The Mediating Role of Health Literacy in the Relationship between Care Burden and Health Perception among Caregivers of Children with Type 1 Diabetes: A Comparison Based on Continuous Glucose Monitoring System Usage

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Background and Objective: Parents who assume the responsibility of caregiving for children diagnosed with Type 1 Diabetes Mellitus play a crucial role in effective diabetes management. This study aims to investigate the mediating role of health literacy in the relationship between health perception and caregiving burden among caregivers of children with Type 1 Diabetes Mellitus, separately for those using continuous glucose monitoring and those using self-monitoring of blood glucose.

Materials and Methods: This descriptive and cross-sectional study was conducted with 289 caregivers of children with Type 1 Diabetes Mellitus. The data were collected online between October 2024 and January 2025 using a sociodemographic data collection form, the Health Perception Scale, Zarit Caregiver Burden Scale, and the Short Form of the Health Literacy Scale. The data analysis was conducted using the SPSS 27 software and included descriptive statistics (frequency, percentage, mean, and standard deviation), Pearson correlation, regression analysis, and mediation testing. A significance level of $p<0.05$ was considered statistically significant.

Results: It was found that children using self-monitoring of blood glucose had higher HbA1c levels compared to those using continuous glucose monitoring. The findings indicated that health literacy played a mediating role in the relationship between caregiver burden and health perception among caregivers of children using continuous glucose monitoring, whereas no such effect was observed among caregivers of children using self-monitoring of blood glucose. Additionally, caregivers of children using continuous glucose monitoring reported lower caregiver burden and better glycemic control.

Conclusions: Health literacy was identified as a significant factor associated with reduced caregiver burden in the continuous glucose monitoring group. Interventions aimed at enhancing health literacy, particularly among caregivers of children using self-monitoring of blood glucose, may help promote more favorable outcomes in diabetes care.

Keywords: Caregivers, Caregiver Burden, Diabetes Mellitus, Health Literacy, Type 1
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Introduction

Type 1 diabetes mellitus (T1DM), most commonly diagnosed in children and adolescents, is a chronic, metabolic, and autoimmune disease resulting from the interaction of genetic, environmental, and other factors (1). Globally, T1DM affects approximately 1.52 million individuals, with an estimated 530,000 new cases diagnosed annually, of which 201,000 are under the age of 20 (2). According to data from the International Diabetes Federation, there are approximately 500,000 children under the age of 15 living with diabetes worldwide (3).

Lifelong diabetes management and ongoing monitoring are crucial for children with T1DM to maintain a healthy lifestyle and prevent complications. Diabetes management encompasses a multifaceted and ongoing process, including insulin administration, glycemic control, nutrition planning, physical activity monitoring, and regular health checkups. However, children with T1DM often have limited experience in managing fundamental adult responsibilities such as maintaining glycemic control, scheduling health check-ups, using medical equipment, and storing supplies. This situation leads to the continuation of T1DM management and care responsibilities by caregivers (4,5). In this long-term and comprehensive care process, meeting the child's age-specific developmental needs as well as T1DM management can create a significant physical, emotional, and social burden on caregivers (5-7). In the literature, this situation is defined as the concept of caregiver burden and is frequently reported at increased levels, especially in families of children living with chronic diseases. Adib-Hajbaghery and Ahmadi (2019) reported that 8.5% of caregivers of children and adolescents with chronic illnesses experience a severe caregiving burden, while 35.1% experience a moderate caregiving burden (6). Similarly, studies have found that mothers of children with T1DM experience a moderate level of caregiving burden (5,7,8).

Caregiver burden refers to the totality of physical, psychological, social, and economic difficulties experienced by an individual due to their child's illness. For caregivers of children with type 1 diabetes, the burden of caregiving is not limited to physical workload; it also includes numerous psychosocial dimensions such as emotional exhaustion, anxiety, depression, feelings of guilt, and social isolation (6,7). This burden is closely related to the

caregiver's perception of their health. Health perception is a subjective concept that reflects how an individual evaluates their own health in terms of physical and mental integrity. It is also directly related to the adoption and maintenance of healthy lifestyle behaviors (9-11). Negatively affecting the health perception of caregivers not only puts their own health at risk but also reduces their motivation and capacity for disease management of the child (11). A positive health perception has been associated with effective glycemic control, insulin therapy, dietary regulation, and physical activity, whereas a negative health perception has been identified as a factor that hinders active treatment participation and worsens glycemic outcomes. The success of this complex treatment regimen is largely determined by sustained self-management and the caregiver's perception of health (10,11). In this context, the responsibilities assumed by caregivers extend beyond managing the child's daily diabetes care; they also influence the caregiver's health perception, shaping their attitudes and overall engagement in the caregiving role.

