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Comparative Analysis of Physical Activity, Time Management, and Self-Care Among Individuals with Type 2 Diabetes: A Multi-Population Cross-Sectional Study

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A B S T R A C T

Objective: The present study aims to examine the relationships among time management, physical activity, and self-care behaviors in individuals with T2DM, with a cross-population comparative method to better understand adherence challenges and inform culturally responsive strategies for diabetes care.

Methods: This cross-sectional descriptive-analytical study examined the relationships between physical activity, time management, and self-care behaviors in adults with type 2 diabetes from Spanish and Iranian populations (n= 404, $55/51 \pm 12/84\ years; 76/09 \pm 13/3\ kg$). Validated questionnaires—IPAQ-SF, TMBS, and DSMQ—were used to assess physical activity Met, time use, and diabetes-related self-care, respectively, with all data collected ethically under approval code. Statistical analyses included MANOVA, Bonferroni-adjusted post hoc tests, and Pearson correlations to evaluate differences and associations across country, gender, and interaction effects.

Results: Significant differences were found in physical activity and time management across gender, age, and cultural groups, with Spanish males demonstrating higher scores. No group-level differences were observed in self-care behaviors. Time management was positively correlated with both physical activity and self-care in both populations.

Conclusion: This comparative study highlights time management as a key behavioral determinant of self-care in individuals with type 2 diabetes, surpassing physical activity in predictive strength across Spanish and Iranian cohorts. Findings underscore the need for culturally tailored, time-focused interventions that support sustainable self-management, particularly among older adults and women. Culturally tailored strategies—such as Iran's localized health instruction initiatives and Spain's region-specific dietary counseling rooted in Mediterranean traditions—play a fundamental role in enhancing diabetes self-management. By connecting clinical objectives with cultural recognition and personal relevance, these suggestions foster greater patient engagement, behavioral adherence, and long-term health improvement.

Keywords: *Diabetes Mellitus Type 2, T2DM, Self-Care, Physical Activity, Time Management, Cultural Characteristics*

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1. Introduction

Type 2 diabetes mellitus (T2DM) is explained by pancreatic β-cell dysfunction and target organs resistance to insulin hormone which is called insulin resistance (1). This disease large and growing economic burden causes individual and social problems (2). Non-pharmacological treatments can be effective in this regard. Physical activity, time management, and self-care can be considered as non-pharmacological factors in diabetes treatment. Physical inactivity possibly from genetic modulations, Beta cells' insufficiency, increase dyslipidemia & obesity, oxidative damages, mitochondrial dysfunction, inflammation, and ceramide synthesis and decrease capitalization, can contribute to the worsening of diabetes (3).

Effective management of T2DM requires the disorder controlling methods include pharmacological treatment, regular physical activity, dietary regulation, and consistent self-care behaviors (4). Implementation and adherence are two key components in diabetes management. Of these methods, participating in a physical activity program can be more effective in controlling diabetes than others (4). However, adherence to physical activity recommendations remains low among patients with T2DM (5). Self-care behaviors included healthy eating, blood glucose monitoring, and medication adherence are also essential for glycemic control and other complications prevention (6). However, maintaining a sustainable course of self-care routines remains a struggle for patients with diabetes (7). These challenges are exacerbated in parallel with other related barriers such as adherence to physical activity.

One underexplored factor that may influence both physical activity and self-care is time management. Time management refers to the potential to plan and allocate personal time effectively to meet health-related goals (8). For individuals with chronic metabolic disorders, effective time management can facilitate adherence to complex treatment regimens, including medication schedules, dietary planning, and physical exercise (9). Conversely, insignificant time management may lead to missed appointments, skipped medications, and neglect of physical activity (10).

In the context of T2DM, time management may consider as a critical mediator tool between knowledge and action. Self-care and physical activity importance clear for many patients, but yet fail to implement these behaviors consistently due to competing demands, lack of structure, or poor planning. This disconnect strongly highlights the need to examine how time-related perceptions and skills influence diabetes self-management.

Moreover, time management is not merely an operational skill—it is also a psychological construct linked to self-regulation, motivation, and perceived control. Studies have demonstrated that individuals with better time management skills report good self-efficacy and are more likely to become involved in health-promoting behaviors (11). In contrast, disorganization and time pressure are associated with stress, burnout, and reduced adherence to treatment (10). Despite its potential importance, the relationship between time management, physical activity, and self-care in patients with T2DM has received limited empirical attention (8). Most existing studies have focused on individual components—such as physical activity or self-care—without considering how these behaviors are influenced by time-related factors (6, 7). A more integrated approach is needed to understand how these variables interact and contribute to overall disease management. This study aims to fill this gap by examining the relationship between physical activity level, time management, and self-care behaviors in patients with type 2 diabetes.

2. Methods and Materials

2.1 Study Design and Participants

This study employed a descriptive-analytical, cross-sectional design to examine the relationship between physical activity level, time management, and self-care behaviors among patients with type 2 diabetes mellitus (T2DM). A combination of random and cluster sampling methods was used to recruit participants. The required sample size was calculated using G*Power software, based on an expected effect size of 0.25, a statistical power of 0.95, and an alpha level of 0.05. Given that statically analysis, the minimum sample size was determined to be 404 participants.

