Title: Delay discounting of gains and losses, glycemic control and therapeutic adherence in type 2 diabetes

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HIGHLIGHTS

- Delay discounting is the tendency to prefer smaller, sooner rewards to larger, later ones.
- Poorer adherence could be explained by a discounted value of health, as a function of delay.
- A positive correlation was found between delay discounting and HbA1c.
- These findings could lead to new strategies to improve glycemic control.

Delay discounting of gains and losses, glycemic control and therapeutic adherence in type 2 diabetes.

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Abstract

Objective: Delay discounting is the tendency to prefer smaller, sooner rewards to larger, later ones. Poor adherence in type 2 diabetes could be partially explained by a discounted value of health, as a function of delay. Delay discounting can be described with a hyperbolic model characterized by a coefficient, k. The higher k, the less future consequences are taken into account when making decisions. This study aimed to determine whether k would be correlated with glycated hemoglobin and adherence in type 2 diabetes.

Methods: Ninety-three patients were recruited in two diabetology departments. Delay discounting coefficients were measured with a computerized task. HbA1c was recorded and adherence was assessed by questionnaires. Potential socio-demographic and clinical confounding factors were collected.

Results: There was a positive correlation between delay discounting of gains and HbA1c ($r=0.242$, $P=0.023$). This association remained significant after adjusting for potential confounding factors ($F=4.807$, $P=0.031$, $\eta^2 = 0.058$). This association was partially mediated by adherence to medication ($\beta = 0.048$, 95% CI [0.004-0.131]).

Conclusions: Glycemic control is associated with delay discounting in patients suffering from type 2 diabetes. Should these findings be replicated with a prospective design, they could lead to new strategies to improve glycemic control among these patients.

Keywords: Adherence; Delay Discounting; Diabetes Mellitus Type 2; Glycated Hemoglobin

1. Introduction

According to the World Health Organization, only 50% of patients with chronic illness demonstrate satisfactory adherence, at best [1]. Adherence is defined as the extent to which a patient's behavior is consistent with medical or health advice. It applies to all aspects of the treatment, including: accepting a screening, attending a consultation, taking medication as prescribed, monitoring its efficiency and changing health behavior. It is particularly essential and difficult for patients with chronic, asymptomatic diseases, for which treatment has preventive rather than curative goals and may impact quality of life [2]. Type 2 diabetes is typically one of these diseases. In the treatment of diabetes, poor adherence has dramatic, yet delayed, consequences in terms of quality of life, complications and expenses [3]. The determinants of adherence have been thoroughly studied [4] but means of improving adherence are scarce and of a modest efficiency. Poor adherence might be interpreted as partially resulting from a lower value attributed to health as compared to other goals. This study is based on the hypothesis that the value of health, as any other reward, might be discounted as a function of the delay necessary to obtain this reward. Indeed, expected benefits of patients' care are often delayed [5].

The concept of delay discounting is a central element of behavioral economics, the branch of psychology that studies decision-making based on the attribution of values. It describes the extent to which one's behavior is driven by an immediate gratification vs. the prospect of a larger, but delayed, reward. Behavioral economics have demonstrated that human beings make decisions as if they attribute to each option a subjective value and then choose the option with the highest value. There is evidence that delay discounting can best be described with a hyperbolic mathematical model: $V=A/(1+kD)$, where V is the subjective value, A the objective value, D the delay and k the delay discounting coefficient [6], [7]. For individuals with higher values of k, the subjective value that underlies decision-making decreases more steeply when the delay necessary to obtain the reward increases. In other words, the higher k, the discounting coefficient, the less distant outcomes are considered in decision-making. For instance, in the context of health behaviors, individuals with high k will prefer the sooner/smaller reward of high caloric food rather than the later/larger reward of a better health [8].