It is essential for caregivers to possess specific knowledge, skills, and competencies to manage their caregiving burden and make various health-related decisions (4,12). At this point, one of the most important elements to consider is health literacy, defined as an individual's capacity to understand, evaluate, and use health information to make informed decisions (13). Health literacy plays a critical role in chronic disease management, including accessing accurate information, effectively using technological tools (e.g., continuous blood glucose monitoring systems (CGM), preventing complications, and properly utilizing healthcare services. Especially for diseases requiring complex management processes, such as Type 1 diabetes, a high level of health literacy among caregivers stands out as a factor that reduces caregiving burden and strengthens health perception. In the study by McLarty et al. (2020), a decline in glycemic control, an increased risk of hospitalization, and a higher incidence of diabetes-related complications among adolescents with diabetes were found to be associated with low levels of health literacy (14).

This study aims to investigate the mediating role of health literacy in the relationship between health perception and caregiving burden among caregivers of children with T1DM, separately for those using continuous glucose monitoring and those using self-monitoring of blood glucose. This study aims to make an original contribution to the literature, particularly by understanding the role health literacy plays in this relationship. It also offers a perspective that

emphasizes the importance of improving health literacy in interventions designed to reduce caregiver burden and support health perception.

Materials and Methods

Study Design

This study was conducted using a descriptive and cross-sectional design.

Study settings and sample

The study population consisted of caregivers of children diagnosed with T1DM. The study sample was determined using the snowball sampling method, one of the non-probability sampling techniques. In this approach, initial participants recruited other eligible individuals, facilitating access to a broader and otherwise hard-to-reach population of caregivers. This sampling method was implemented on a national scale across Türkiye, allowing the inclusion of participants from various regions and increasing the diversity of the sample. Data were collected online via Google Forms between October 2024 and January 2025 from caregivers of children with T1DM registered with the Black Sea Diabetes Association and additional caregivers they referred. The sample size was calculated using the standard deviation of the Zarit Caregiver Burden Scale (SD = 12.14) from a similar study (Bilgehan et al., 2024). Since the population size was unknown, the formula $n = (z \times SD / d)^2$ ($z = 1.96$, $p = 0.50$, and $d = 0.07$) was applied, resulting in a minimum required sample size of 226. Considering potential sample attrition, an additional 20% of participants were targeted, and the study was completed with a total of 289 caregivers (15). Within this scope, a total of 289 caregivers who met the inclusion criteria were included in the study, comprising 184 caregivers of children using a continuous CGM system and 105 caregivers of children using an SMBG system.

Inclusion Criteria

Caregivers were eligible to participate in the study if they met the following criteria: (1) being the primary caregiver of a child with T1DM, (2) being between 18 and 65 years of age, (3) having a child diagnosed with T1DM for at least 12 months. (4) the child had to be between 6 and 18 years old (5) the child have been using either a continuous CGM system or SMBG for at least one year for blood glucose management (6) Caregivers were also required to possess sufficient literacy to read and (7) Participants were voluntarily agree to participate in the study. Caregivers of children with chronic illnesses other than T1DM were excluded from the study.

Data Collection Instruments

In this study, data were collected using a questionnaire form, the Health Perception Scale (HPS), the Zarit Caregiver Burden Scale (ZCBS), and the Health Literacy Scale- Short Form (HLI-SF12).

Sociodemographic Data Collection Form

This form, developed by the researchers based on the relevant literature (16-20). This form included questions about the caregivers' age and child age, child diagnosis year, gender, marital status, education level, income level, number of children and general health status.

Health Perception Scale (HPS): The scale was developed by Diamond et al. (2007) (21) and adapted into Turkish by Kadıoğlu and Yıldız in 2012 (22). The scale is a five-point Likert-type instrument consisting of 15 items and four subdimensions: locus of control, certainty, self-awareness, and importance of health. The total score ranges from 15 to 75, with higher scores indicating a higher level of health perception. The Cronbach's alpha reliability coefficient of the scale was reported as 0.70 (22). In this study, the Cronbach's alpha value was found to be 0.762.

Zarit Caregiver Burden Scale (ZCBS): The scale was developed by Zarit et al. in 1980 to assess the impact of caregiving on caregivers' lives (23). The Turkish adaptation of the scale was conducted by İnci and Erdem in 2008 (24). The scale consists of 22 items, rated on a five-point Likert scale, with total scores ranging from 0 to 88. A higher score indicates a greater caregiving burden. The Cronbach's alpha reliability coefficient of the original scale was reported as 0.95 (24). In this study, the Cronbach's alpha reliability coefficient was found to be 0.922.

Health Literacy Scale – Short Form (HLS-SF12): The scale was developed by Duong et al. (2019) to assess health literacy among individuals aged 18 to 65 years (25). The Turkish validity and reliability study of the scale was conducted by Karahan Yılmaz and Eskici (26). The scale consists of 12 items rated on a four-point Likert scale, with total scores ranging from 0 to 50. Higher scores indicate higher levels of health literacy. The Cronbach's alpha reliability coefficient of the scale was reported as 0.856 (26). In this study, the Cronbach's alpha value was found to be 0.922.