Participants were recruited through diabetes-related health centers and public facilities. In Iran, questionnaires were distributed randomly through the Iranian Diabetes Association, the Metabolic Disease Prevention Research Center, local health houses, and nutrition clinics. In cases where collaboration was possible, the questionnaires were also made available online.

In Spain, data were collected via an online questionnaire distributed through personal email using Google Forms. The survey link was: [Google Form – Mediterranean Diet, Physical Activity, and Diabetes Self-

Management])https://docs.google.com/forms/d/e/1FAIpQLSdFtetVxdWFKK_efeN10Lweta0YXycbO6nM3xO9_a5VEi-iDw/viewform?usp=sf_link(. The research was conducted from 2022 to 2025 in different cities in Iran and Spain. Ethical approval was obtained from the institutional ethics committee (Approval Code: IR.UMA.REC.1401.072).

The study population consisted of adult patients diagnosed with T2DM for at least one year. Inclusion criteria were: age ≥ 30 years (to ensure maturity in self-care responsibilities and reduce variability due to adolescent or early adult behaviors), confirmed diagnosis of T2DM, ability to read and write, no severe cognitive or psychiatric disorders, and willingness to participate and provide informed consent. Participants were excluded from the study based on the following criteria: individuals with any form of diabetes other than type 2 were excluded to maintain sample homogeneity;patients who were unable to engage in physical activity due to physical impairments (e.g., paralysis, recent orthopedic surgery, advanced arthritis) were excluded, as this would significantly affect physical activity performing during life style, individuals with diagnosed cognitive deficits (e.g., dementia) or severe psychiatric conditions (e.g., schizophrenia, bipolar disorder) that could interfere with understanding or completing the questionnaires were excluded; patients who had been hospitalized or experienced acute illness (e.g., infection, surgery, cardiovascular event) within the past month were excluded to avoid temporary disruptions in self-care or activity patterns; individuals currently enrolled in other structured lifestyle, exercise, or time management intervention programs were excluded to prevent confounding effects; participants who failed to complete more than 20% of the questionnaire items or whose responses were inconsistent or clearly unreliable were excluded from the final analysis, and pregnant or breastfeeding women were excluded due to physiological changes that could influence physical activity and self-care behaviors.

2.2 Data Collection Tools

Data were collected using a structured questionnaire consisting of four sections: (1) Demographic and clinical information included age, gender, duration of diabetes, education level, BMI, and comorbidities; (2) physical activity level included assessed using the international physical activity questionnaire – Short Form (IPAQ-SF), which measures frequency and duration of walking, moderate, and vigorous activities over the past days; (3) time management included measured using the time management behavior scale (TMBS) developed by Macan (1994), which includes subscales such as goal setting, prioritization, and perceived control of time; (4) self-care behaviors included evaluated using the summary of diabetes self-care activities (SDSCA) scale developed by Toobert et al. (2000), covering domains such as diet, exercise, blood glucose monitoring, foot care, and medication adherence. All instruments used had been previously validated in similar populations and demonstrated acceptable reliability (Cronbach's alpha > 0.70) (13-15). We also conducted a comprehensive psychometric evaluation of the instruments within the current study population, including internal consistency analysis and expert validation procedures, to ensure that the tools were not only theoretically sound but also empirically robust in capturing the constructs of time management, physical activity, and self-care behaviors in individuals with type 2 diabetes. The Time Management Questionnaire demonstrated acceptable internal consistency with a Cronbach's alpha of 0.86. For the Self-Care Inventory, Cronbach's alpha was 0.88, and for the Physical Activity Scale, it was 0.89.

To assess physical activity, the validated short-form physical activity questionnaire was used, consisting of 7 items across four domains: work, transportation, household, and leisure-time activities. Participants reported the frequency and duration of activities in four intensity levels (sitting, walking, moderate, and vigorous). Energy expenditure was calculated using standardized MET values assigned to each activity type. Based on total weekly energy output, individuals were categorized into three levels: inactive, moderately active, and highly active, following established scoring criteria outlined in the questionnaire's analysis guide (12).

Time management was assessed using a validated 21-item questionnaire covering three core dimensions: activity planning (AP), activity monitoring (AM), and activity simplification (AS). Items were rated on a 5-point Likert scale ranging from 1 (very rarely) to 5 (very often). Composite scores for each dimension were summed to determine overall time management levels, categorized from "no time management" to "excellent (13).

Self-care behaviors were assessed using the 15-item Diabetes Self-Management Questionnaire (DSMQ), which includes four subscales: Glucose Management, Dietary Control, Physical Activity, and Healthcare Use. Responses were rated on a 4-point Likert scale, with higher scores indicating better self-care performance. One composite item was used to reflect overall self-care effectiveness. Negatively worded items were reverse-coded, and participants were classified into three categories—poor, moderate, and good self-care—based on total scores. The DSMQ has demonstrated strong psychometric properties and was applied in accordance with ethical standards (14).