There is some evidence that lower discounting rates are associated with more engagement in healthy behavior such as wearing a seatbelt, sunscreen or exercising [6], [8], [9]. Previous

studies have also examined the ties between certain personality traits and medication adherence [10] or glycemic control [12], showing for instance a link between conscientiousness (i.e. a trait associated with the ability to pursue long term goals) and a positive health outcome. In a previous study, patients suffering from type 2 diabetes with a poorer glycemic control were found to prefer a smaller-sooner reward [13]. However, this study was based on a 3-option single choice that did not allow the computing of a discounting coefficient. Based on these preliminary findings, our hypothesis was that delay discounting might play a role in adherence and thus in metabolic control of patients suffering from type 2 diabetes. However, some patients may prefer to avoid small, immediate losses because of the delay discounting of larger, but delayed and uncertain losses: the complications of type 2 diabetes. Since being adherent in the context of type 2 diabetes could be more about cutting losses than receiving rewards, the delay discounting of losses might better reflect what patients with diabetes actually go through. Overall, assessment of patients' delay discounting tendencies could help to explain their behavior towards adherence and contribute to design new interventions to improve their adherence [14].

Our main objective was to examine the relationships between delay discounting coefficients, glycated hemoglobin (HbA1c) and self-reported adherence in patients with type 2 diabetes. First, we hypothesized that there would be a positive correlation between the delay discounting coefficients and HbA1c. Second, we hypothesized that this relationship would be partially mediated by adherence and would thus be significantly attenuated after adjustment for this variable.

2. Methods

2.1 Participants

Between February and May 2013, we recruited 102 patients with type 2 diabetes in two departments of diabetology in Pitié-Salpêtrière Hospital and Hôtel-Dieu Hospital (Paris, France). The participants were recruited during either a consultation of diabetology, a day or week hospitalization, or a full time diabetology hospitalization. The inclusion criteria were: patients aged 40 to 75, diagnosed with type 2 diabetes for at least 6 months, French-speaking, having a glycated hemoglobin measure dating from less than a week and having given a written consent. The exclusion criteria were: a current psychotropic treatment (antipsychotic drugs or antidepressants in the last 4 weeks or benzodiazepine/anti-anxiety medication in the last 72 hours), cognitive impairment due to psychosis, severe head trauma, dementia, stroke, or any chronic affection of the central nervous system. The age boundaries excluded patients under 40 years-old because type 2 diabetes is less common before that age, and patients over 75 in order to avoid patients with undiagnosed cognitive impairment. We also excluded patients with a non-interpretable measure of HbA1c (severe chronic renal failure, hemoglobinopathy interfering with HbA1c assay, and recent bloodlettings). Among 109 patients approached, only 7 refused to participate.

2.2 Study protocol

Written information about the study, completed with oral information was given to each participant and we gathered their written, informed consent. The patient's inclusions and evaluations were performed in only one time frame by the same investigator (GL). First, socio-demographic, clinical (i.e. treatment regimen, complications, duration of disease) data were gathered from clinical records and treating physicians and patients filled out questionnaires for the psychometric evaluation. Then, the patients completed computer-based tasks designed to calculate the discounting coefficients. Finally, they completed questionnaires concerning their adherence. Clinical data and the last HbA1c value were also collected by consulting the medical records. The patients' participation lasted approximately an hour. This study was approved by the

local ethics committee (Comité de Protection des Personnes, Ile de France II) on October 10th, 2012.

2.3 Psychosocial assessment

The psychometric evaluation was based on the French versions of the following scales: the Hospital Anxiety and Depression Scale (HADS), the Working Alliance Inventory (WAI-12) and the EPICES questionnaire. The HADS is a 14-item questionnaire divided into 7 items concerning anxiety and 7 items concerning depression. It was specifically designed to evaluate the anxiety or depression in patients with co-morbid somatic conditions. Each item calls for an answer on a scale of 0 to 3 for a final score up to 21 for each subscale, either anxiety or depression, with high internal consistency (Cronbach's alpha coefficient = 0.79 and 0.80 for anxiety and depression respectively). This questionnaire was included because depression might affect the measure of delay discounting coefficients and the quality of adherence [15], [16]. The WAI-12 is a 12-item questionnaire with each item scoring between 0 and 7 on a Likert-type scale, examining 3 important dimensions of alliance: the doctor-patient relationship, agreeing on goals of treatment and agreeing on means of treatment. A general score with high internal consistency (Cronbach's alpha coefficient = 0.89 in the present sample) can be computed by adding the scores of the 12 items and is usually given as a percentage from 0 to 1. This questionnaire was included because the quality of the doctor-patient relationship might influence glycemic control [17]. The EPICES questionnaire is an 11-item questionnaire that evaluates the level of social deprivation on a scale of 0 to 100. A score over 30 indicates social deprivation. This test was included because delay discounting rates vary according to socioeconomic status and social adversity [18], and because social deprivation is a cause of poor adherence [19] and poor metabolic control [20].

