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Barriers to adapting to type 2 diabetes, adaptation profiles and their relationship to complications

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ABSTRACT

Effective coping with type 2 diabetes is often hindered by insufficient understanding of the disease, its management, associated comorbidities, complications, and mental health challenges. This study aims to identify barriers to adaptation to type 2 diabetes, examine their associations with complications, and characterize patient adaptation profiles to inform tailored management strategies. A cross-sectional sample of 151 outpatients diagnosed with type 2 diabetes was analyzed. Data were collected using the diabetes obstacles questionnaire-30 and analyzed using statistical methods, including latent profile analysis, to identify distinct adaptation profiles and their association with clinical and demographic factors.

The mean age at disease onset was 50.39 years (standard deviation (SD) = 11.02), with an average body mass index (BMI) of 32.90 (SD = 6.64) and a mean glycohemoglobin (HbA1c) level of 7.7% (SD = 1.30). Hypertension (78.1%), retinopathy (33.1%), and neuropathy (22.5%) were the most common complications. Patients expressed fear of diagnosis (mean (M) = 2.99, SD = 1.28), high blood sugar readings (M = 3.19, SD = 1.23), and insulin therapy (M = 3.38, SD = 1.30), along with low motivation for physical activity (M = 3.04, SD = 1.30). Four distinct adaptation profiles were identified, influenced by information needs, social support, and the presence of complications such as neuropathy, which significantly affected adaptation. Adaptation to type 2 diabetes varies significantly across patients, influenced by clinical, psychological, and social factors. Identifying and addressing individual barriers – including the need for tailored education, social support, and comorbidity management – is critical. Personalized medicine approaches that integrate these factors can enhance disease adaptation and improve outcomes, emphasizing the need for holistic and patient-centered care in diabetes management.

1. Introduction

In Estonia, about 7–8% of the adult population has diabetes, which is a common chronic comorbidity among post-hypertension patients [1,2]. Type 2 diabetes frequently affects the organ systems and leads to complications in 56% of patients [3]. These complications are multifactorial, necessitating attention to mental health [4]. Conditions such as depression, anxiety, eating disorders, fear of hypoglycemia, and diabetes-related stress strongly influence blood glucose levels, monitoring, and treatment adherence [5–7]. Compared to neurodegenerative diseases with prominent physical symptoms, adaptation barriers in type 2 diabetes involve lifestyle adjustments – such as blood sugar monitoring, weight management, dietary changes, and quitting harmful habits – which significantly impact psychological well-being and diabetes management [8,9]. A major barrier to effective coping in type 2 diabetes management is also a gap in clinicians' knowledge and confidence, particularly regarding insulin initiation, which complicates treatment intensification [10,11]. This extends to patient education, leading to poor compliance [12]. Additionally, patients' socioeconomic status, occupational constraints, comorbidities and psychosocial barriers – such as depression and anxiety – hinder effective diabetes management. Emphasizing behavior change support and managing the emotional aspects of care are essential for improving outcomes [7,13].

The best results in managing type 2 diabetes are achieved through trust-based cooperation between healthcare professionals and patients [14]. Patients face numerous challenges, both clinical and psychosocial. Clinically, achieving optimal glycemic control is crucial to prevent complications such as neuropathy, nephropathy, and retinopathy, with elevated glycohemoglobin (HbA1c) levels and obesity increasing these risks [13,15]. Psychosocial issues, such as depression and reduced well-being, severely affect patients' ability to manage their condition [16]. The degree of control patients feel they have over their disease and their coping styles (emotion-oriented vs. task-oriented) is vital for successful management [17]. Previous research has shown that mental health issues, unhealthy lifestyles, and advanced age are primary reasons for adaptation barriers in type 2 diabetes [4,16]. This study aims to explore these adaptation barriers and their link to complications, and to identify patient profiles based on clinical parameters that predict group membership, which previous studies have not addressed.

2. Methods

2.1. Study design

A quantitative cross-sectional study was conducted among endocrinology outpatients aged 30–87 (n = 151) with type 2 diabetes in Estonia, encompassing two large central hospitals and two regional hospitals. The study aimed to evaluate patients' adaptation barriers to disease management and their association with diabetes-related complications. Data were collected from March 1 to August 1, 2022.