All questionnaires were self-administered to ensure consistency across populations. In Iran, participants completed the surveys either in person or online, depending on accessibility. In Spain, data collection was conducted entirely online via Google Forms. To address language and translation concerns, the original questionnaires were professionally translated into Persian and Spanish using a forward–backward translation method. This process involved bilingual experts and independent reviewers to ensure semantic and conceptual equivalence across both languages. Minor cultural adaptations were also made to enhance clarity and relevance for each population. To minimize social desirability bias, all questionnaires were self-administered anonymously, and items were neutrally worded to encourage honest responses. Regarding missing data, incomplete questionnaires were excluded from analysis, and data screening procedures were applied to ensure the integrity of statistical results.

2.3 Data analysis

All statistical analyses were performed using SPSS version 22.0. Descriptive statistics, including mean and standard deviation, were calculated to summarize the primary variables—physical activity, time management, and self-care—for both Iranian and Spanish participants. The normality of data distribution was assessed using the Kolmogorov–Smirnov test. Variables that met the assumption of normality were included in subsequent parametric analyses. To examine differences across countries and genders simultaneously, a multivariate analysis of variance (MANOVA) was conducted using country (Iran vs. Spain), gender (male vs. female), and their interaction (country × gender) as fixed factors. Dependent variables included the three behavioral constructs (physical activity, time management, and self-care). Where significant multivariate effects were observed, follow-up univariate ANOVAs were conducted. Post hoc comparisons were performed using Bonferroni correction to identify pairwise differences among groups while controlling for Type I error. Effect sizes (partial eta squared) were reported to quantify the magnitude of differences. Pearson correlation analysis was used to evaluate the relationships between physical activity, time management, and self-care within each national cohort. Differences in correlation strengths between Iranian and Spanish populations were examined using Fisher's z transformation. Statistical significance was set at $p < 0.05$ for all tests, and 95% confidence intervals were reported where appropriate.

3. Results

All statistical analyses were performed using SPSS version 22.0. Descriptive statistics, including mean and standard deviation, were calculated to summarize the primary variables—physical activity, time management, and self-care—for both Iranian and Spanish participants. The normality of data distribution was assessed using the Kolmogorov–Smirnov test. Variables that met the assumption of normality were included in subsequent parametric analyses. To examine differences across countries and genders simultaneously, a multivariate analysis of variance (MANOVA) was conducted using country (Iran vs. Spain), gender (male vs. female), and their interaction (country × gender) as fixed factors. Dependent variables included the three behavioral constructs (physical activity, time management, and self-care). Where significant multivariate effects were observed, follow-up univariate ANOVAs were conducted. Post hoc comparisons were performed using Bonferroni correction to identify pairwise differences among groups while controlling for Type I error. Effect sizes (partial eta squared) were reported to quantify the magnitude of differences. Pearson correlation analysis was used to evaluate the relationships between physical activity, time management, and self-care within each national cohort. Differences in correlation strengths between Iranian and Spanish populations were examined using Fisher's z transformation. Statistical significance was set at $p < 0.05$ for all tests, and 95% confidence intervals were reported where appropriate.

Table 1. Participant's demographic, physical activity, time management, and self-care data in study multi-population.

Measure		Study Population Spain Female (n = 97)	Spain Male (n = 101)	Iran Female (n = 115)	Iran Male (n= 91)
		Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Demographic data	Age (year)	57.40 (1.28)	54.75 (1.37)	56.39 (1.13)	53.25 (1.41)
	Height (cm)	160.52 (6.92)€*	169.28 (10.88)¥#	161.05 (6.31)€*	172.35 (10.72)¥#
	Weight (cm)	72.35 (1.24)€	77.16 (1.33)	74.13 (1.11)€	81.37 (1.51)¥#
	BMI (cm)	27.62 (0.48)	26.54 (0.52)	28.06 (0.43)	26.98 (0.58)
Physical Activity	vigorous exercise day	0.75 (1.07)	1.34 (1.49)	0.60 (1.10)	1.26 (1.54)
	vigorous exercise min	34.02 (19.36)	58.31 (14.91)	29.24 (17.45)	53.51 (16.59)
	vigorous exercise met	6507.2 (1896.8)	13893.3 (2779.6)	6365.2 (1983.4)	13020.8 (2611.2)
	moderate exercise day	1.47 (1.66)	1.60 (1.88)¥	0.95 (1.59)*	1.00 (1.89)
	moderate exercise min	41.90 (18.40)	47.52 (18.43)	31.17 (12.34)	36.48 (17.60)
	moderate exercise met	5041.2 (1137.4)	6059.4 (1236.1)	3772.2 (931.34)	5547.3 (1546.8)
	light exercise day	2.16 (1.91)	3.10 (2.43)	2.82 (5.83)	2.85 (2.69)
	light exercise min	37.39 (6.27)	48.21 (8.10)	35.36 (8.96)	42.58 (9.47)
	light exercise met	4149.1 (620.1)*	7181.9 (843.4)#¥	4475.2 (661.3)*	6532.5 (819.8)
	Total met	15698.3 (2247.6)	27134.3 (3760.1)¥	14612.3 (2305.4)*	25100.3 (3822.3)
Time Management	plan creating	7.08 (2.15)	7.58 (2.07)€¥	6.40 (2.16)*	6.75 (2.04)*
	activities prioritizing	6.36 (2.31)	6.82 (2.38)¥	5.87 (2.24)*	6.26 (2.19)
	time allocating	8.68 (3.26)	9.46 (3.22)¥	8.23 (3.14)*	8.83 (3.16)
	goals defining	6.50 (2.17)	6.53 (2.28)	6.10 (2.16)	5.92 (2.40)
	activity planning	28.62 (7.90)	30.40 (7.65)¥	26.61 (7.75)*	27.78 (7.63)
	program instruction	3.88 (1.43)¥€	3.92 (1.37)¥€	3.28 (1.31)*#	3.19 (1.23)*#
	time allocate observing	11.06 (3.05)	11.59 (3.45)	10.54 (3.16)	10.93 (3.35)
	time redistributing	3.31 (1.53)	3.43 (1.50)¥	2.89 (1.41)*	3.12 (1.36)
	activity monitoring	18.26 (4.63)	18.95 (4.58)¥	16.73 (4.60)*	17.25 (4.28)
	activities accessing	4.98 (2.18)¥	5.29 (2.03)¥	4.19 (2.08)*#	4.74 (2.03)
	support requesting	6.02 (1.92)	5.91 (2.02)	5.39 (1.91)	5.28 (1.92)
	using opportunities	6.07 (2.49)	6.41 (2.29)¥	5.33 (2.37)*	5.83 (2.31)
	activity simplification	17.08 (4.19)¥	17.62 (4.18)¥€	14.97 (3.99)*#	15.86 (4.25)*
	Total Score	63.97 (14.43)¥	66.98 (13.78)¥€	58.32 (14.12)*#	60.90 (13.89)*
Self-Care	glucose management	7.43 (2.59)	8.29 (3.06)	6.99 (2.62)	7.58 (3.16)
	health care	5.84 (1.90)	6.27 (2.06)	5.19 (1.75)	5.65 (2.00)
	physical activity	1.59 (1.08)	1.53 (1.1)	0.93 (0.97)	0.86 (0.94)
	dietary control	3.55 (1.52)	3.69 (1.70)	3.09 (1.55)	3.12 (1.75)
	diabetes self-care	2.52 (1.10)	2.53 (1.15)	1.86 (0.95)	1.80 (1.01)
	Total score	20.95 (5.00)	22.33 (5.57)	18.06 (4.91)	19.01 (5.67)