Data Collection

The data for this study were collected through an online survey using Google Forms after obtaining ethical approval and institutional permission. In the first section of the survey,

participants were presented with an informed consent form, and they were required to accept it in order to proceed to the subsequent sections. Participants who provided consent advanced to the second section, where they answered questions related to demographic information and scale items. To ensure data completeness, all questions were mandatory, and only the responses of participants who provided consent and completed the survey in its entirety were included in the study.

Data Analysis

Data analysis was conducted using IBM SPSS Statistics version 27 and R software (27). The Shapiro-Wilk normality test was applied to determine whether the variables followed a normal distribution, and parametric tests were used accordingly. Descriptive statistics were presented as frequency, percentage, mean, and standard deviation. Correlation findings were visualized using the sjPlot package (28). Mediation analysis was performed using IBM SPSS Statistics 27 with the PROCESS macro (version 4.1, Model 4; 29). In the mediation analysis, the direct effect of the independent variable (health perception) on the dependent variable (caregiver burden) was first examined. Subsequently, the effect of the independent variable on the mediator (health literacy) and the effect of the mediator on the dependent variable were tested. The significance of both direct and indirect effects was assessed using the Bootstrap method with 95% confidence intervals (29).

Results

This study offers a novel contribution to the literature by demonstrating, for the first time, that health literacy serves as a partial mediator between health perception and caregiver burden specifically among caregivers of children using CGM. This highlights not only the physiological benefits of CGM but also its potential to enhance psychosocial outcomes through improved caregiver engagement and health literacy.

Information regarding the 289 caregivers and their children who participated in the study is presented in Table 1, categorized based on the child's use of CGM or SMBG for blood glucose management. As shown in **Table 1**, the majority of caregivers were women (78.2%), 47.4% had a university or postgraduate education, and 89.6% were married. Additionally, it was found that the HbA1c levels of children using CGM were lower than those of children using SMBG (7.27±1.42 vs. 8.07±1.35, respectively).

Table 1. Characteristics of Caregivers and Children

Variables	Caregiver Using CGM (n=184) Mean ± SD	Caregiver Using SMBG (n=105) Mean ± SD	Total (n=259) Mean ± SD
HbA1c	7.27±1.42	8.07±1.35	7.56±1.4
Child's Age	10.02±3.74	11.44±3.71	10.54±3.79
Years Since Diagnosis	3.61±2.83	3.48±2.49	3.48±2.49
	n (%)	**n (%)**	**n (%)**
Gender			
Male	153 (83.2)	73 (69.5)	226 (78.2)
Female	31 (16.8)	32 (30.5)	63 (21.8)
Education Level			
Primary School	25 (13.6)	11 (10.5)	36 (12.5)
High School	52 (28.3)	64 (61.0)	116 (40.1)
University/Postgraduate	107 (58.1)	30 (28.5)	137 (47.4)
Marital Status			
Married	168 (91.3)	91 (86.7)	259 (89.6)
Single	16 (8.7)	14 (13.3)	30 (10.4)
Income Level			
Less than Expenses	74 (40.2)	37 (35.2)	111 (38.4)
Equal to Expenses	84 (45.7)	55 (52.4)	139 (48.1)
More than Expenses	26 (14.1)	13 (12.4)	39 (13.5)
Number of Children			
1	35 (19.1)	31 (29.5)	66 (22.8)
2	102 (55.4)	57 (54.3)	159 (55.0)
3 or more	47 (25.5)	17 (16.2)	64 (22.1)
General Health Status			
Good	60 (32.6)	20 (19.0)	90 (27.7)
Moderate	120 (65.2)	76 (72.4)	196 (67.8)
Poor	4 (2.2)	9 (8.6)	13 (4.5)

The mean, standard deviation, minimum, and maximum values for the overall and subdimensions of the scales used in the study are presented in Table 2. The mean scores for caregivers of children using CGM were as follows: PHS: 45.78±6.14, ZBI: 35.42±12.56, and HLI-SF12: 28.81±8.04. In contrast, the mean scores for caregivers of children using SMBG were PHS: 47.09±3.81, ZBI: 40.33±16.22, and HLI-SF12: 26.73±9.57 **(Table 2).**

Table 2. Mean Scores of Overall and Subdimensions of the Scales by Groups

Group	Scale Total	Subdimensions	Mean ± SD	Min	Max
Caregiver Using CGM for Her Child (n=184)	Perception of Health Scale		45.78±6.14	30	61
		Center of Control	14.45±3.94	5	23
		Certainty	10.94±2.22	5	16
		Self-Awareness	10.04±2.19	3	15
		Importance of Health	10.34±1.48	7	15
	Zarit Caregiver Burden		35.42±12.56	4	70