2.2. Study sample

The participant cohort consisted of outpatients recruited from four principal endocrinology departments across Estonia. To ensure a representative cross-section of the type 2 diabetes population, we adopted stratified random sampling. This method facilitated the inclusion of a demographically and clinically diverse group of participants, thereby enhancing the generalizability of the study findings [18]. Potential participants were identified through hospital database records. Eligibility required a confirmed diagnosis of type 2 diabetes for no less than six months. This exclusion criterion was applied to omit individuals who were newly diagnosed or had severe, multiple complications diagnosed within the preceding six months, thereby mitigating potential biases linked to recent onset or acute conditions. Following the establishment of an eligible pool, participants were randomly selected using stratification based on age, gender, and presence of comorbidity. This stratification ensured that the sample accurately reflected the disease's demographic and medical variance. Participants were approached by their respective healthcare providers during routine clinical visits, which enhanced the trustworthiness of the recruitment process. Detailed explanations regarding the study's objectives, potential impacts, and the nature of involvement were provided. Informed consent was secured from all individuals who agreed to participate.

2.3. Data collection tools

The primary instrument utilized in this study was the validated diabetes obstacles questionnaire-30 (DOQ-30). This tool, available in both Estonian and Russian, was specifically designed to assess the prevalence and nature of barriers encountered by patients in managing type 2 diabetes daily [19]. It comprises 30 questions across nine subtopics, focusing on the disease's impact on patients' lives, including diagnosis, treatment protocols, self-monitoring, lifestyle adjustments, and interactions with healthcare providers. To accommodate all participants' understanding – particularly given the specialized medical terminology such as "microangiopathy" and "HbA1c level" – each term was clearly defined within the questionnaire. This approach ensured that participants, irrespective of their prior medical knowledge, could comprehend and respond accurately. Concerning clinical measurements such as HbA1c levels, participants were instructed to provide the most recent values recorded during their latest medical visit, reflecting standard practice in chronic disease management, where such values are routinely monitored. Respondents could also indicate other comorbid conditions, including mental health problems (stress, anxiety), cardiovascular diseases (myocardial infarction, dyslipidemia, arrhythmia), apnea, polycystic ovary syndrome, gout, and problems with bones and muscles.

Given the potential biases associated with self-reported anthropometric data, height and weight measurements were conducted by healthcare professionals at the endocrinology departments prior to participants completing the questionnaire. This method guaranteed the accuracy of these critical metrics. Subsequently, the body mass index (BMI) was calculated by the research team using these precise measurements, thereby ensuring consistency and reliability of BMI data across the study.

The questionnaire was administered on-site from March 1 to August 1, 2023. It utilized a 5-point Likert scale to gauge participants' attitudes and perceptions regarding their treatment and the psychosocial impacts of living with diabetes. This scale ranged from '1' (strongly disagree) to '5' (strongly agree) and was employed for questions related to subjective experiences such as treatment satisfaction, emotional support, and lifestyle stress, but not for objective data such as BMI or HbA1c levels, which were collected as described previously. The Russian version of the questionnaire, employed for the first time in this study, underwent a rigorous forward-backward translation process to ensure linguistic accuracy and cultural relevance. This process was conducted by a professional translation company, thus maintaining the integrity and comparability of data across different language groups within the study.

2.4. Statistical analysis

For the analysis of our data, except for the latent profile analysis, we employed the statistical package Jamovi (version 2.3.19) [20]. Various statistical tests were utilized to examine the relationships and differences in the data related to adaptation to type 2 diabetes. The Spearman correlation coefficient was used to assess the strength and direction of association between ordinal variables. For example, it helped explore the correlations between participants' perceptions of adaptation barriers and their HbA1c levels. The Mann–Whitney U test was applied to compare differences between two independent groups, particularly when the dependent variable was continuous but not normally distributed [21]. It was instrumental in analyzing differences in adaptation barriers between participants with and without specific diabetes complications, such as microangiopathy or neuropathy.

Employed for categorical data, the chi-square test [22] evaluated the associations between categorical variables, such as the presence of comorbidities (e.g., hypertension, diabetic retinopathy), and participants' responses to survey questions about their disease management practices. ANOVA was used to compare the means of continuous variables across more than two groups, providing insights into how demographic (e.g., age, sex) and clinical data (e.g., BMI, HbA1c level, occurrence of complications) influence adaptation to diabetes [23]. Latent profile analysis (LPA), performed using the statistical software MPlus version 8.8 [24], helped identify distinct subgroups of patients exhibiting similar patterns of coping and response to treatment. The selection of the most appropriate number of subgroups was based on comparative model fit indices, entropy values, and the interpretability of the profiles.

2.5. Ethical considerations

This study received approval from the Ethics Committee of the National Institute for Health Development (Decision No. 1090; dated April 20, 2022). Participation was strictly voluntary and anonymous, ensuring compliance with ethical standards. Each participant was fully informed of the study's objectives before consenting to participate, and confirmation of agreement was obtained through a signed consent form.