Notes: the sign [#] represents statistically significant changes to Spain female. The sign [*] represents statistically significant changes to Spain male. The sign [¥] represents statistically significant changes to Iran female and the sign [€] represents statistically significant changes to Iran male populations.

No statistically significant differences were observed between males and females from both populations in terms of vigorous physical activity, including frequency (days/week), duration (minutes/day), and MET intensity ($p > 0.05$). However, Iranian females engaged in moderate physical activity on fewer days, for shorter durations, and at lower MET levels compared to the other three groups. Additionally, for light physical activity, both Iranian and Spanish females demonstrated lower engagement across all three dimensions—frequency, duration, and MET intensity—when compared to their male counterparts ($p < 0.05$). Overall, total MET scores for physical activity were lower among females from both populations compared to their male counterparts. However, a statistically significant difference was observed only between Iranian females and Spanish males ($p < 0.05$), indicating a notable disparity in physical activity intensity across these specific populations.

Among the three dimensions of time management, activity planning emerged as a key differentiator across groups. Spanish males demonstrated the highest scores in this domain, with statistically significant differences observed only in comparison to Iranian females ($p < 0.05$). Subcomponent analysis of activity planning including plan creating, activities prioritizing, time allocating, and goals defining revealed nuanced patterns. Spanish males scored significantly higher in plan creation compared to both Iranian females and Spanish males ($p < 0.05$), suggesting a distinct strength in structuring daily routines. In the areas of activities prioritization and time allocation, Spanish males also outperformed Iranian females ($p < 0.05$). However, no significant differences were found among any groups in the goals defining subcomponent ($p > 0.05$), indicating a shared baseline in strategic intent across populations. Within the activity monitoring domain, Spanish males exhibited significantly higher scores compared to Iranian females ($p < 0.05$). Subcomponent analysis revealed that in the program instruction item, both Spanish males and females outperformed Iranian males and females, with statistically significant differences across all comparisons ($p < 0.01$). In the time redistributing item, a significant difference was observed exclusively between Spanish males and Iranian females ($p < 0.05$). However, no significant differences were found among any groups in the time allocate observing item ($p > 0.05$), indicating a consistent baseline across populations in this subdomain. In the domain of activity simplification, Spanish males scored significantly higher than both Iranian males and females ($p < 0.05$), while Spanish females showed a significant differences only over Iranian females ($p < 0.05$). Subcomponent analysis revealed that in the activities accessing item, both Spanish males and females outperformed Iranian females ($p < 0.05$), indicating greater ease and initiative in engaging with structured activities. In the using opportunities item, Spanish males demonstrated significantly higher scores compared to Iranian females ($p < 0.05$), suggesting a gendered disparity in leveraging available time or resources. No statistically significant differences were observed among any groups in the support requesting item ($p > 0.05$), indicating a shared baseline in seeking assistance or external input across populations. Overall, time management total scores revealed significant group-level differences. Spanish males demonstrated notably higher scores compared to both Iranian males and females ($p < 0.05$), indicating superior proficiency in organizing and allocating time-related tasks. Spanish females also outperformed Iranian females ($p < 0.05$), though no significant differences were observed between Spanish females and Iranian males. These findings suggest a gendered and cultural gradient in time management capabilities, particularly favoring Spanish participants.