	Health Literacy Instrument-Short-Form		28.81±8.04	12	48
Caregiver Using SMBG for Her Child	Perception of Health Scale		47.09±3.81	38	59
		Center of Control	16.30±3.37	8	23
		Certainty	12.43±1.83	7	16
		Self-Awareness	9.33±1.35	6	12
		Importance of Health	9.01±2.08	6	14
	Zarit Caregiver Burden		40.33±16.22	4	74
	Short-Form Health Literacy Instrument-		26.73±9.57	12	48

Mean: SD, SS: Standard Deviation, Min: Minimum, Max: Maximum
SMBG: Self-Monitoring of Blood Glucose; CGM:Continuous Glucose Monitoring

Figure 1 presents the correlation between the total and subdimension scores of PHS, ZBI, and HLI-SF12 among caregivers of children using CGM for blood glucose monitoring. According to **Figure 1**, a weak but significant negative correlation was found between ZBI and PHS ($r=-0.31$, $p<0.05$) as well as between ZBI and HLI-SF12 total scores ($r=-0.34$, $p<0.05$). Additionally, a weak but significant positive correlation was observed between PHS and HLI-SF12 total scores ($r=0.23$, $p<0.05$).

Figure 2 illustrates the correlation between PHS, ZBI, and HLI-SF12 total and subdimension scores among caregivers of children using SMBG for blood glucose monitoring. According to Figure 2, no significant correlation was found between ZBI and PHS or between ZBI and HLI-SF12 total scores ($p>0.05$). Similarly, no significant correlation was detected between PHS and HLI-SF12 total scores ($p>0.05$). However, a weak but significant negative correlation was identified between ZBI and the "Certainty" and "Self-Awareness" subdimensions of PHS ($r=-0.40$, $p<0.05$). Additionally, a weak but significant positive correlation was found between HLI-SF12 total scores and the "Self-Awareness" subdimension of PHS ($r=0.26$, $p<0.05$).

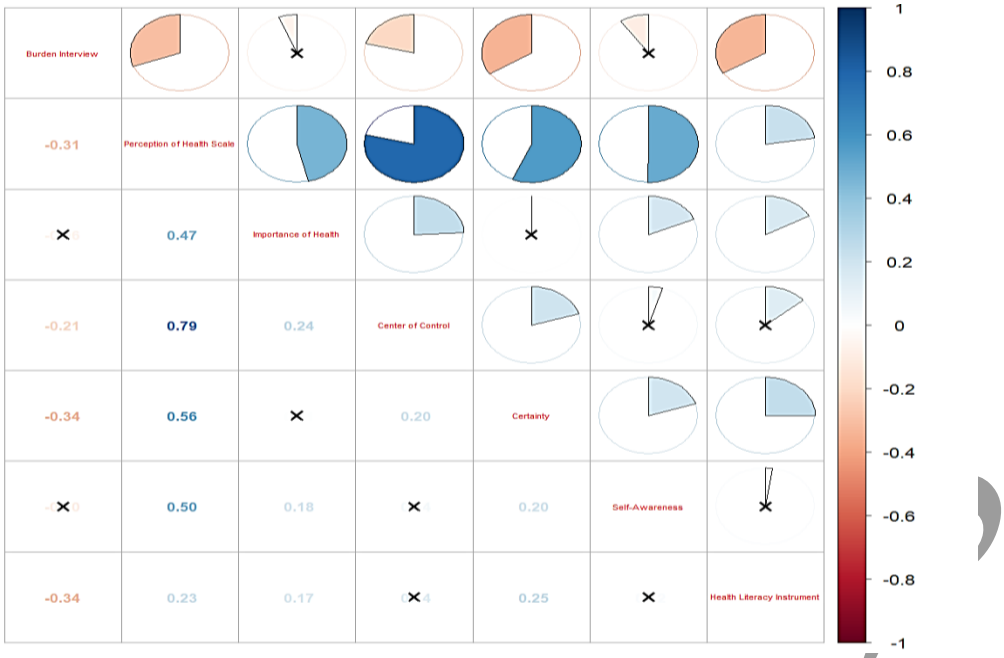


Figure 1. Correlation Graph Showing the Relationships Between PHS, BI, and HLI-SF12 Among Caregivers Using CGM

