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Research Article

Clinical and Sociodemographic Barriers to Medication Adherence in Patients with Diabetes: A Cross-Sectional Study in Greece

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Abstract

Background and objective: An interesting issue that needs to be investigated is the effect of physical and mental fatigue on medication adherence in patients with diabetes mellitus. The study aimed to investigate physical and mental fatigue in patients with diabetes mellitus and its relation to medication intake.

Methods: Participants were approached in person at the clinics of the municipality of Drama and in the association of individuals with disabilities of Drama. The data collection tool used in the study was the questionnaire, which included questions regarding the general characteristics of the participants, the fatigue assessment questionnaire - Fatigue Assessment Scale (FAS), and the Self-Efficacy for Appropriate Medication Use Scale (SEAMS). The data collected using the questionnaire were processed and statistically analyzed with the statistical package IBM SPSS Statistics, version 21.

Results: In the sample of patients with diabetes mellitus in the present study, physical fatigue levels were moderate, mental fatigue levels were low (below average), and overall fatigue levels were moderate, while the prevalence of fatigue was very high (75.5%). In addition, higher levels of physical fatigue were also associated with significantly lower levels of self-efficacy for proper medication intake in patients with diabetes mellitus, and vice versa; patients without fatigue were associated with the highest mean levels of self-efficacy for proper medication intake.

Conclusion: There is a moderate association between physical and mental fatigue in patients with diabetes mellitus and its effect on medication intake.

Keywords: diabetes mellitus, physical fatigue, mental fatigue, self-efficacy, medication, adherence

Abbreviations: FAS: Fatigue Assessment Scale, SEAMS: Self-Efficacy for Appropriate Medication Use Scale, SRF-S: Self-Regulatory Fatigue Scale

1. Introduction

Diabetes mellitus is a progressive metabolic disorder that interferes with the human body's ability to process and absorb glucose and is currently a significant public health burden [1, 2]. It is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both, the two most common types of diabetes being type I diabetes mellitus and type II diabetes mellitus [3–5].

Self-management is the cornerstone of the overall management of diabetes mellitus and aims for blood glucose levels close to normal in order to reduce the risk of acute blood glucose levels and prevent long-term complications of diabetes [6]. Therefore, continuous self-regulation of blood glucose levels by patients themselves is required, while, at the same time, patients with diabetes mellitus are asked to strictly follow specific instructions, which are mostly related to their diet and physical activity [5, 6].

Although chronic fatigue is a common phenomenon among the general population, patients with diabetes mellitus constitute a subpopulation with a higher probability of experiencing fatigue, tending to present a 2-fold higher frequency of complaints of fatigue compared to individuals without diabetes mellitus [7]. Fatigue, whether physical or mental exhaustion, has

been recognized for many years as one of the most frequent and bothersome complaints of patients with diabetes mellitus [8].

Many social, psychological, and physiological factors influence the development and progression of fatigue, while, at the same time, fatigue itself, physical or mental, can also influence a variety of factors [8]. Among the problems caused in particular by fatigue, whether physical or mental, in patients with diabetes are the lack of sufficient concentration, motivation, and energy, as well as the failure to comply with medical instructions and health recommendations due to the lack of willingness to participate in education programs and the necessary participation in self-care programs [7].

Laranjo et al. [9] conducted a study to assess patients' perceived expectations, barriers and facilitators regarding self-management of type 2 diabetes. The study involved patients with type 2 diabetes who were approached by an outpatient clinic in Portugal, and 3 main issues emerged: glycemic control, physical activity and diet. Difficulties in changing dietary habits were distinguished in 4 main categories: diet plan, food quantity, food quality, and dietary decision-making [9]. Barriers related to physical activity included fatigue, comorbidities, muscle and joint pain, and decision-making. Therefore, fatigue is a significant barrier to patient compliance with physical exercise included in their treatment; however, it did not appear to be a barrier to patient compliance with their diet or glycemic control [9].

The main purpose of the cross-sectional, descriptive study by Park et al. [10] was to assess the mediating effect of diabetes characteristics, such as diabetes symptoms, depression, and diabetes distress, on the relationship between glucose control and fatigue among patients with type 2 diabetes. In patients with A1C levels less than or equal to 7%, fatigue was significantly associated with diabetes symptoms and diabetes distress, but not with glucose levels, either directly or indirectly [10]. In contrast, in patients with A1C levels higher than 7%, fatigue was indirectly associated with glucose levels, and this relationship was mediated by depression, diabetes symptoms, and diabetes distress. Therefore, fatigue is indirectly associated with glycemic control but only in patients with high A1C levels [10].