Participants completed the questionnaires anonymously, which were then returned in sealed envelopes to ensure confidentiality. These envelopes were collected by the medical team and handed directly to the researcher without being opened. Data collection occurred once, and the gathered data are securely stored on the cloud server of Tallinn Health University of Applied Sciences – protected by two-factor authentication, and anonymized – for a duration of five years. This period aligns with the institutional data retention policy, primarily set for audit and compliance purposes. The information was collected explicitly for this study and was not merged with any other medical records, thereby maintaining the integrity and confidentiality of the participant data. All study procedures were performed in accordance with the ethical standards of both the institutional and national research committees and conformed to the ethical guidelines of the 1964 Helsinki Declaration and its subsequent amendments [25]. We ensure comprehensive transparency in how the collected data are managed, shared, and utilized, reflecting our commitment to ethical research practices and respect for participant rights.

3. Results

3.1. Sample description

The sample consisted of 151 individuals, with an average age of 61.04 (SD = 11.37). The largest age group included individuals between 30 and 64 years, comprising 59% (n = 91) of the sample (Table 1). Of the respondents, 51% were women and 35.8% were men. A total of 55.6 % of the respondents were Estonian, and 35.8% marked Russian as their nationality. Most respondents were non-smokers (74.2%).

The average age of the respondents at the onset of type 2 diabetes was 50.39 years (SD = 11.02), and the average duration of the disease was 10.92 years (SD = 8.84). The respondents' average BMI was 32.90 (SD = 6.64), with the most recent average glycohemoglobin (HbA1c) level of 7.7% (SD = 1.30). In the age group of 65–87 years, 64% had a BMI in the obesity range, and 3.3% were class 3 extreme obesity.

7.9% of the respondents were receiving insulin therapy and 29.8% were on a combined medication regimen. The largest portion of type 2 diabetes complications which the respondents knew they had was hypertension (78.1%), followed by retinopathy (33.1%), neuropathy (22.5%), nephropathy (13.9%), and diabetic foot (11.3%), (Table 1).

Table 1. Demographic and clinical characteristics of study participants

Demographics		Smoking	
Female	77 (51%)	Current smokers	24 (15.9%)
Male	54 (35.8%)	Non-smokers	112 (74.2%)
Did not specify	20 (13.2%)		
Average age	M = 61.04, SD = 11.37; Min = 34, Max = 70		
Age 30–64 years	91 (59%)		
Age 65–87 years	61 (41%)		
Nationality		Type of diabetes treatment	
Estonian	84 (55.6%)	Insulin	12 (7.9%)
Russian	54 (35.8%)	Medications	66 (43.7%)
Other	11 (7.3%)	Combination of medications and insulin	45 (29.8%)
Clinical parameters		Diabetes complications	
Age at onset	M = 50.39, SD = 11.02; Min = 30, Max = 66	Diabetic retinopathy	50 (33.1%)
Disease duration	M = 10.92, SD = 8.84; Min = 1 year, Max = 26 years	Diabetic nephropathy	21 (13.9%)
BMI	M = 32.90, SD = 6.64; Min = 23, Max = 44.9	Diabetic neuropathy	34 (22.5%)
HbA1c level	M = 7.67, SD = 1.30; Min = 6.2%, Max = 11.6%	Diabetic foot	17 (11.3%)

M – mean, SD – standard deviation, Min – minimum, Max – maximum, HbA1c – glycohemoglobin, BMI – body mass index

3.2. Results of type 2 diabetes adaptation barriers

Responses showed that insulin therapy makes life complicated (M = 3.38, SD = 1.299), taking insulin means that diabetes is getting worse (M = 3.44, SD = 1.315), self-monitoring causes fear of high readings in blood sugar (M = 3.19, SD = 1.232), there is lack of motivation to increase physical activity (M = 3.04, SD = 1.299), and the way diabetes diagnosis was communicated caused fear (M = 2.99, SD = 1.276) (Table 2).

The dispersion analysis delineated several critical factors integral to individual adaptation to type 2 diabetes. These factors include the total barriers score, BMI, HbA1c level, and total complications, as detailed in Table 3. The statistical analyses revealed significant differences between groups for each of these variables ($p < 0.001$), emphasizing their pivotal role in the adaptation process. Participants were categorized based on a dual approach: subjective total barriers scores derived from questionnaire responses and objective clinical parameters, such as HbA1c levels and BMI. This classification strategy enabled a robust examination of the influence of these variables on diabetes adaptation. To encapsulate the multidimensional aspects of adaptation, an adaptation indicator was developed by synthesizing these subjective and objective measures, offering a comprehensive assessment of adaptation potential to the illness.