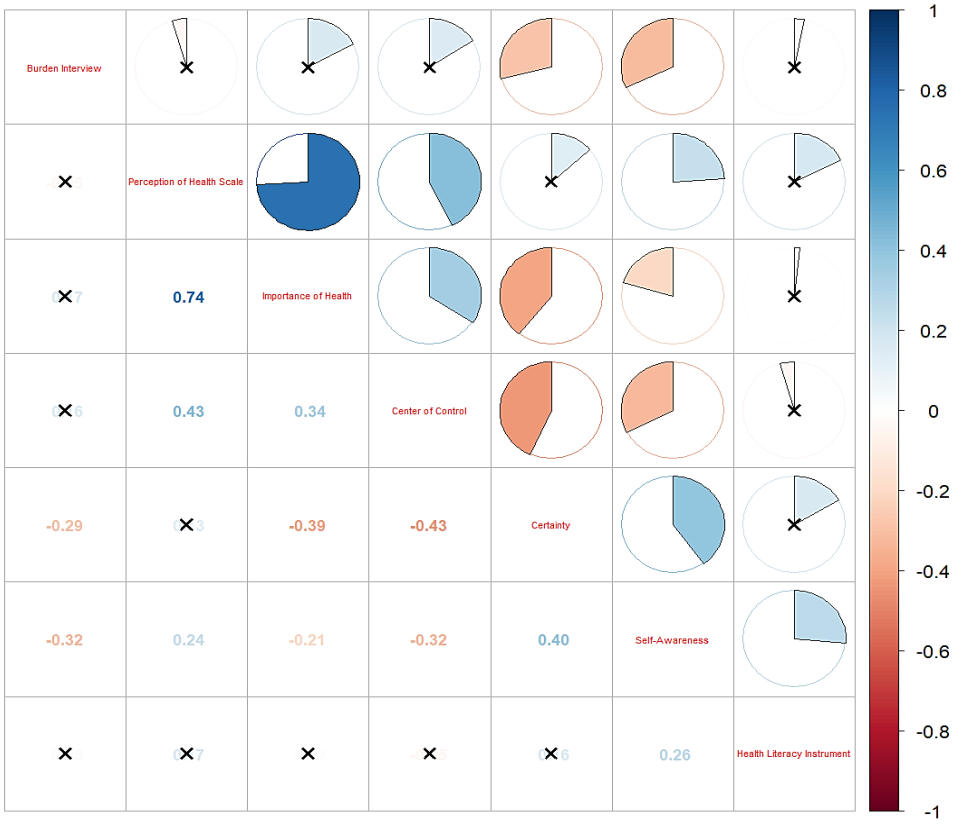


Figure 2. Correlation Graph Showing the Relationships Between PHS, BI, and HLI-SF12 Among Caregivers Using SMBG

Before examining the mediation effect in the measurement model for each group, the direct effect of the independent variable (health perception) on the dependent variable (caregiver burden) was tested, as presented in **Table 3**. The results indicated that health perception had a significant effect on caregiver burden among caregivers of children using CGM (β=-0.1406, $p<0.05$). Since the independent variable had a significant effect on the dependent variable, the presence of a mediating role of health literacy was examined. The 95% confidence interval did not include zero (-0.2606 to -0.0426), indicating the presence of a mediation effect.

Table 3. The Mediating Role of Health Literacy in the Relationship Between Caregiver Burden and Health Perception

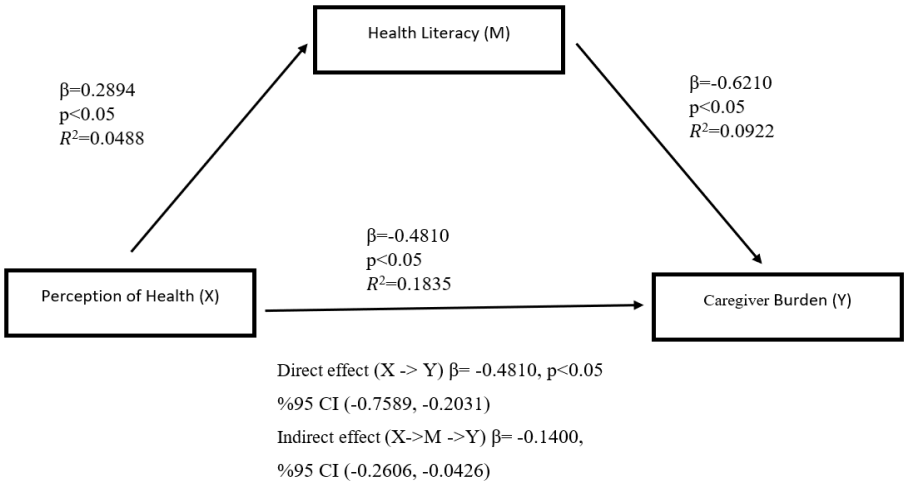
Group	Effect	Estimate	Standard Error	t	p	Result
Caregiver Using CGM for Her Child (n=184)	Perception of Health → Health Literacy	0.2894	0947	3,0566	0.0026*	Significant
	Health Literacy → Caregiver Burden	-0.6210	-0.1444	-4.2997	0.000*	Significant
	Perception of Health → Caregiver Burden	-0.4810	0.1408	-3,4154	0.0008*	Significant
	Direct Effect					Significant
	Perception of Health → Caregiver Burden	-0.4810	0.1408	-3,4154	0.008*	Significant / Partial Mediator
	Indirect Effect	Estimate		Confidence Interval		
	Perception of Health → Caregiver Burden	-0.1400		(-0.2606,-0.0426)		Significant
Group	**Effect**	**Estimate**	**Standard Error**	**t**	**p**	**Result**
Caregiver Using SMBG for Her Child (n=105)	Perception of Health → Health Literacy	0.5292	0.2418	2.1886	0.0309*	Significant
	Health Literacy → Caregiver Burden	-0.1473	0.4434	-0.3322	0.7404	Non-significant
	Perception of Health → Caregiver Burden	-0.1406	0.4558	-0,3084	0.7584	Non-significant
	Direct Effect					
	Perception of Health → Caregiver Burden	-0.1406	0.4558	-0,3084	0.7584	Non-significant
	Indirect Effect	Estimate		Confidence Interval		
	Perception of Health → Caregiver Burden	-0.0067		(-0.1902, 0.2306)		Non-significant