In the cross-sectional study by Zhao et al. [11], it was examined whether adequate diabetes-related self-care activities are associated with fatigue, anxiety, and perceived stress among patients with type 2 diabetes. This study was conducted in China on a total of 251 patients with type 2 diabetes and showed low levels of anxiety and moderate levels of fatigue, stress, and self-care activities among these patients [11]. High levels of diabetes-related self-care activities, which were found to be influenced by diabetes education, diabetes duration, and high social support, were not significantly associated with fatigue and anxiety, but can reduce perceived stress. Therefore, type 2 diabetes self-care is not significantly associated with fatigue in patients with type 2 diabetes [11].

The cross-sectional association study by Kuo et al. [12] was conducted to examine the relationship between fatigue, factors affecting fatigue, and diabetes self-management, as well as the mediating effect of fatigue on the association between factors and diabetes self-management among adults with type 2 diabetes in Taiwan. Through convenience sampling, 150 patients with type 2 diabetes were recruited, in whom fatigue was assessed with the "Multidimensional Fatigue Inventory" and "Fatigue Symptom Inventory" tools and diabetes self-management with the "Summary of Diabetes Self-Care Activities" tool [12]. Based on the findings, higher levels of fatigue were significantly associated with poorer sleep quality, more depressive symptoms, and a more recent diagnosis of diabetes, while it was also significantly associated with poorer performance in diabetes self-management. In addition, fatigue appeared to mediate the relationship between depressive symptoms, sleep quality, and diabetes self-management. Thus, fatigue may affect diabetes self-management both directly and indirectly, through its mediation of the relationship between psychological factors and diabetes self-management [12].

Wang et al. [13] conducted a cross-sectional study to examine the interaction between self-regulated fatigue, social support, and health-promoting behaviors among patients with type II diabetes mellitus. Fatigue was assessed using the Self-Regulatory Fatigue Scale (SRF-S) tool, and the participants were a total of 316 patients with type II diabetes. According to the findings of this study, social support in patients with type II diabetes mellitus positively predicted health-promoting behaviors, and the main regression coefficients of self-regulated fatigue in these patients were social support and health-promoting behaviors, factors that both showed significant differences. Self-regulated fatigue was found to mediate the relationship between social support and health-promoting behaviors in these patients, with a total effect of 29.28%. Therefore, a significant interaction is observed between self-regulated fatigue, social support, and health-promoting behaviors in patients with type 2 diabetes [13].

The main purpose of this research is to study the physical and mental fatigue of patients with diabetes mellitus and its effect on medication intake.

The specific objectives of this research are as follows:

1) The assessment of physical and mental fatigue in patients with diabetes mellitus.
2) The assessment of self-efficacy in terms of compliance in taking medication in patients with diabetes mellitus.
3) The assessment of the effect of physical and mental fatigue on the self-efficacy of patients

with diabetes mellitus in terms of taking medication.

4) The assessment of the effect of general data (gender, age group, etc.) on the self-efficacy of patients in terms of taking medication.

2. Methods

Participants were approached in person at the clinics of the municipality of Drama and in the association of individuals with disabilities of Drama. Before visiting the above points, communication and verbal and written consent of the responsible persons were obtained. The sampling that was applied was convenience sampling, and the criteria for entry into the study were (1) age over 18 years and (2) diabetes mellitus (regardless of type), while there was no additional exclusion criterion other than age under 18 years and the absence of diabetes mellitus. A total of 90 participants were gathered, while approximately 5% of the individuals initially approached refused to answer, citing lack of time. All participants, when receiving the printed questionnaire, received verbal information about the research topic and the context in which it was conducted, while at the same time they were encouraged to raise any questions they had. The distribution of the questionnaires began in early December 2024 and was completed in late January 2025. Questionnaires were self-administered. This research had the approval of the directors of the public units (approval numbers 916/20.1.2025, 7/30.1.2025). Helsinki Declaration has been followed to involve human subjects in the study.

The data collection tool used in the study was a questionnaire. The questionnaire included questions about the general characteristics of the participants, the Fatigue Assessment Scale (FAS), and the Self-Efficacy for Appropriate Medication Use Scale (SEAMS).