Analysis of self-care indicators revealed no statistically significant differences across any of the measured items—including components such as glucose management, health care, physical activity, dietary control, and diabetes self-care—between male and female participants from either population. These findings suggest a consistent pattern of self-care behaviors across gender and cultural groups, with no observable disparities in engagement or performance within the assessed dimensions ($p > 0.05$).

Table 2. Results of the mixed model ANOVAs for effects of gender (male and female) and age (30-60 years and above 60 year) on physical activity Met, time management and self-care. Significant items are marked in bold.

Statically interaction effect					Statically difference (P-value)				
Measure	Source	F	*p-value*	partial eta^2		Spain female	Spain male	Iran female	Iran male
Physical Activity Met	gender	5.45	0.005	0.27	Spain female	NA	0.05	0.85	0.22
	age	4.72	0.009	0.23	Spain male	0.05	NA	0.01	0.89
	gender× age	0.35	0.70	0.002	Iran female	0.85	0.01	NA	0.09
					Iran male	0.22	0.89	0.09	NA
Time Management	gender	3.94	0.04	0.28	Spain female	NA	0.80	0.02	0.80
	age	0.29	0.74	0.01	Spain male	0/80	NA	0.001	0.01
	gender× age	0.004	0.99	0.001	Iran female	0.02	0.001	NA	0.88
					Iran male	0.80	0.01	0.88	NA
Self-Care	gender	2.95	0.05	0.15	Spain female	NA	0.40	0.09	0.07
	age	1.21	0.29	0.08	Spain male	0.40	NA	0.11	0.15
	gender× age	1.32	0.26	0.06	Iran female	0.09	0.11	NA	0.92
					Iran male	0.07	0.15	0.92	NA

Age-based comparisons of vigorous physical activity revealed significant group-level differences. Spanish participants aged 30–60 engaged in vigorous exercise on more days per week than both Spanish and Iranian individuals over the age of 60 ($p < 0.05$). Additionally, Spanish seniors and Iranian adults aged 30–60 demonstrated significantly higher frequencies of vigorous activity compared to Iranian seniors ($p < 0.05$), suggesting age and cultural factors may influence exercise engagement in older populations. Daily duration of vigorous physical activity varied significantly across age groups and populations. Both Spanish and Iranian participants over the age of 60 reported significantly fewer minutes of vigorous exercise per day compared to Spanish adults aged 30–60 ($p < 0.05$). Additionally, total MET scores for vigorous activity showed a statistically significant difference only between Spanish adults (30–60 years) and Iranian seniors ($p < 0.05$), highlighting a pronounced disparity in exercise intensity among older Iranian individuals.

Table 3. Participant's physical activity data in study multi-population according to age category.

Measure		Study Population Spain 30-60 years (n = 123)	Spain ≥60 year (n = 75)	Iran 30-60 years (n = 137)	Iran ≥60 year (n= 69)
		Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Physical Activity	vigorous exercise $_{day}$	1.29 (1.38)*€	0.66 (1.15)#€	1.09 (1.42)€	0.50 (1.10)#¥
	vigorous exercise $_{min}$	56.17 (17.30)€	30.40 (16.32)#	50.24 (15.74)	19.56 (8.76)#
	vigorous exercise $_{met}$	12676.2 (2634.8)€	6336.2 (1942.2)	11766.3 (2623.6)	4417.4 (1348.6)#
	moderate exercise $_{day}$	1.77 (1.90)€	1.16 (1.47)	1.21 (1.89)€	0.49 (1.19)#¥
	moderate exercise $_{min}$	51.82 (19.20)€	33.20 (14.13)	41.93 (14.64)€	16.81 (19.27)#¥
	moderate exercise $_{met}$	6941.2 (1375.6)€	3296.2 (739.2)	5636.5 (1256.7)	2411.6 (1189.7)#
	light exercise $_{day}$	2.51 (2.17)	2.86 (2.34)	2.92 (5.47)	2.66 (2.61)
	light exercise $_{min}$	45.26 (15.88)	39.06 (17.63)	42.78 (18.17)	30.14 (12.78)
	light exercise $_{met}$	5949.7 (799.9)	5280.2 (681.2)	5911.2 (805.5)	4336.8 (583.1)
	Total $_{met}$	25568.3 (3348.9)€	14912.3 (2707.1)	23314.3 (3285.7)€	11166.3(2545.8)#¥

Measure		Statically difference (P-value)	Spain 30-60	Spain ≥60	Iran 30-60	Iran ≥60
	vigorous exercise $_{met}$	Spain 30-60	NA	0.38	0.95	0.04
		Spain ≥60	0.38	NA	0.64	0.92
		Iran 30-60	0.95	0.64	NA	0.20
		Iran ≥60	0.04	0.92	0.20	NA
	moderate exercise $_{met}$	Spain 30-60	NA	0.23	0.95	0.01
		Spain ≥60	0/23	NA	0.89	0.91
		Iran 30-60	0.95	0.89	NA	0.42
		Iran ≥60	0.01	0.91	0.42	NA
	light exercise $_{met}$	Spain 30-60	NA	0.75	0.88	0.12
		Spain ≥60	0.75	NA	0.73	0.82
		Iran 30-60	0.88	0.73	NA	0.92
		Iran ≥60	0.12	0.82	0.92	NA
	Total Physical Activity $_{met}$	Spain 30-60	NA	0.11	0.86	0.01
		Spain ≥60	0.11	NA	0.35	0.85
		Iran 30-60	0.86	0.35	NA	0.04
		Iran ≥60	0.01	0.85	0.04	NA