3.3. Relation of type 2 diabetes adaptation barriers to complications

The most common complication or comorbidity was hypertension (n = 118), and its main adaptation barriers related to lack of motivation to do physical exercise ($p < 0.01$), fear and uncertainty regarding insulin therapy ($p = 0.029$), the need for more support in coping with the disease ($p = 0.033$) and with blood sugar monitoring ($p = 0.030$). The respondents with neuropathy as a complication more often thought that they lacked sufficient knowledge about diabetes treatment ($p = 0.028$). The manner in which they were informed about diabetes caused fear ($p = 0.01$) and uncertainty about insulin therapy ($p = 0.004$) (Table 4). There were no statistically significant associations regarding other listed complications.

3.4. Profiles of patients in adaptation to type 2 diabetes treatment

Next, we performed LPA to identify the subgroups of patients with different patterns of coping and adjustment to treatment.

Table 2. Results of type 2 diabetes adaptation barriers

Type 2 diabetes adaptation barriers	Mean	SD
I lack the motivation to exercise	3.04	1.299
Self-monitoring makes me fearful of a high reading	3.19	1.232
The way I was told that I had diabetes made me feel afraid	2.99	1.276
Taking insulin makes life too complicated	3.38	1.299
Taking insulin means my diabetes is getting worse	3.44	1.315

SD – standard deviation

Table 3. Factors influencing adaptation to type 2 diabetes

Factor	Mean square	df	Mean square	df	F	*p*-value
Barriers total score	32.199	2	0.518	130	**62.153**	0.001
BMI	23.163	2	0.676	130	34.240	0.001
HbA1c	27.599	2	0.560	130	**49.275**	0.001
Total complications	29.697	2	0.570	130	**52.104**	0.001

df – degrees of freedom, F – F-statistic, BMI – body mass index, HbA1c – glycohemoglobin

Table 4. Relation of type 2 diabetes adaptation barriers to complications

Coping barrier	With hypertension Mean ± SD	No hypertension	*p*-value	Cohen's d
I would cope with diabetes treatment better if I got more encouragement from others	3.01 ± 1.216	2.50 ± 1.137	0.033	0.433
I lack the motivation to exercise	3.25 ± 1.250	2.24 ± 1.185	<0.01	0.829
Self-monitoring makes me fearful of a high reading	3.31 ± 1.192	2.81 ± 1.276	0.030	0.405
Taking insulin means my diabetes is getting worse	3.58 ± 1.257	2.97 ± 1.426	0.029	0.454
Coping barrier	With diabetic neuropathy Mean ± SD	No diabetic neuropathy	*p*-value	Cohen's d
I do not know enough about diabetes treatment	3.03 ± 1.045	2.54 ± 1.180	0.028	0.440
The way I was told I had diabetes made me feel afraid	3.48 ± 1.176	2.84 ± 1.272	0.010	0.522
Insulin therapy makes life more complicated	3.94 ± 1.153	3.21 ± 1.299	0.004	0.594
Taking insulin means my diabetes is getting worse	3.94 ± 1.093	3.30 ± 1.344	0.017	0.522

SD – standard deviation

We compared models consisting of one to five subgroups. The comparative fit indices and entropy of each model are presented in Table 5. Altogether, N = 149 patients were included in the LPA, as two patients had not responded to any of the five included items. Based on model fit, interpretability and group sizes, the four-subgroup solution was considered the best for describing the heterogeneity in the data.

Figure 1 displays the average standardized scores for coping barriers across four distinct profiles. Table 6 details the average scores and standard deviations for the raw scores of coping barriers for each profile. The *Low barriers* profile represents 22.1% (n = 33) of the patients and includes those who have managed their disease effectively. Individuals in this group are motivated to improve their lifestyle, particularly by increasing physical activity (M = 1.94, SD = 0.91). They are also receptive to blood sugar monitoring (M = 1.52, SD = 0.83) and possess adequate knowledge about diabetes (M = 1.94, SD = 1.24). A notable characteristic of this profile is the absence of fear regarding treatment, including insulin therapy (M = 1.41, SD = 0.50). The *Seeking social support* profile, comprising 29.3% (n = 44) of the respondents, includes individuals requiring more social support, possibly due to limited personal resources or a heightened need for emotional assistance. Their motivation for lifestyle changes is moderate (M = 2.92, SD = 1.29), suggesting awareness of the need for change but potentially requiring additional motivation or support. Their attitude toward blood sugar monitoring is also moderate (M = 2.49, SD = 0.99), indicating possible challenges in daily self-monitoring. Knowledge about diabetes in this group is average (M = 2.97, SD = 0.98),