The FAS is a tool for assessing perceived fatigue that includes 10 Likert-type scale questions with 5 possible answers: never, sometimes, regularly, often, always. The total score of the 2 main areas of the tool (physical and mental fatigue) is obtained by summing all the questions and can take values from 10 to 50, with the highest value corresponding to higher levels of fatigue and vice versa [14]. Based on this total score, patients can be distinguished into "patients without fatigue" when the score is less than 22, into "patients with fatigue" when the score is greater than 22, and into "patients with excessive fatigue" when the score is higher than or equal to 35 [15]. Regarding the areas of this scale, the 5 questions of the questionnaire are related to physical fatigue and the other 5 questions to mental fatigue [14]. The FAS tool has been used in many studies in the Greek population, such as in patients with chronic diseases, in patients with rheumatoid arthritis and osteoarthritis, and in patients undergoing hemodialysis, with very good reliability [16]. Its completion in just a few minutes makes this questionnaire a useful tool that can be used by nursing and medical staff to assess fatigue levels [14].

The SEAMS questionnaire is a valid and reliable, short tool that assesses patients' self-efficacy for medication use. This questionnaire includes 16 questions on a three-point Likert scale that indicate the degree of self-confidence of individuals regarding the correct administration of medications: not at all confident, somewhat confident, and very confident [17]. The SEAMS questionnaire was translated and standardized in Greek by Theofilou [18], where it was found to have high validity and reliability, and the total self-efficacy score is obtained from the sum of the questions, with the lowest possible score being 16 and the highest possible score being 48. Higher values indicate higher self-confidence regarding the correct administration of medication [18].

The data collected using a questionnaire were processed and statistically analyzed with the statistical package IBM SPSS Statistics, version 21. Statistical analysis was divided into descriptive and inferential. In the descriptive analysis, frequencies and percentages were estimated, as well as range, minimum value, maximum value, mean value, and standard deviation. In the inferential analysis, regression analysis, t-test for independent samples, one-way ANOVA, and Spearman correlation were used. The results of the inferential statistical analysis were evaluated at a 95% confidence interval (p value < 0.05).

3. Results

Cronbach's alpha was conducted for FAS and SEAMS scales. The results indicated a very good level of reliability for both questionnaires. In particular, physical fatigue presented 0.860, mental fatigue 0.889, and total fatigue 0.854. Moreover, SEAMS items presented values ranging from 0.835 to 0.853.

Regarding the effect size, Pearson correlation was conducted between the relevant variables. The results showed only negative associations, in particular -0.427 between physical fatigue and SEAMS, -0.272 between mental fatigue and SEAMS, and -0.377 between total fatigue and SEAMS.

In the first question of the general data of the questionnaire, participants were asked to state their gender. Based on the results, out of the total of 90 participants, approximately half (52.2%) were female, and 47.8% were male.

In the next question, the patients in the sample were asked to state their age based on specific groups, and approximately half of the participants (48.9%) belonged to the age group of 51 years and older, 35.6% of the patients with diabetes mellitus in the sample were between 31 and 50 years old, while 15.6% of the participants were between 18 and 30 years old.

When asked about their marital status, 37.8% of patients with diabetes mellitus who participated in the survey stated that they were married, 32.2% of patients were single, 18.9% were widowed, and 11.1% were divorced.

From the question regarding the participants' education, it emerged that most patients with diabetes in the sample (37.1%) had completed secondary education, 28.1% of the participants had completed tertiary education, 21.3% had completed primary education, while 13.5% of the patients had received a master's degree or doctorate.

In the next question of the questionnaire, respondents were asked to state the type of diabetes they were suffering from. According to the answers recorded, all participants were patients suffering from diabetes mellitus; however, 2/3 of them suffered from type 2 diabetes mellitus and 1/3 of them suffered from type 1 diabetes mellitus **(Table 1)**.

According to the answers recorded to the question regarding when the patients in the sample were diagnosed with diabetes mellitus, the patients participating in this study had been diagnosed with diabetes mellitus from less than a year ago to 50 years ago. The average time of diagnosis of diabetes in the entire sample was equal to 14.87 (±12.82) years **(Table 2)**.

In the last question, participants were asked to indicate the length of time they had been on treatment. Based on the results, treatment for diabetes mellitus in the sample ranged from less than a year to 47 years ago. The average time of treatment for diabetes mellitus in the entire sample was 14.43 (±12.23) years **(Table 3)**.

Overall, the physical fatigue score ranges from 7 to 22, with approximately half of the participants (51.1%) receiving values from 1 to 15, while the mean value of physical fatigue was 15.68 (±4.16). Given that the physical fatigue score is calculated based on 5 questions and can receive values from 5 to 25, it is concluded that the levels of physical fatigue were moderate in the sample of patients with diabetes mellitus in this study.