Notes: the sign [#] represents statistically significant changes to Spain 30-60 years. The sign [*] represents statistically significant changes to Spain above 60 years. The sign [¥] represents statistically significant changes to Iran 30-60 years and the sign [€] represents statistically significant changes to Iran above 60 year populations.

Comparative analysis of moderate-intensity physical activity revealed age-related disparities across populations. Participants aged 30–60 from both Spain and Iran engaged in moderate exercise on significantly more days and for longer daily durations compared to Iranian individuals over 60 years of age ($p < 0.05$). However, when examining total MET scores for moderate activity, only Spanish adults (30–60 years) demonstrated a statistically significant advantage over Iranian seniors ($p < 0.05$), suggesting a sharper decline in exercise intensity among older Iranian participants. No significant difference was observed in the number of days or minutes of light-intensity physical activity among the specified age groups when comparing Iran and Spain. However, in the comparison of total physical activity levels across age groups, individuals aged 30 to 60 years in both Spain and Iran demonstrated significantly higher levels of physical activity compared to Iranian individuals aged over 60 years.

The comparative analysis of physical activity levels—vigorous, moderate, and light—revealed that light-intensity exercise was widely practiced in both Iran and Spain. This consistent engagement across populations highlights the universal accessibility and popularity of light physical activity, suggesting its role as a common and inclusive form of exercise for diverse age groups.

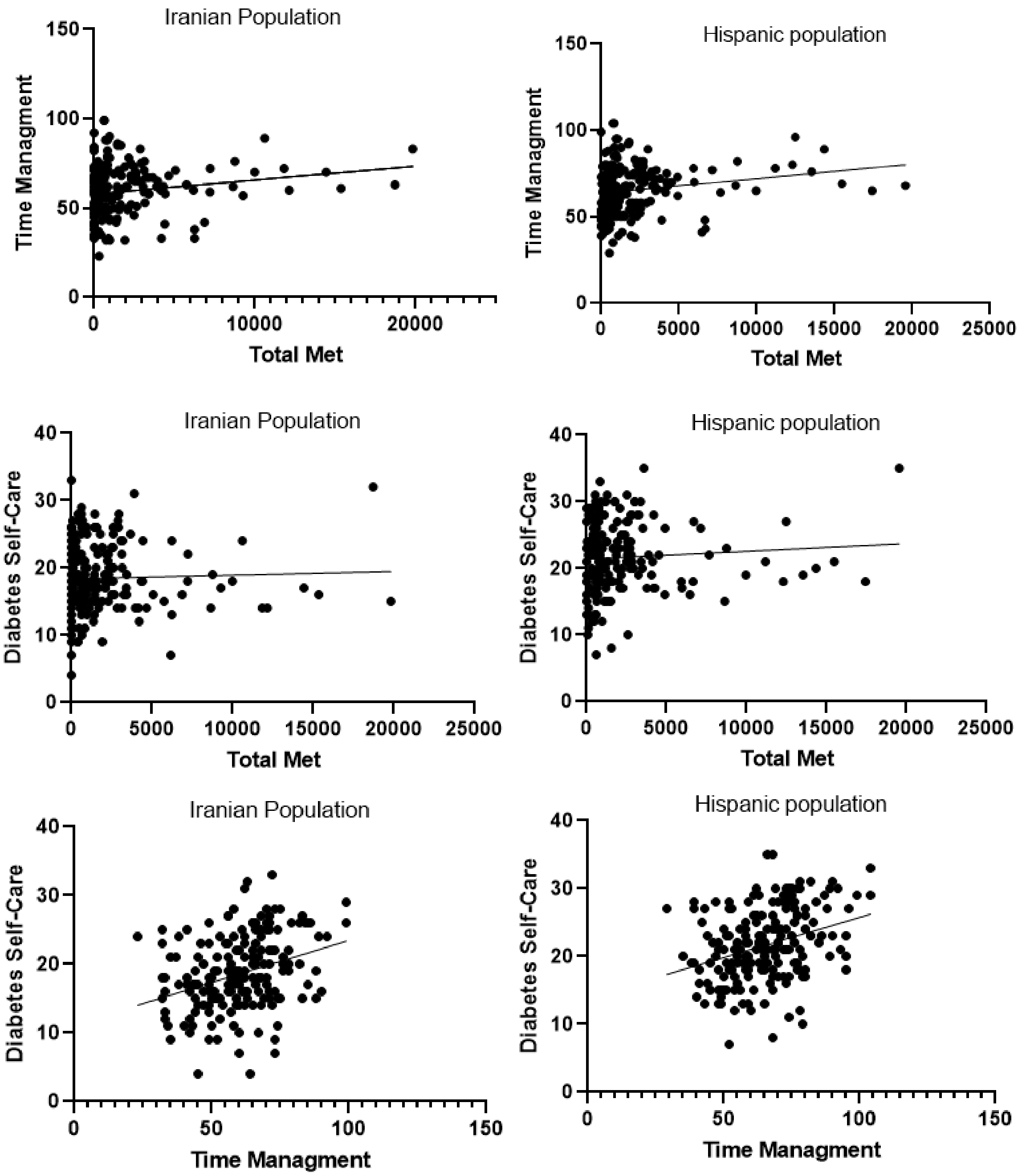

Figure 1. Correlation between physical activity, time management, and self-care practices in the study populations