Table 5. Comparative model fit indices and entropy of models with different number of patient subgroups

Number of profiles	N	AIC	BIC	aBIC	Entropy	VLMR *p*-value	BLRT *p*-value
1	149	2017	2047	2016	–	–	–
2	40/109	1839	1887	1836	0.87	<0.001	<0.001
3	36/73/40	1793	1859	1790	0.78	0.36	<0.001
4	**33/39/44/33**	**1765**	**1849**	**1760**	**0.90**	**0.21**	**<0.001**
5	7/34/32/43/33	1761	1863	1755	0.90	0.41	0.27

N – sizes of subgroups, AIC – Akaike information criterion, BIC – Bayesian information criterion, aBIC – sample-size adjusted Bayesian information criterion, VLMR – Vuong–Lo–Mendell–Rubin likelihood ratio test, BLRT – bootstrapped likelihood ratio test. Estimates of the selected four-subgroup solution are shown in bold.

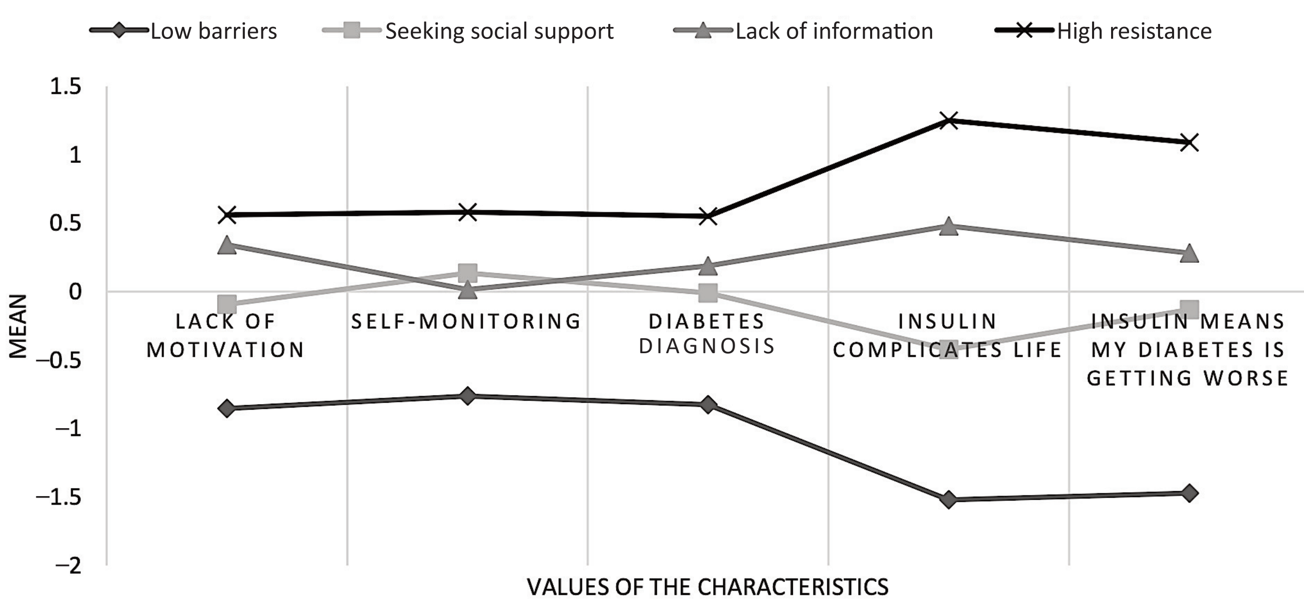

Fig. 1. Profiles of type 2 diabetes adaptation barriers.

Table 6. Differences in type 2 diabetes adaptation between the 4 profiles

	Lack of motivation		Self-monitoring		Diabetes diagnosis		Insulin complicates life		Insulin means my diabetes is getting worse
Profile	M	SD	M	SD	M	SD	M	SD	M
Low barriers	1.94	0.91	1.52	0.83	1.94	1.24	1.41	0.50	1.52
Seeking social support	2.92	1.29	2.49	0.99	2.97	0.98	2.83	0.37	3.27
Lack of information	3.49	1.05	2.49	1.08	3.23	1.08	4	0	3.81
High resistance	3.77	1.19	3.41	1.01	3.69	1.28	5	0	4.87

M – mean, SD – standard deviation

highlighting the importance of increasing knowledge. Their attitude towards treatment, particularly insulin therapy, is moderately positive (M = 2.83, SD = 0.37 and M = 3.27, SD = 0.96), suggesting they view treatment as necessary and manageable.