Correspondingly, the mental fatigue score ranges from 5 to 21, with approximately half of the participants (52.2%) receiving values from 5 to 21, while the mean value of mental fatigue was 12.18 (±3.82). Given that the mental fatigue score is calculated based on 5 questions and can take values from 5 to 25, it is concluded that the levels of mental fatigue were low (below average) in the sample of patients with diabetes mellitus in this study. Overall, the fatigue score was found to take values from 13 to 42, with approximately half of the participants (52.2%) taking values from 13 to 26, while the mean value of total fatigue was 27.86 (±7.47). Given that the fatigue score is calculated based on 10 questions and can take values from 10 to 50, it is concluded that the levels of overall fatigue were moderate in the sample of patients with diabetes mellitus in this study.

From the mapping of the total fatigue score to fatigue levels, half of the patients in the sample (54.4%) experienced fatigue, 24.4% of the patients did not experience fatigue, while 21.1% of the participants were categorized in the group of "patients with excessive fatigue" **(Table 4)**.

Overall, the score of the self-efficacy questionnaire for appropriate medication use ranges from 25 to 44, with approximately half of the participants (53.3%) receiving scores between 25 and 39, while the mean self-efficacy score for appropriate medication use was 38.41 (±5.12). Given that the self-efficacy score for appropriate medication use is calculated based on 16 questions and can range from 16 to 48, it can be concluded that the levels of self-efficacy for appropriate medication use in the sample of patients with diabetes mellitus in this study were relatively high **(Table 5)**.

Higher levels of physical fatigue were associated with lower levels of self-efficacy for taking medication correctly in patients with diabetes mellitus, and vice versa, and these relationships were statistically significant at a 95% confidence interval (p-value = 0.000 < 0.05). Similarly, higher levels of mental fatigue and higher levels of overall fatigue were associated with lower levels of self-efficacy for taking medication correctly in patients with diabetes mellitus, and these relationships were statistically significant at a 95% confidence interval (p-value = 0.010 < 0.05 and p-value = 0.000 < 0.05) **(Table 6)**.

Patients without fatigue were associated with the highest mean levels of self-efficacy for taking medications correctly, and these observed differences between patients with different levels of fatigue in levels of self-efficacy for taking medications correctly were statistically significant at a 95% confidence interval (p-value = 0.000 < 0.05) **(Table 7)**.

Female gender was associated with lower levels of mental fatigue, but with lower mean levels of self-efficacy for taking medication correctly, with higher levels of physical fatigue, and with higher levels of overall fatigue, compared to male gender. However, none of these observed differences between the two genders were statistically significant at a 95% confidence interval (p value > 0.05).

The older age group (51 years and older) was associated with the lowest mean levels of mental fatigue, the middle age group (31 to 50 years) was associated with the highest mean levels of self-efficacy for taking medications correctly and the highest mean levels of mental fatigue, while the younger age group (18 to 30 years) was associated with the highest mean levels of physical fatigue and the highest mean levels of overall fatigue. However, none of these observed differences between ages were statistically significant at a 95% confidence interval (p-value > 0.05).

Widowed patients with diabetes were associated with the highest mean levels of physical fatigue, the highest mean levels of mental fatigue, and the highest mean levels of total fatigue, while married patients with diabetes were associated with the highest mean levels of self-efficacy regarding the correct administration of medications. These observed differences between patients with diabetes with different marital status were statistically significant at a 95% confidence interval for physical fatigue (p-value = 0.023 < 0.05) and for the total fatigue score (p-value = 0.036 < 0.05) **(Table 8)**.

Patients with diabetes mellitus with lower levels of education (primary education) were associated with the highest mean levels of physical fatigue and the highest mean levels of overall fatigue, while patients with diabetes mellitus with higher levels of education (master's/doctoral) were associated with the highest mean levels of self-efficacy for taking medications correctly and the lowest mean levels of mental fatigue. These observed differences between patients with diabetes mellitus with different levels of education were statistically significant at a 95% confidence interval for physical fatigue (p-value = 0.029 < 0.05) **(Table 9)**.

Patients with type I diabetes mellitus were associated with lower mean levels of self-efficacy for taking medications correctly, higher mean levels of physical fatigue, higher mean levels of mental fatigue, and higher mean levels of total fatigue, compared to patients with type II diabetes mellitus. These observed differences between patients with different types of diabetes mellitus were statistically significant at a 95% confidence interval only for self-efficacy for taking medications correctly (p-value = 0.001 < 0.05), for physical fatigue (p-value = 0.003 < 0.05), for mental fatigue (p-value = 0.001 < 0.05), and for the total fatigue score (p-value = 0.001 < 0.05) **(Table 10)**.