Total physical activity Met in Spanish participants showed a significant positive correlation with their overall time management score (r= 0.18; p=0.009). Additionally, total physical activity Met in Spanish individuals presented a non-significant positive correlation with the self-care index (r= 0.06; p=0.33). However, a significant positive correlation was observed between total time management score and self-care index in the Spanish sample (r= 0.31; p=0.001). In the Iranian population, total physical activity Met exhibited a significant positive correlation with overall time management score (r= 0.17; p=0.01). Additionally, total physical activity Met showed a non-significant positive correlation with the self-care index (r= 0.03; p=0.64). Furthermore, total time management score was significantly positively correlated with the self-care index within this population (r= 0.32; p=0.001).

4. Discussion and Conclusion

This study compared physical activity, time management, and self-care factors across Spanish and Iranian individuals with type 2 diabetes. The main hypothesis of this study was that there is a significant difference between the populations of Spain and Iran in time management, physical activity, and diabetic self-care indicators, which is confirmed according to the results of this study. While demographic variables were largely comparable, gender and age played crucial roles in shaping behavioral patterns. Females in both cohorts engaged in significantly less physical activity across all intensities, with Iranian females showing the lowest scores overall. Spanish males demonstrated consistently superior time management performance, particularly in activity planning and simplification dimensions. Differences in self-care behaviors were not statistically significant across gender or geography, indicating a shared baseline of disease management practices. Age-stratified comparisons revealed that individuals aged 30–60 in both countries participated more frequently and intensively in physical activity than older adults, with the sharpest decline observed among Iranian seniors. Light-intensity exercise emerged as a universally popular mode of activity across all individuals.
Correlation analyses showed that physical activity was significantly positively associated with time management in both populations, but its relationship with self-care was weak and non-significant. However, time management was strongly and significantly correlated with self-care behaviors, underscoring its potential as a central pillar for improving diabetes-related outcomes in both cultural contexts.

The present study revealed significant relationship between physical activity levels, time management, and self-care practices among individuals with type 2 diabetes in Spain and Iran. These findings align with several previous studies emphasizing the beneficial role of structured time use and physical activity in chronic disease management. For instance, Indreica et al. (2022) report strong correlations between time management, physical activity, and dietary adherence in Spanish and Romanian students, reinforcing the importance of time structure in health-related behaviors (13). Similarly, Narayanan et al. (2025) reported that integrated time management and physical activity routines improved psychological well-being and life satisfaction (15). Yan et al. (2024) showed that age-specific variations in physical activity influenced mental health outcomes among adolescents, which resonates with our age-stratified results (16). Altunalan et al. (2024) linked physical activity frequency to improved sleep quality, indirectly supporting the value of self-care habits (17). Moreover, Bailey et al. (2024) emphasized the timing of physical activity—particularly morning routines—as a critical factor in reducing cardio metabolic risks, reflecting the time-sensitive nature of our findings. Conversely, other studies have presented differing perspectives (18). Domínguez-Amorós and Aparicio-Chueca (2020), in their analysis of Eurobarometer data, concluded that personal motivation outweighed time allocation in determining physical activity engagement, challenging our emphasis on time management (19). Kundakcı et al. (2024) indicated that psychological and social barriers played more dominant roles than organizational skills in physical activity adherence among Turkish university students (20). Zhang et al. (2024) argued that procrastination and motivational dynamics were stronger predictors of physical activity than time control strategies (21). Terzi et al. (2024) report that leisure satisfaction was a more significant contributor to quality of life than structured time use, introducing an alternative framework to understanding behavioral outcomes (22). Healy et al. (2024), through the EXPERT model, questioned the simplicity of associating “lack of time” with poor activity levels, advocating for deeper, multifaceted approaches to time perception (23). Overall, while the present findings are supported by a substantial body of literature, conflicting studies highlight the complexity of behavior change in chronic conditions. These discrepancies underscore the need for multifactorial models that integrate psychological, social, and cultural variables to explain individual differences in physical activity and time management practices.

The nuanced associations observed between physical activity, time management, and self-care behaviors suggest a complex web of behavioral determinants that are both culturally and psychologically modulated (24). These constructs—often studied separately—require a unified lens to explain interdependent patterns of chronic disease management (25). The absence of significant linkage between physical activity and self-care underscores the potential involvement of mediating psychological factors such as self-perception and identity reinforcement (26). For example, individuals may engage in exercise for aesthetic or emotional benefits without translating those efforts into disease-specific regimens (27). Interestingly, time management exhibited a strong correlation with self-care outcomes, suggesting it may serve as a foundational behavioral domain from which other habits stem (28). Efficient time planning has previously been associated with increased autonomy in medication routines and dietary tracking among diabetic adults (29).