*p<0.05 SMBG: Self-Monitoring of Blood Glucose; CGM:Continuous Glucose Monitoring

After confirming mediation, the type of mediation was determined by assessing the significance of the direct effect. The direct effect remained significant (β=-0.1400, p<0.05), suggesting that health literacy acted as a partial mediator. The results of the mediation analysis examining the relationship between caregiver burden and health perception with health literacy as a mediator among CGM users are illustrated in Figure 3. Health perception had a statistically significant effect on both caregiver burden and health literacy (p<0.05), and health literacy also had a significant effect on caregiver burden (p<0.05). Thus, the mediation effect of health literacy in the relationship between caregiver burden and health perception among caregivers of children using CGM was confirmed. Health perception accounted for 18% of the variance in caregiver burden (R^2=0.1855), while health literacy explained 4.8% of the variance in health perception (R^2=0.0488). Additionally, health literacy accounted for 9% of the variance in caregiver burden (R^2=0.0922) **(Figure 3).**

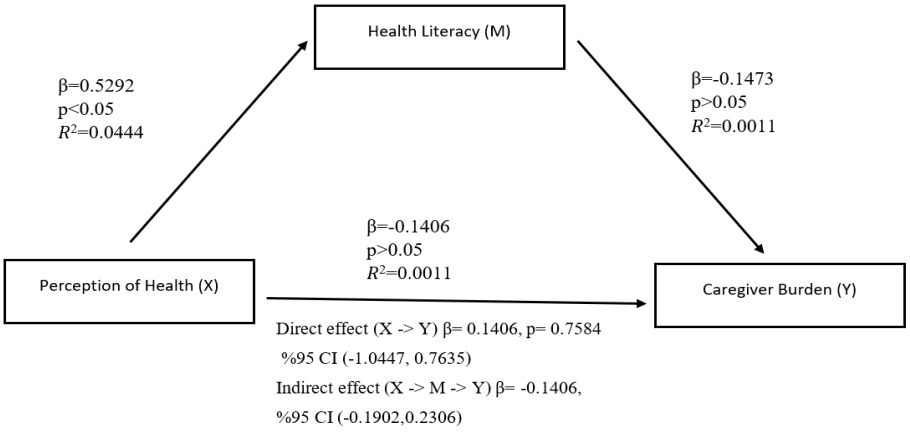
For caregivers of children using SMBG, no statistically significant correlation was found between PHS, ZBI, and HLI-SF12 total scores **(Figure 2).** To confirm the lack of mediation and maintain the coherence of the study, mediation analysis was also conducted for SMBG users, and the results are presented in **Figure 4.**

The results showed that health perception had a significant effect on caregiver burden (β=0.5292, p<0.05). Although the independent variable had a significant effect on the dependent variable, the mediation effect was tested. The 95% confidence interval included zero (-0.1902 to 0.2306), indicating that health literacy did not have a mediating role in this relationship. Furthermore, the direct effect was also found to be non-significant (p>0.05). Therefore, it was concluded that health literacy did not mediate the relationship between caregiver burden and health perception among caregivers of children using SMBG (Table 3).



M: Mediator, X: Independent variable, Y: Dependent variable

Figure 3. The Mediating Role of Health Literacy in the Relationship Between Caregiver Burden and Health Perception Among Caregivers Using CGM



M: Mediator, X: Independent variable, Y: Dependent variable

Figure 4. The Mediating Role of Health Literacy in the Relationship Between Caregiver Burden and Health Perception Among Caregivers Using SBMG

Discussion

This study examined the relationship between health perception and caregiver burden among parents of children with T1DM, with a specific focus on the mediating role of health literacy in the context of glucose monitoring methods (CGM vs. SMBG). The findings revealed three key outcomes: (1) caregivers of children using CGM reported significantly lower caregiver burden and better glycemic control (HbA1c: 7.27 ± 1.42) compared to SMBG users (HbA1c: 8.07 ± 1.35); (2) health literacy partially mediated the relationship between health perception and caregiver burden only in the CGM group; and (3) no such mediation effect was observed

among SMBG users. These results underscore the critical interplay between diabetes technology, health literacy, and psychosocial outcomes in caregiving.