The longer time since the diagnosis of diabetes mellitus for the patients in the sample was associated with higher levels of physical fatigue, mental fatigue and overall fatigue, but with lower levels of self-efficacy regarding the correct taking of medications, and vice versa. However, of these relationships, only the one between the time since the diagnosis of diabetes and the self-efficacy regarding the correct taking of medications was statistically significant at a 95% confidence interval (p-value = 0.024 < 0.05, Correlation coefficient = -0.237), according to which, patients who have more time since the diagnosis of diabetes have lower levels of self-efficacy regarding the correct taking of medications, and vice versa **(Table 11)**.

Patients without fatigue were associated with the lowest mean number of years since diagnosis with diabetes mellitus, compared to patients with fatigue and excessive fatigue who had a higher mean time since diagnosis of diabetes; however, these observed differences were not statistically significant at a 95% confidence interval (p-value = 0.387 > 0.05).

Longer duration of diabetes treatment was associated with higher levels of physical fatigue, mental fatigue, and overall fatigue, but with lower levels of self-efficacy for taking medications correctly, and vice versa. However, of these relationships, only the one between the duration of diabetes treatment and self-efficacy for taking medications correctly was statistically significant at a 95% confidence interval (p-value = 0.011 < 0.05, Correlation coefficient = -0.268), indicating that patients who are treated for diabetes for a longer period of time have lower levels of self-efficacy for taking medications correctly, and vice versa **(Table 12)**.

Patients without fatigue were associated with the lowest mean number of years of diabetes treatment, compared to patients with fatigue and excessive fatigue who had a higher mean time of diabetes treatment, however, these observed differences were not statistically significant at a 95% confidence interval (p-value = 0.466 > 0.05).

Finally, regression analysis was conducted indicating that physical fatigue (Beta -0.493), diabetes type (Beta 0.383), and duration of disease (Beta -0.260) were statistically significant prognostic factors of the SEAMS.

		Frequency	Percent	Valid percent	Cumulative percent
Valid	Type 1 diabetes mellitus	30	33,3	33,3	33,3
	Type 2 diabetes mellitus	60	66,7	66,7	100,0
	Total	90	100,0	100,0	

Table 1: Type of diabetes.

	N	Range	Minimum	Maximum	Mean	Std. deviation
I was diagnosed with diabetes mellitus before:	90	50	0	50	14,87	12,819
Valid N (listwise)	90					

Table 2: Years of diagnosis.

	N	Range	Minimum	Maximum	Mean	Std. Deviation
I have been undergoing treatment for diabetes mellitus here and:	90	47	0	47	14,43	12,232
Valid N (listwise)	90					

Table 3: Years of treatment.

		Frequency	Percent	Valid percent	Cumulative percent
Valid	Patients without fatigue	22	24,4	24,4	24,4
	Patients with fatigue	49	54,4	54,4	78,9
	Patients with excessive fatigue	19	21,1	21,1	100,0
	Total	90	100,0	100,0	

Table 4: Levels of fatigue.

	N	Range	Minimum	Maximum	Mean	Std. deviation
Self-efficacy of proper medication intake	90	19	25	44	38,41	5,123
Valid N (listwise)	90					

Table 5: Self-efficacy of proper medication intake.

		Physical fatigue	Mental fatigue	Total fatigue score
Self-efficacy of proper medication intake	Pearson correlation	-,427**	-,272**	-,377**
	Sig. (2-tailed)	,000	,010	,000
	N	90	90	90
**Correlation is significant at the 0.01 level (2-tailed).				

Table 6: Correlations among variables.

Self-efficacy of proper medication intake						
	N	Mean	Std. deviation	Std. Error	Minimum	Maximum
Patients without fatigue	22	40,09	2,991	,638	32	44
Patients with fatigue	49	39,18	5,044	,721	25	44
Patients with excessive fatigue	19	34,47	5,481	1,257	26	43
Total	90	38,41	5,123	,540	25	44

ANOVA					
Self-efficacy of proper medication intake					
	Sum of squares	df	Mean square	F	Sig.
Between groups	385,887	2	192,943	8,609	,000
Within groups	1949,902	87	22,413		
Total	2335,789	89			

Table 7: Self-efficacy of proper medication intake in different levels of fatigue.