The gender disparities observed—particularly the reduced activity levels among Iranian women—may be influenced by social constructs surrounding female mobility, public visibility, and time entitlement in collectivist cultures (30). Studies have shown that sociocultural constraints often limit not only physical space but also temporal agency for women, directly impacting their capacity to plan and engage in health routines (31). Age-related differences, including the sharp decline in physical activity among Iranian seniors, resonate with broader gerontological research indicating that environmental accessibility, physical limitations, and perceived futility serve as primary deterrents for older adults (32). This pattern is not unique to Iran but reflects a global aging challenge where structured interventions are rarely tailored to age-related transitions in lifestyle (33).

Further examination reveals that self-care practices are frequently disrupted by inconsistent daily routines, often exacerbated by work-life imbalance and digital distractions (34). This supports the proposition that time management is not merely an organizational tool but a stress-buffering mechanism in chronic illness contexts (35). Though scheduling discipline improves self-care, it may not suffice unless coupled with intrinsic motivation and emotional regulation strategies (36). Behavioral activation theories posit that long-term health adherence hinges on goal salience and affective engagement rather than routine alone (37). Moreover, digital solutions like wearable devices and time-aware health apps have shown promise in synchronizing daily activities with health goals, especially among tech-literate populations (38). However, digital dependency may exclude vulnerable groups with limited access or literacy, requiring hybrid models that combine tech with human-led counseling (39).

Our cross-cultural comparisons reveal both divergence and convergence. While Spanish participants demonstrated more structured time usage, Iranian participants displayed comparable self-care indicators, suggesting cultural adaptation of health behaviors despite infrastructural limitations (40). These findings contribute to the growing field of culturally contextualized health psychology, advocating for models that factor in local belief systems, norms, and behavioral incentives (41). In addition, psychosocial factors like perceived control, future orientation, and interpersonal support networks emerged as latent variables mediating the relationship among the three core behaviors studied (42). Literature increasingly favors multifactorial frameworks such as the Health Action Process Approach (HAPA), which integrates intention formation, planning, and maintenance constructs (43). One theoretical insight worth considering is the "Behavioral Cascade Hypothesis"—the idea that once a primary habit (e.g., time structure) is cultivated, it initiates downstream effects across other behavioral domains through increased cognitive bandwidth and reduced executive fatigue (44). Our data supports this hypothesis, showing robust indirect effects of time management on dietary adherence and medical tracking. At the policy level, results advocate for health promotion strategies emphasizing behavioral scaffolding—where individuals receive sequential coaching to develop foundational habits before attempting higher-order self-care tasks (45). This approach aligns with the principles of the COM-B model, where Capability, Opportunity, and Motivation combine to facilitate Behavior change (46).

Lastly, limitations must be acknowledged. The cross-sectional nature of this study prevents causal inference, and further longitudinal work is required to track behavioral evolution. Additionally, future studies may incorporate qualitative interviews to uncover latent cultural themes and emotional narratives not captured through standardized measures (47).

This study offers an integrative perspective on the behavioral dynamics of individuals with type 2 diabetes in Spain and Iran, examining the relationships among physical activity, time management, and self-care practices. Findings revealed that while physical activity correlated strongly with time management, its association with self-care was weak, highlighting the presence of intervening psychological factors. Time management, however, emerged as a consistent predictor of self-care across both populations, reinforcing its role as a foundational pillar in chronic disease regulation. Age and gender further influenced these behaviors, with older adults—particularly Iranian seniors—exhibiting reduced activity levels, and Iranian females showing the lowest scores overall. These differences underscore the necessity of culturally responsive interventions that address societal norms, age-related barriers, and health literacy. Moreover, the study emphasizes the concept of behavioral synergy, wherein structured time use facilitates broader health-promoting routines. Such interdependence supports multifactorial models of lifestyle intervention that move beyond isolated habit changes. Integrating digital tools, personalized planning, and culturally sensitive counseling can bridge gaps between intention and action.

To reinforce the study's implications and align with best practices in diabetes care, the integration of culturally responsive strategies is recommended. In Iran, community health workshops tailored to local customs and delivered in native languages have proven effective—particularly among older women with lower health literacy. In Spain, region-specific dietary counseling, such as promoting Mediterranean-style meal planning, supports better adherence to nutritional guidelines. These culturally grounded approaches exemplify how personal relevance and cultural sensitivity can bridge the gap between health intentions and sustained behavioral change. In sum, the research contributes to the growing literature on behavioral health in diabetes management, proposing that time-centered strategies—when aligned with motivation, identity, and emotional support—hold transformative potential for improving outcomes.

Authors' Contributions

MS and HN conceived the study design and analyzed the data. SA conducted the experiments and interpreted the data. SA wrote the initial manuscript drafts. HN and AA performed critical editing and writing. All authors approved the final version of the manuscript.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethical Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants. Prior to participation, all subjects in this study signed an informed consent document approved by the Ethical Committee of the Mohaghegh Ardabili University (Approval Code: IR.UMA.REC.1401.072).

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