In this study, the majority of caregivers were women, aligning with previous research showing that mothers predominantly manage care for children with T1DM (18-20,29). Bu çalışmada, bakım verenlerin çoğunluğu kadındı ve annelerin ağırlıklı olarak T1DM'li çocukların bakımını yönettiğini gösteren önceki araştırmalarla uyumluydu (18-20,30). Mothers with lower income or inflexible jobs may face greater challenges, particularly with time-intensive methods like SMBG. Conversely, higher-income families may benefit from easier access to CGM, though this can introduce financial or technological burdens.

In this study, it was determined that the HbA1c levels of children using SMBG were higher compared to those using CGM. Previous studies have similarly reported that CGM use is associated with lower HbA1c levels (17,20). Likewise, the study by Azari and Salehpour (2022) indicated a significant reduction in HbA1c levels among children with T1DM who transitioned from SMBG to CGM (31). The continuous glucose monitoring capability provided by CGM allows for the early detection of hyperglycemia and hypoglycemia episodes, enabling timely interventions to prevent blood glucose fluctuations and enhance diabetes management. It is believed that CGM use contributes to reducing HbA1c levels and promotes the sustainability of glycemic control.

When examining the caregiver burden, it was found that caregivers of children using SMBG experienced a higher burden compared to those of children using CGM. However, in both groups, the caregiver burden remained at a moderate level. Similar findings have been reported in the literature, indicating that parents caring for children with T1DM experience a moderate level of caregiver burden (18,19,32,33). The higher caregiver burden observed among those caring for children using SMBG may be explained by the increased time and effort required for frequent blood glucose monitoring through fingerstick testing. While some studies suggest that diabetes technology can help reduce caregiver burden to some extent (19), others report that the additional responsibilities associated with diabetes technology use are linked to caregiver burden (17). This finding helps explain the moderate level of perceived caregiver burden observed in both groups.

Caregivers' health perception was found to be moderate and similar in both groups. This finding is consistent with the existing literature. In a study conducted by Bilgehan and Uludaşdemir (2024) among caregivers of children with T1DM, the majority of caregivers rated their health status as moderate (33). Since T1DM is a lifelong chronic disease, its diagnosis often represents an unexpected, shocking, distressing, and stressful experience for parents (17,34). Therefore, a moderate level of health perception may reflect both caregivers' concerns about their child's health and their ongoing process of acceptance and adaptation.

In this study, it was found that caregivers of children using CGM had above-average health literacy levels, whereas caregivers of children using SMBG had average health literacy levels. These findings suggest that caregivers of children using CGM are more proficient in accessing, interpreting, and applying digital health information. Several studies in the literature have examined the health literacy of caregivers of children with T1DM (18,20). The study by Hölgyesi et al. (2024) demonstrated that parents of children using CGM had significantly higher electronic health literacy levels compared to those using SMBG (20). This may be due to the complex digital interfaces and data interpretation demands associated with CGM, which require and potentially reinforce higher levels of e-health literacy. Furthermore, individuals with higher baseline health literacy may be more inclined to adopt and effectively use CGM technologies, suggesting a bidirectional relationship between CGM use and health literacy. It is believed that CGM use enhances caregivers' health literacy, enabling them to play a more informed and active role in diabetes management. Moreover, caregivers with higher health literacy may be more likely to choose CGM for their child's T1DM management and develop greater awareness of this system. Therefore, it is recommended to promote the widespread adoption of CGM in the care of children with T1DM and to implement more active educational programs aimed at improving caregivers' health literacy. This approach could enhance caregivers' competence in diabetes-related decision-making processes and support them in managing their child's glycemic control more effectively.

In caregivers of children using CGM, it was found that as health literacy increased, caregiver burden decreased. This finding is supported by previous studies that have reported a negative relationship between health literacy and caregiver burden (16,18). In a study conducted by Barutcu (2019) among caregivers of individuals with chronic illnesses, a significant association was identified between health literacy and caregiver burden, with higher health literacy levels

associated with lower caregiver burden (16). Similarly, in the study by Yu et al. (2023)(18), although glucose monitoring methods were not specified, it was found that as caregivers' electronic health literacy increased, their caregiver burden decreased.