The *Lack of information* profile represents 17.6% (n = 26) of the respondents and is characterized by significant adaptation barriers due to insufficient information. This group shows considerably less motivation to increase physical activity compared to profile 2, with an average score of 3.49 (SD = 1.05). Self-monitoring is challenging for them, as indicated by a high average score of 2.49 (SD = 1.08). Concerns about their diabetes diagnosis suggest a lack of understanding about the disease (M = 3.23, SD = 1.08). Their perception of insulin therapy is strongly negative (M = 4, SD = 0), demonstrating how a lack of information can negatively impact attitudes toward treatment.

The *High resistance* profile, comprising 31% (n = 46) of the respondents, shows the greatest resistance to managing diabetes and accepting treatment. Members of this group are demotivated regarding physical exercise (M = 3.77, SD = 1.19), and the idea of glucose monitoring provokes fear of high readings (M = 3.41, SD = 1.01). Their resistance to insulin therapy is very high (M = 5, SD = 0), indicating that they view the treatment as particularly burdensome or unsuitable. They also believe that insulin therapy signifies the progression of the disease (M = 4.87, SD = 0.43), further compounding their resistance.

3.4.1. Associations between demographic and clinical factors and latent profiles of adaptation to type 2 diabetes

The analysis in Table 7 investigates the relationships between various demographic and clinical factors – such as age, sex, BMI, HbA1c level, insulin therapy, and complications including diabetic neuropathy and hypertension – and the adaptation profiles of patients with type 2 diabetes. According to the chi-square test results, most variables – including age, sex, BMI, HbA1c level, hypertension, and insulin therapy – do not exhibit significant associations with the adaptation profiles, indicating that these factors do not distinctly influence how patients adapt to diabetes treatment. Diabetic neuropathy emerges as the only variable with a significant association, highlighting its potential impact on adaptation processes.

In detailing the characteristics of each adaptation profile, the *Low barriers* profile generally comprises older individuals, suggesting that experience in managing health may contribute to effective long-term disease management, as indicated by fewer complications such as diabetic neuropathy. Conversely, the *Seeking social support* profile tends to include a younger demographic that relies heavily on social support networks. This profile, with its balanced gender distribution and consistent BMI and HbA1c levels, likely reflects either early disease stages or active engagement in preventive treatment strategies, leading to fewer complications and more favorable health outcomes.

The *Lack of information* profile is marked by a higher occurrence of complications, pointing to significant management challenges that could stem from advanced disease stages or less effective treatment approaches. The uniformity across age, sex, and BMI suggests that these challenges are pervasive, underscoring the profound impact of disease-related factors on adaptation difficulties. Meanwhile, the *High resistance* profile includes individuals dealing with severe diabetes-related consequences, primarily evident through a significant occurrence of diabetic neuropathy. This profile does not show significant differences in hypertension and insulin therapy, potentially indicating access to comprehensive treatment plans despite the complexity of clinical symptoms. Across all profiles, the consistent levels of BMI and HbA1c – essential parameters in diabetes management – imply that coping strategies are not necessarily linked to these factors. However, slight differences by sex in the *High resistance* profile suggest that coping strategies may differentially impact women. The prevalence of hypertension is consistent across profiles, emphasizing its commonality among diabetes patients. The notable presence of neuropathy in the third and fourth profiles highlights the serious impact of neurological complications on quality of life and coping strategies, stressing the critical need for focused neurological care in diabetes management to enhance patient's quality of life and improve adaptation strategies.

4. Discussion

This study focused on identifying the barriers to adaptation in type 2 diabetes and examining how these barriers correlate with the complications arising from the condition. Additionally, it described the distinct profiles of patients managing their diabetes and the clinical parameters that influence their classification into these profiles. A significant finding was that the majority of participants, 78.1%, reported hypertension as a comorbidity, highlighting its prevalence among the diabetic population we studied. The mean HbA1c level was 7.7% with a standard deviation of 1.30, and an average BMI of 32.90 indicates that many participants are classified as class 1 obesity. These findings suggest a correlation in which higher BMI is associated with an increased desire for support, knowledge about treatment, encouragement, and a heightened fear of disease progression [26–28]. Our analysis further indicates that age and longer duration of diabetes are linked to increased cardiovascular risk and pose significant barriers to diabetes management. Adults diagnosed between the ages of 50 and 59 exhibit a substantial increase in cardiovascular risk [15,29]. Implementing personalized, multidisciplinary medical strategies that incorporate long-term, integrated treatment plans for diabetes and its comorbid conditions – coupled with continuous collaboration between patients and medical teams – is critical in mitigating these challenges [28,30,31].

