence of families' shared perceptions and environment on individuals' physical activity levels and sedentary behaviour in adult patients with diabetes. In contrast to earlier evidence, our study revealed that the FHC-PA and its individual domains were not associated with physical activity levels or sedentary behaviour after sociodemographic factors and self-determined motivation were considered. Instead, higher identified regulation was associated with sufficient physical activity, whereas higher external regulation and being employed were associated with insufficient physical activity. More autonomous motivation, being non-Chinese, and not working were associated with reduced sedentary behaviour.

In our bivariate analysis, higher FHC-PA scores were associated with higher physical activity levels, and lower scores were associated with increased sedentary behaviour. However, this significant association was lost after adjusting for sociodemographic variables and self-determined motivation. This contrasts with findings from prior studies exploring the influence of FHC-PA on adolescents. Compared to adolescents, adults assert more autonomy over their behaviours [39] and are less often in close proximity to their family including parents [40]. Thus, individual level factors such as self-determined motivation may have a greater influence on the health behaviours of adults as compared to the FHC. Another consideration for this discrepancy between the bivariate analysis and multiple logistic regression is the sample size that was calculated based on the Pearson correlation coefficient between FHC-PA and physical activity. It may have insufficient power to detect significant associations in a logistic regression after adjusting for other variables. Other considerations include the possibility of non-linear or indirect associations between FHC-PA and these health behaviours in adults with diabetes, with FHC-PA exerting significant mediating effects via motivation. This was demonstrated by Niermann et al. [29] in the adolescent population. Further studies employing structural equation modelling are required to understand the complex relationship between FHC-PA, motivation, physical activity, and sedentary behaviour in adults with

Table 3 Results of logistic regression analyses examining correlates of physical activity and sedentary behaviour

	Physical activity				Sedentary behaviour			
	Inactive vs. sufficiently active				<7 h vs. ≥7 h			
	Adjusted OR	95% CI		*p*	Adjusted OR	95% CI		*p*
		Lower	Upper			Lower	Upper	
Family Health Climate - Physical Activity Questionnaire								
Value	1.75	0.86	3.56	0.13	1.07	0.56	2.03	0.84
Cohesion	1.13	0.60	2.10	0.71	0.96	0.54	1.69	0.87
Information	1.10	0.66	1.82	0.72	0.98	0.63	1.54	0.95
Behavioural Regulation in Exercise Questionnaire								
Amotivation	0.82	0.53	1.28	0.39	1.22	0.83	1.81	0.31
External Regulation	0.49	0.29	0.84	**0.01**	1.01	0.66	1.54	0.96
Introjected Regulation	1.39	0.88	2.19	0.16	1.56	1.05	2.33	**0.03**
Identified Regulation	2.07	1.18	3.66	**0.01**	0.35	0.21	0.59	**<0.001**
Intrinsic Regulation	1.63	0.98	2.72	0.06	0.61	0.39	0.95	**0.03**
Gender								
Female	REF.				REF.			
Male	1.37	0.71	2.64	0.35	0.80	0.44	1.45	0.46
Age Group								
Below 65 years	REF.				REF.			
65 years and above	1.10	0.55	2.18	0.80	1.37	0.72	2.62	0.34
Ethnicity								
Chinese	REF.				REF.			
Non-Chinese [a]	1.71	0.85	3.47	0.14	0.47	0.26	0.88	**0.02**
Marital Status								
Married/Cohabitating	REF.				REF.			
Single/Divorced/Separated/Widowed	1.02	0.44	2.34	0.96	1.19	0.55	2.58	0.66
Education Level								
Primary and below	REF.				REF.			
N level/O level/NTC 3	1.96	0.81	4.71	0.13	0.98	0.45	2.14	0.95
A level and above	2.31	0.91	5.86	0.08	1.42	0.62	3.22	0.40
Work Status								
Not working [b]	REF.				REF.			
Working	0.41	0.19	0.88	**0.02**	3.77	1.87	7.62	**<0.001**
Dwelling Type								
1–3 Room HDB	REF.				REF.			
4–5 Room HDB/hybrid [c]	1.15	0.53	2.49	0.72	1.14	0.57	2.29	0.71
Private property [d]	0.46	0.14	1.54	0.21	0.79	0.27	2.33	0.67
No. of Household members	0.76	0.61	0.96	**0.02**	1.21	0.98	1.48	0.08

[a] Malays, Indians, Eurasians, Others

[b] Unemployed, student, housewife, retiree

[c] Executive condominium/HUDC

[d] Condominium/Private Apartment/Landed Property

diabetes. This can help us identify effective determinants and mechanisms underlying behaviour patterns.

It is important to understand which subtype of motivation promotes physical activity. Our study revealed that sufficient physical activity was associated with identified regulation but not intrinsic motivation, which is the most autonomous form of motivation. In the latter, the behaviour is performed out of inherent interest and enjoyment [18], whereas in identified regulation, the behaviour is performed owing to high personal value and importance placed upon it [18]. Our finding is supported by a systematic review by Teixeira et al. [41], in which identified regulation, compared with intrinsic motivation, was more consistently associated with greater physical activity. As postulated by Edmunds et al. [42], this could be because adopting a physically active lifestyle, particularly for mundane or repetitive activities, requires a high degree of effort, which may be driven by how the individual values and places importance on the behaviour [18] rather than interest or enjoyment [19].