In this study, it was found that as caregiver burden increased, health perception decreased among caregivers of children using CGM. The complexity of T1DM management, including continuous glucose monitoring, insulin dose adjustments, and the regulation of the child's daily life (35), can lead to physical and emotional exhaustion among caregivers (17). This exhaustion may cause caregivers to neglect their own health or perceive their health status more negatively. Additionally, this situation may contribute to poor glycemic control in the child, creating a vicious cycle (35). Developing intervention programs aimed at alleviating caregiver burden may improve caregivers' health perception while also enhancing the effectiveness of diabetes management in children.

In this study, it was found that as health perception increased, health literacy levels also increased among caregivers of children using CGM. An improved health perception can lead caregivers to adopt healthier behaviors. Moreover, higher health literacy among caregivers has been positively associated with the child's health outcomes (36). This relationship may contribute to both caregivers maintaining their own health and enhancing their ability to manage their child's diabetes. Higher health literacy enables caregivers to navigate the healthcare system more effectively, communicate better with diabetes care teams, and engage more actively in their child's treatment process, ultimately leading to better care outcomes (20).

In this study, it was found that among caregivers of children using SMBG, an increase in the "self-awareness" subdimension of health perception was associated with higher health literacy. Self-awareness enhances an individual's ability to assess their own health-related knowledge and skills, allowing caregivers to make more informed decisions and use health information more effectively during the caregiving process. Particularly, caregivers managing blood glucose through SMBG play a more active role in their child's daily care routines and are required to interpret frequent measurement results. This continuous involvement in diabetes management may increase caregivers' awareness and, in turn, contribute to the development of their health literacy.

This study's mediation analysis revealed a crucial distinction: health literacy significantly mediated the relationship between health perception and caregiver burden in the CGM group ($\beta = -0.1400$, $p < 0.05$), while no such effect emerged for SMBG users. This finding suggests that the continuous data flow provided by CGM contributes to more informed decision-making in diabetes management, enhances health literacy, and ultimately reduces caregiver burden. These findings suggest that caregivers with higher health literacy are better able to manage the caregiving process, leading to a reduction in their burden. Given the challenges of caregiving, protecting caregivers' health and alleviating their burden is of great importance. Specifically, enhancing health literacy can facilitate easier access to information, enabling caregivers to make more informed decisions and manage the caregiving process more effectively. Therefore, it is recommended to implement educational programs aimed at improving caregivers' health literacy and to establish personalized support mechanisms to assist them throughout the caregiving process. Caregivers of children using CGM may benefit from better glucose monitoring and more accurate and timely responses to fluctuations, which can positively influence their health perception. In contrast, among caregivers of children using SMBG, health literacy did not demonstrate a significant mediating effect in this relationship. This may be attributed to the manual nature of SMBG, which requires intermittent blood glucose checks, leading to longer periods of uncertainty between measurements for caregivers. Additionally, caregivers who continue to rely on SMBG may have limited exposure to digital health technologies and fewer opportunities to develop e-health literacy skills, resulting in overall lower health literacy levels compared to CGM users. Socioeconomic barriers, such as lower income or limited digital access, may also contribute to this disparity, as they can restrict both access to CGM technology and participation in health education resources. This finding supports the literature indicating that CGM use in diabetes management provides not only physiological benefits but also plays a crucial role in alleviating caregivers' psychosocial burden and improving health literacy (16,18-20).Therefore, to enhance caregivers' health literacy and reduce caregiver burden, the use of CGM in children with T1DM should be encouraged, and CGM integration into diabetes nursing education programs should be prioritized. Health professionals—particularly diabetes nurses—should take an active role in assessing caregivers' health literacy levels during routine care, tailor communication accordingly, and provide structured training on interpreting glucose data. By incorporating health literacy components into caregiver education nurses can help bridge gaps

in both knowledge and technology use. However, it is important to note that CGM use is not without limitations. Factors such as high device cost, unequal access depending on geographic or socioeconomic conditions with proper use may pose significant barriers to widespread adoption. These challenges must be considered when designing interventions or recommending CGM as part of standard diabetes management.

Study Limitations and Strengths: This study has several limitations. First, data were collected through an online survey, which may introduce self-report bias. Additionally, the study was conducted in a specific region, limiting its generalizability to caregivers from different countries or cultures. Furthermore, other potential factors, such as caregivers' psychosocial status and support mechanisms, were not examined in detail.

Conclusıon

This study found that health literacy mediates the relationship between caregiver burden and health perception in CGM users, but not in SMBG users. The continuous data flow from CGM aids decision-making, reducing caregiver burden. Diabetes nurses should enhance caregivers' health literacy through educational programs and encourage CGM use for better health perception and reduced burden. Additionally, psychosocial support, including counseling and support groups, should be provided. Future research should assess interventions for improving health literacy and explore digital health technologies in diabetes management. Longitudinal and intervention-based studies are particularly needed to determine whether targeted educational programs can sustainably enhance caregivers' health literacy and, in turn, alleviate their perceived burden.

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