		N	Mean	Std. deviation	Std. error	Minimum	Maximum
Self-efficacy of proper medication intake	Unmarried	29	38,00	3,937	,731	29	44
	Married	34	39,24	4,000	,686	29	44
	Divorced	10	36,00	8,718	2,757	25	44
	Widower(s)	17	38,88	6,123	1,485	26	44
	Total	90	38,41	5,123	,540	25	44
Physical fatigue	Unmarried	29	15,97	4,648	,863	7	22
	Married	34	14,62	3,758	,644	8	22
	Divorced	10	14,30	4,692	1,484	10	21
	Widower(s)	17	18,12	2,643	,641	14	22
	Total	90	15,68	4,162	,439	7	22

Mental fatigue	Unmarried	29	12,93	4,605	,855	6	21
	Married	34	10,88	3,812	,654	5	20
	Divorced	10	12,30	2,003	,633	9	16
	Widower(s)	17	13,41	2,373	,576	11	20
	Total	90	12,18	3,821	,403	5	21
Total fatigue score	Unmarried	29	28,90	8,902	1,653	13	42
	Married	34	25,50	6,990	1,199	13	42
	Divorced	10	26,60	6,132	1,939	19	37
	Widower(s)	17	31,53	4,502	1,092	25	40
	Total	90	27,86	7,465	,787	13	42

ANOVA						
		Sum of squares	**df**	**Mean square**	**F**	**Sig.**
Self-efficacy of proper medication intake	Between groups	89,907	3	29,969	1,148	,335
	Within groups	2245,882	86	26,115		
	Total	2335,789	89			
Physical fatigue	Between groups	160,796	3	53,599	3,338	,023
	Within groups	1380,860	86	16,057		
	Total	1541,656	89			
Mental fatigue	Between groups	99,546	3	33,182	2,379	,075
	Within groups	1199,609	86	13,949		
	Total	1299,156	89			
Total fatigue score	Between groups	465,297	3	155,099	2,968	,036
	Within groups	4493,825	86	52,254		
	Total	4959,122	89			

Table 8: Self-efficacy of proper medication intake and fatigue in different levels of marital status.

		N	**Mean**	**Std. deviation**	**Std. error**	**Minimum**	**Maximum**
Self-efficacy of proper medication intake	Primary	19	38,32	5,568	1,277	26	44
	Secondary	33	38,73	6,022	1,048	25	44
	Tertiary	25	37,64	4,405	,881	25	44
	Master's / PhD	12	39,67	2,934	,847	34	44
	Total	89	38,46	5,130	,544	25	44
Physical fatigue	Primary	19	17,58	3,271	,750	8	22
	Secondary	33	15,09	3,987	,694	8	22
	Tertiary	25	16,24	4,585	,917	7	22
	Master's / PhD	12	13,33	3,985	1,150	9	21
	Total	89	15,71	4,176	,443	7	22
Mental fatigue	Primary	19	13,00	3,367	,772	5	20
	Secondary	33	11,36	2,498	,435	7	18
	Tertiary	25	13,24	5,532	1,106	6	21
	Master's / PhD	12	11,08	2,678	,773	8	16
	Total	89	12,20	3,835	,407	5	21
Total fatigue score	Primary	19	30,58	6,345	1,456	13	40
	Secondary	33	26,45	5,969	1,039	16	39
	Tertiary	25	29,48	9,666	1,933	13	42
	Master's / PhD	12	24,42	6,142	1,773	17	35
	Total	89	27,91	7,489	,794	13	42

ANOVA						
		Sum of squares	**df**	**Mean square**	**F**	**Sig.**
Self-efficacy of proper medication intake	Between groups	37,035	3	12,345	,460	,711
	Within groups	2279,077	85	26,813		
	Total	2316,112	88			
Physical fatigue	Between groups	153,819	3	51,273	3,157	,029
	Within groups	1380,586	85	16,242		
	Total	1534,404	88			

Mental fatigue	Between groups	77,247	3	25,749	1,798	,154
	Within groups	1217,113	85	14,319		
	Total	1294,360	88			
Total fatigue score	Between groups	413,311	3	137,770	2,590	,058
	Within groups	4521,970	85	53,200		
	Total	4935,281	88			

Table 9: Self-efficacy of proper medication intake and fatigue in different levels of education.

	I am a patient:	N	Mean	Std. deviation	Std. error mean
Self-efficacy of proper medication intake	Type 1 diabetes mellitus	30	35,93	4,806	,877
	Type 2 diabetes mellitus	60	39,65	4,853	,627
Physical fatigue	Type 1 diabetes mellitus	30	17,47	4,167	,761
	Type 2 diabetes mellitus	60	14,78	3,893	,503
Mental fatigue	Type 1 diabetes mellitus	30	14,37	4,522	,826
	Type 2 diabetes mellitus	60	11,08	2,884	,372
Total fatigue score	Type 1 diabetes mellitus	30	31,83	8,330	1,521
	Type 2 diabetes mellitus	60	25,87	6,155	,795

Independent samples test								
		Levene's test for equality of variances		t-test for equality of means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean difference	Std. error difference
Self-efficacy of proper medication intake	Equal variances assumed	,136	,714	-3,436	88	,001	-3,717	1,082
	Equal variances not assumed			-3,447	58,619	,001	-3,717	1,078
Physical fatigue	Equal variances assumed	,575	,450	3,011	88	,003	2,683	,891
	Equal variances not assumed			2,943	54,717	,005	2,683	,912
Mental fatigue	Equal variances assumed	18,601	,000	4,185	88	,000	3,283	,785
	Equal variances not assumed			3,625	41,156	,001	3,283	,906
Total fatigue score	Equal variances assumed	7,494	,007	3,841	88	,000	5,967	1,553
	Equal variances not assumed			3,477	45,333		5,967	1,716

Table 10: Self-efficacy of proper medication intake and fatigue in different type of diabetes.