When comparing our findings to global trends, the observed HbA1c levels align with studies from developing regions, where glycemic control remains suboptimal due to limited access to care and personalized treatment [26,32]. In contrast, countries with advanced healthcare systems report lower HbA1c levels, achieved through proactive early interventions, education, and technology-driven self-manage-

Table 7. Predictors of latent profiles of adaptation to 2 type diabetes

Age (*<60 vs. > 60*)				χ^2 tests	
Profile	0	1	Total		
Low barriers	15	18	33	χ^2	2.11
Seeking social support	19	20	39	df	3
Lack of information	15	29	44	*p*	0.55
High resistance	15	18	33		
Total	64	85	149		
Sex (*men vs. women*)					
Low barriers	16	17	33	χ^2	6.96
Seeking social support	22	16	38	df	3
Lack of information	21	23	44	*p*	0.073
High resistance	9	24	33		
Total	68	80	148		
BMI (*<30 vs. ≥ 30*)					
Low barriers	13	19	32	χ^2	3.58
Seeking social support	17	22	39	df	3
Lack of information	14	30	44	*p*	0.311
High resistance	8	25	33		
Total	52	96	148		
HbA1c level (*>7 vs. <7*)					
Low barriers	11	19	30	χ^2	0.295
Seeking social support	15	20	35	df	3
Lack of information	18	26	44	*p*	0.961
High resistance	12	19	31		
Total	56	84	140		
Rate of complications (*≤ 2 vs. ≥ 2*)					
Low barriers	27	6	33	χ^2	4.65
Seeking social support	31	8	39	df	3
Lack of information	29	15	44	*p*	0.199
High resistance	21	12	33		
Total	108	41	149		
Diabetic neuropathy (*yes vs. no*)					
Low barriers	30	3	33	χ^2	11.2
Seeking social support	34	5	39	df	3
Lack of information	30	14	44	*p*	0.011
High resistance	21	12	33		
Total	115	34	149		
Hypertension (*no vs. yes*)					
Low barriers	9	24	33	χ^2	5.86
Seeking social support	11	28	39	df	3
Lack of information	4	40	44	*p*	0.119
High resistance	8	25	33		
Total	32	117	149		
Insulin treatment (*yes vs. no*)					
Low barriers	18	13	31	χ^2	1.94
Seeking social support	23	16	39	df	3
Lack of information	27	16	43	*p*	0.586
High resistance	24	9	33		
Total	92	54	146		

χ^2 – chi-square, df – degrees of freedom, *p* – *p*-value

ment tools [27]. Similarly, hypertension as a prevalent comorbidity is consistent with global studies, where its management remains a cornerstone of diabetes care to prevent macrovascular and microvascular complications [29,33]. These differences highlight the need for tailored interventions in our study population, emphasizing resource optimization and early management strategies. The association between higher BMI and an increased need for support and knowledge can be explained through several biological and psychosocial mechanisms. Higher BMI is linked to chronic inflammation and metabolic dysfunction, which exacerbate diabetes complications, thereby increasing the need for additional health-contribute to a perceived lack of control and a greater reliance on external resources [30,34]. These findings suggest that addressing the psychological and social aspects of obesity in diabetes management is as critical as targeting the metabolic dimensions.

The identification of distinct adaptation profiles underscores the potential of personalized medicine in diabetes care. By tailoring care plans to address specific barriers within each profile – such as knowledge gaps, fear of disease progression, or lack of motivation for physical activity – healthcare providers can enhance patient engagement and outcomes [26,31,35]. Recent advancements in personalized diabetes management, including AI-driven predictive models and genetic profiling for treatment optimization, offer promising tools to further refine these strategies. For instance, programs that integrate behavioral interventions with pharmacological treatments have demonstrated improved adherence and glycemic control, particularly in patients facing psychological or social barriers [27,36].

The study highlights the importance of continuous blood sugar monitoring and diabetes education to address patients' misconceptions and fears regarding diabetes management. Real-time blood glucose monitoring technologies can support patients undergoing intensive insulin therapy, while newer medications, such as GLP-1 receptor agonists, focus on long-term cardiovascular protection with reduced monitoring requirements [36–39]. Addressing psychological issues such as anxiety and depression – which are often exacerbated by diabetes and its comorbidities – is essential for improving both adaptation and quality of life [40]. Future research should explore the integration of mental health services into diabetes care frameworks, particularly for high-risk populations such as those with elevated BMI or diabetic neuropathy.