Conversely, participants with higher external regulation scores (the least self-determined form of extrinsic motivation, driven by rewards and punishment [18]) were less likely to be sufficiently active. This is in keeping with studies by Markland et al. [43] and Teixeira et al. [41] that showed external regulation correlating with lower levels of physical activity. Zamarripa et al. [44] showed that external regulation was closely associated with earlier stages of change according to the transtheoretical model, i.e., pre-contemplation and contemplation. It could be that individuals driven by external regulation may experience physical activity as a chore, leading to decreased enjoyment and less willingness to engage in adequate physical activity.

It is surprising that compared to external regulation, the highest level of motivation - intrinsic regulation is not significantly associated with having adequate physical activity. One reason for this paradox may be the near immediate effect of external regulation on short-term behaviour especially towards initiation of behaviour change [18], given the context of our cross-sectional study. Another surprising finding was that amotivation, was not significantly associated with insufficient physical activity. Review of the empirical literature [41] revealed inconsistent associations between amotivation and exercise outcomes via multivariate analyses.

With respect to sedentary behaviour, our study found that identified and intrinsic regulation towards physical activity were associated with reduced sedentary time. This association was also found by Quartiroli et al. [45], though they correlated more strongly with physical activity levels than sedentary behaviour [45]. Our study also revealed that introjected regulation was associated with increased sedentary time. Although a systematic review by Rollo et al. [20] did not find such evidence of an association, it did find that external regulation and amotivation toward physical activity had no association with sedentary behaviour, which we also found. As postulated by Quartiroli et al. [45], physical activity and sedentary behaviour may be influenced by unique motivational factors. However, it is note-worthy that in our study, identified regulation towards physical activity was associated with both increased physical activity and reduced sedentary behaviour.

Participants who were working were less likely to be physically active and more sedentary. This finding is similar to that of a Singaporean study, which revealed that participants who were not employed full-time exercised more regularly and had lower levels of sedentary behaviour [46]. During a full-time working day, the contribution of occupational physical activity and sitting time at work to total physical activity levels and sedentary time is substantial [47]. The majority of Singapore's labour force comprises professionals, managers and executives [48], who presumably work in office-based settings with greater sedentary time and reduced occupational physical activity.

Clinical implications

Our findings have several implications for the design of interventions. First, family-level interventions in an adult population may not be as efficacious given that there was no significant direct association between FHC-PA and individual physical activity and sedentary behaviour. However, targeting individual motivation via self-determined theory-based interventions is promising. A meta-analysis examining the effects of self-determination theory-based motivational interventions on health behaviour has shown modest efficacy in changing physical activity behaviour [49].

As identified regulation was associated with both increased physical activity and reduced sedentary behaviour, interventions can be mapped to promote identified regulation. Teixeira et al. [41] suggests that identification can be promoted by emphasizing the personal value of exercising with regard to health, including improved function and quality of life.

Insufficient physical activity and higher levels of sedentary behaviour were prevalent in participants who were employed. Interventions should be targeted to this group, with a focus on increasing both physical activity participation and reducing sedentary time, as both are independently associated with poorer health outcomes [50, 51].

Strengths and limitations

To our knowledge, our study is the only study thus far exploring the associations of FHC and motivation with individual physical activity levels and sedentary behaviour in adults with diabetes. We utilized validated questionnaires to assess FHC, levels of physical activity/sedentary behaviour and degree of self-determined motivation.

However, some notable limitations include the recruitment of only English-speaking participants from one polyclinic, which may not be sufficiently representative of Singapore's population. This was also a cross-sectional study, from which causal relationships cannot be drawn.

Also, physical activity and sedentary behaviour may be determined by unique motivational factors. However, with the paucity of validated scales used to assess motivation in the context of sedentary behaviour, we chose to focus on self-determined motivation towards physical activity and its influence on sedentary behaviour as an initial step to gather insights in our local Singapore population, particularly that of in those with type 2 diabetes mellitus. To our knowledge, there is no local study that has explored self-determined motivation (towards both physical activity and sedentary behaviour) and its impact on sedentary behaviour as yet.

Conclusion

The family health climate, in the presence of self-determined motivation and sociodemographic factors, is not associated with individual physical activity levels of adults with diabetes. It is possible that individual-level factors like motivation play a greater role. Further studies can explore any indirect mediating effect of the FHC on physical activity in adults to identify potential loci for intervention.

An additional important aspect to consider in future studies of this population would be predictors of long-term physical activity maintenance. Our study has uncovered findings consistent with available literature with regards to more autonomous motivation being associated with higher physical activity levels. However, motivation sub-types may differ for physical activity initiation or adoption, versus long-term activity maintenance [41].

Our study examined the association between self-determined motivation (towards physical activity), and sedentary behaviour. Future studies may explore the development and use of validated scales to assess motivation in the specific context of sedentary behaviour. Nevertheless, our study showed that identified regulation was associated with both physical activity and sedentary behaviour, and interventions can be mapped to target this motivational deficit to simultaneously enable physical activity adoption and reduce sedentary behaviour.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12875-025-02789-y.

Supplementary Material 1

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Author contributions
AAH, HLK and SZS contributed to the design of the study. AAH was involved in the recruitment of participants. AAH, HLK and SZS contributed to the analysis and interpretation of the data. AAH drafted the manuscript, and all authors contributed to writing the paper and revising it critically and gave final approval of this version.

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Data availability
The datasets used and/or analysed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
This study involved human participants and was performed in accordance with the Declaration of Helsinki. This study was performed in accordance with the Declaration of Helsinki. Ethical approval was obtained from the National Healthcare Group Domain Specific Review Board (reference number: 2023/00115), and the need for participant consent was waived as the study involved questionnaires without identifiers.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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