		I was diagnosed with diabetes mellitus before:
Self-efficacy of proper medication intake	Pearson correlation	-,237*
	Sig. (2-tailed)	,024
	N	90
Physical fatigue	Pearson correlation	,044
	Sig. (2-tailed)	,678
	N	90
Mental fatigue	Pearson correlation	,035
	Sig. (2-tailed)	,744
	N	90
Total fatigue score	Pearson correlation	,043
	Sig. (2-tailed)	,690
	N	90
*Correlation is significant at the 0.05 level (2-tailed).		
**Correlation is significant at the 0.01 level (2-tailed).		

Table 11: Correlations among variables.

		I have been undergoing treatment for diabetes mellitus here and:
Self-efficacy of proper medication intake	Pearson correlation	-,268*
	Sig. (2-tailed)	,011
	N	90
Physical fatigue	Pearson correlation	,048
	Sig. (2-tailed)	,653
	N	90
Mental fatigue	Pearson correlation	,039
	Sig. (2-tailed)	,712
	N	90
Total fatigue score	Pearson correlation	,047
	Sig. (2-tailed)	,660
	N	90
*Correlation is significant at the 0.05 level (2-tailed).		
**Correlation is significant at the 0.01 level (2-tailed).		

Table 12: Correlations among variables.

4. Discussion

In addition to increased mortality, diabetes mellitus can lead to poor physical and mental health [2]. Complications of diabetes mellitus are related to various body systems, such as the eyes, kidneys, and cardiovascular system, while chronic ulcers associated with diabetes (diabetic ulcers) are also common, often leading to amputation of the lower extremities [19]. A common complication of diabetes mellitus is fatigue, both physical and/or mental. Although chronic fatigue is a common phenomenon among the general population, patients with diabetes mellitus constitute a subpopulation with a higher probability of experiencing fatigue, tending to present a 2-fold higher frequency of complaints of fatigue compared to people without diabetes [7]. Indeed, fatigue, whether physical or mental, has been recognized for many years as one of the most frequent and bothersome complaints of patients with diabetes mellitus [8].

Many social, psychological, and physiological factors influence the development and progression of fatigue, while, at the same time, fatigue itself, whether physical or mental, can also be associated with various factors, such as quality of life and compliance with treatment [8, 12]. In order to avoid short-term and long-term complications of diabetes, self-management is necessary, and for this reason, it is important to ensure full compliance of patients with their medication and with all instructions they receive from their attending physician [6]. In this context, it is important to investigate the possible relation of physical or mental fatigue to the compliance of patients with diabetes mellitus with their treatment.

Based on the above, an interesting issue that needs to be investigated is the effect of physical and mental fatigue on medication adherence. However, in the recent international literature, no primary study was identified that examined the relationship between physical and mental fatigue and medication adherence in parallel. Therefore, the main purpose of this research was to study physical and mental fatigue in patients with diabetes mellitus and its effect on medication adherence.

Overall, in the sample of patients with diabetes mellitus in the present study, physical fatigue levels were moderate, mental fatigue levels were low (below average), and overall fatigue levels were moderate. The mean FAS value in the total sample was equal to 27.86 (±7.47), a value that is fully consistent with the mean FAS value obtained in another sample of patients with type II diabetes mellitus in Greece (27 (±7.63)) [14]. In contrast, in another study, the average levels of fatigue were relatively high [20]. Overall, the prevalence of fatigue among patients with diabetes mellitus ranges between 23% and 50% in the international literature [8]; however, in the present study, this prevalence was much higher (75.5%). This high percentage is consistent with the conclusions of the study by Christian et al. [21], which highlighted the high levels of fatigue among patients with diabetes mellitus [21].

In addition to fatigue, in the present study, the levels of self-efficacy regarding the correct intake of medication among patients with diabetes mellitus were also assessed. Achieving and maintaining optimal glycemic control through appropriate medication is an important goal of diabetes treatment [22]. In the present study, self-efficacy levels regarding the correct use of medications in the sample of patients with diabetes were relatively high. Non-adherence to medication has been recognized as a serious problem in the management of patients with diabetes, as only 45% of patients with diabetes are able to maintain glycemic control during their treatment [17].