5. Limitations

Several limitations should be considered when interpreting these findings. First, the cross-sectional study design does not allow for causal inferences regarding the relationships between adaptation barriers, patient profiles, and diabetes-related complications. Second, although stratified random sampling was used, the study population was drawn exclusively from endocrinology outpatient clinics in four hospitals, which may limit generalizability to all individuals with type 2 diabetes in Estonia, particularly those managed in primary care. Third, self-reported data on psychosocial factors and some clinical history variables may be subject to recall bias or social desirability bias, despite the use of standardized and validated measures. Finally, the modest sample size – especially within some latent profile subgroups – may limit statistical power to detect small effect sizes and could influence the stability of the latent profile analysis. Future longitudinal studies with larger and more diverse populations are needed to confirm these findings, assess changes in adaptation over time, and evaluate the impact of tailored interventions based on adaptation profiles.

6. Conclusion

The current study highlights the critical link between adaptation barriers and complications in type 2 diabetes. The analysis reveals that patients encounter numerous challenges daily, such as fear of the disease, treatment regimen compliance, insecurity, difficulties with physical activity, and the responsibility of monitoring blood sugar levels. These challenges are intertwined with both the physical symptoms of diabetes and the lack of psychological and social support essential for effective management. Additionally, comorbidities such as hypertension and diabetic neuropathy exacerbate these difficulties, with hypertension present in over half of the diabetic patients, heightening the risk of cardiovascular issues. Effective communication and active involvement in the treatment process between patients and medical teams are vital for addressing psychosocial problems associated with diabetes and its complications. Future research and practice should further examine demographic, cultural, socioeconomic, and psychological factors influencing disease management. Improving communication skills among patients and healthcare providers is also recommended to enhance treatment processes.

Author contributions

Study conception and design: MR; data collection: MR; data analysis and interpretation: MR, A-LJ; drafting of the article: MR, JŠ, TT, A-LJ; critical revision of the article: MR, JŠ, A-LJ, TT.

Data availability statement

All data supporting the findings of this study are included in the article. Additional data can be made available upon reasonable request from the corresponding author.

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Haigusega kohanemist takistavad tegurid ja profiilid 2. tüüpi diabeediga toimetulekul ning nende seosed tüsistustega

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Efektiivne toimetulek 2. tüüpi diabeediga võib olla keeruline, kuna haigusest arusaamist raskendavad sageli selle olemus ning kaasuvate haigusseisundite, tüsistuste ja vaimse tervise probleemide puudulik mõistmine. Uuringu eesmärk oli tuvastada tegurid, mis takistavad 2. tüüpi diabeediga kohanemist, analüüsida nende seoseid tüsistustega ning iseloomustada patsientide kohanemisprofiile. Ristlõikeuuringus analüüsiti 151 ambulatoorset ravi saavat patsienti, kellel oli diagnoositud 2. tüüpi diabeet. Andmeid koguti diabeediga toimetuleku küsimustiku abil ning tulemusi analüüsiti statistiliste meetoditega, sealhulgas latentse profiilianalüüsiga, et tuvastada eristuvad kohanemisprofiilid ja nende seosed kliiniliste ning demograafiliste teguritega.

Uuringus osalejate keskmine vanus haiguse diagnoosimisel oli 50,39 aastat (standardhälve (SD) = 11,02), keskmine kehamassiindeks 32,90 (SD = 6,64) ja keskmine glükohemoglobiini tase 7,7% (SD = 1,30). Kõige sagedamini esinesid tüsistustena hüpertensioon (78,1%), retinopaatia (33,1%) ja neuropaatia (22,5%). Patsiendid väljendasid enim muret seoses diagnoosiga (keskmine (M) = 2,99; SD = 1,28), kõrgenenud veresuhkru väärtustega (M = 3,19; SD = 1,23) ja insuliinraviga (M = 3,38; SD = 1,30), samuti mainiti madalat motivatsiooni füüsiliseks aktiivsuseks (M = 3,04; SD = 1,30). Analüüsi käigus tuvastati neli eristuvat kohanemisprofiili, mille kujunemist mõjutasid olulisel määral informatsioonivajadus, sotsiaalne tugi ja tüsistuste (neuropaatia) esinemine.

Kohanemine 2. tüüpi diabeediga võib patsientide vahel märkimisväärselt erineda, sõltudes kliinilistest, psühholoogilistest ja sotsiaalsetest teguritest. Takistuste, nagu puudulik haridus, ebapiisav sotsiaalne tugi ja kaasuvate haigustega toimetuleku vajadused, sihipärane käsitlemine on äärmiselt tähtis. Personaliseeritud lähenemine, mis arvestab neid tegureid, võib märkimisväärselt parandada nii haigusega kohanemist kui ka ravitulemusi, rõhutades tervikliku ja patsiendikeskse ravi olulisust diabeediga toimetulekul.