A very important research question of the present study was whether physical and mental fatigue is related to self-efficacy for proper medication use. In the sample of patients with diabetes mellitus in the present study, it was found that higher levels of physical fatigue were associated with significantly lower levels of self-efficacy for proper medication use in patients with diabetes mellitus, and vice versa;

patients without fatigue were associated with the highest mean levels of self-efficacy for proper medication use. Uncontrolled diabetes mellitus and poor diabetes self-management have also been identified in other studies as a key factor associated with fatigue [12], a fact confirmed in the present study. This can be explained by the fact that patients with diabetes fatigue syndrome face many mental and physical challenges and often experience burnout due to diabetes treatment, which can lead patients to neglect their treatment. This results in the deterioration of their health status and their entry into a state of unregulated treatment [4]. Thus, both physical and mental fatigue can reduce and compromise patients' compliance with diabetes treatment [1]. However, in other studies, fatigue was not significantly associated with diabetes self-care at all [11], was found to be a significant barrier to patient compliance only with physical exercise and not with their medication [9], or was indirectly associated with glycemic control but only in patients with high A1C levels [10].

From the results of the inductive statistical analysis between the various general elements and the levels of fatigue and self-efficacy regarding medication use, various significant relationships were identified. Initially, widowed patients with diabetes mellitus were associated with higher mean levels of physical fatigue and higher mean levels of overall fatigue. Patients with diabetes mellitus with lower levels of education (primary education) were associated with higher mean levels of physical fatigue, while patients with type I diabetes mellitus were associated with significantly lower mean levels of self-efficacy for taking medication correctly, higher mean levels of physical fatigue, higher mean levels of mental fatigue, and higher mean levels of overall fatigue, compared to patients with type II diabetes mellitus.

Patients who have had diabetes for longer have significantly lower levels of self-efficacy for taking medication correctly, and vice versa; patients who have been treated for diabetes for longer also have significantly lower levels of self-efficacy for taking medication correctly, and vice versa. This finding seems somewhat paradoxical, as patients with longer duration of diabetes and longer duration of diabetes treatment would be expected to have greater experience with medication, and therefore, to exhibit higher levels of self-efficacy in taking their medication correctly. However, maybe it is not necessarily paradoxical, and some possible explanations may include treatment fatigue, burnout, complication burden, or ageing effects.

Furthermore, no significant association was observed between fatigue and time since diagnosis of diabetes, a finding that contradicts that of another study, where higher levels of fatigue were significantly associated with a more recent diabetes diagnosis [12].

In contrast, gender and age group were not found to be significantly correlated to fatigue levels in patients with diabetes, a finding that is in complete contrast to other studies, where gender and age emerged as the most important factors shaping fatigue levels [8]. Also, gender and age were not statistically significantly associated with self-efficacy regarding the correct use of medications.

Key limitations of this research include the sampling method, which was convenience sampling, and the relatively small sample of patients with diabetes that was collected. Further, the observed association between fatigue and self-efficacy may be confounded. For example, depression could independently increase fatigue and reduce self-efficacy. Consequently, future studies may be conducted using numerous factors. Nevertheless, there are some strengths. The topic of the present study is relevant and clinically important, addressing an underexplored area in Greek populations with diabetes, the use of established instruments (FAS and SEAMS), while the objectives are clearly stated.

5. Conclusion

Based on all of the above, it is recommended that the levels of physical and mental fatigue of all patients with diabetes be examined during their medical follow-up, especially patients with type 1 diabetes who tend to have higher levels of fatigue, and that health professionals provide ways to deal with fatigue. Given that fatigue was significantly associated with self-efficacy for proper medication administration, this more effective management of fatigue will contribute to increasing their effectiveness in properly taking their medications, and subsequently, to better diabetes management and patient outcomes.

Author's Contribution

Conception and design, supervision, visualization, manuscript review and editing (Giannopoulou X, Theofilou P), data collection, analysis, drafting of the original manuscript (Giannopoulou X, Theofilou P), drafting and critical revision of the manuscript (Giannopoulou X, Theofilou P), drafting of the original manuscript and figure preparation (Giannopoulou X, Nikolopoulou V, Theofilou P), supervision, visualization, manuscript writing, review, and editing (Giannopoulou X, Theofilou P).

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Data Sharing Statement

Data related to this research can be found within this article.

Conflicts of Interest

The authors declare no conflict of interest.

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