2.4 Glycemic control assessment

Quality of glycemic control was assessed by HbA1c measurement: either the measure performed on the day of the visit or the patient's last measure (less than a week old). The individual HbA1C target for each participant was collected from the patient's physician.

2.5 Assessment of adherence

Adherence was assessed by two self-administered questionnaires. To decrease response biases, it was explicitly told to the participants that their answers were anonymous and would not be communicated to their physicians. The Girerd Questionnaire interrogates adherence to medication, it is made up of 6 yes or no questions concerning treatment adherence in the last seven days [21]. The score is computed by summing up the number of "yes" responses so that a higher score reflects a better adherence. The Summary of Diabetes Self-Care Activities (SDSCA) concerns the other aspects of treatment. It questions how frequently the patients followed their physician's advice in the last 7 days in the following activities : dieting, exercising, blood sugar testing, foot care, taking medication and smoking [22]. Sub-scores are computed to obtain a percentage of adherence. Here we considered the 4-item sub-scale that assesses the patients' diet, which was, the only subscale that showed a sufficient internal consistency in the present sample (Cronbach's alpha coefficient = 0.61).

2.6 Assessment of discounting coefficients

Discounting tasks usually assess delay discounting of gains but some studies have also examined discounting of losses [23], [24]. Here, separate delay discounting tasks examined both gains and losses. While future health was used as the commodity in the discounting task in some previous studies [25] money was chosen in the present study for several reasons: first, we built on a preliminary study in which money was used [13]; second, there is some evidence that reinforcing value of health might operate similarly to the reinforcing value of other primary or secondary reinforcers [6]; third, the delay discounting of money was found to be related with several health outcomes, including addictive behaviors and obesity [26], [27]; fourth, we felt that

findings obtained with health as the commodity could have been criticized for circularity because of the nature of the dependent variable, which is a health outcome.

The delay discounting tasks were set up using Matlab® software to enable the determination of k, the coefficient of discounting, based on delay discounting curves. Regarding gain discounting, for instance, the task consisted in presenting the patients with a series of binary choices between a small monetary reward and another, larger one, but available later (e.g. "Would you prefer 10€ now or 20€ in a month?"). The rewards were hypothetical, knowing that real and hypothetical money have produced the same outcome in discounting tasks [28]. The analysis of a patient's choices shows "indifference points" which are the choices for which patients can choose either option with equal probabilities. For example, one patient will always pick €20 now over €21 in a month and always pick €50 in a month over €20 now, but he can pick indifferently €20 now or €30 in a month. For this patient €20 now has the same subjective value as €30 in a month, it is an "indifference point". To determine these indifference points, patients are faced with binary choices, which are adapted on a trial by trial basis, depending on the subject's decisions, so that they converge to indifference points, following a stair-case procedure. The indifference points allow the fitting of the hyperbolic delay discounting model to the obtained indifference points [6], [7]. The same procedure was applied to extract coefficients of delay discounting of losses.

All subjects undertook the two tasks in a randomized order to avoid any order effect. In the delay discounting task regarding gains, they were offered sixty choices between smaller rewards they could win sooner, or bigger rewards associated with 10 delays ranging from 3 days to 10 years, the rewards ranged from 1 to 100€. This led to the determination of the coefficient for delay discounting of gains. In the "loss" delay discounting task, they had sixty choices between losing a small quantity of money sooner or losing a larger one, later, using the same amounts and the same delays.

2.7 Statistical analysis

We used the PASW Statistics 18 software (Chicago: SPSS Inc.) for statistical analysis of our data. The study by Reach et al. [13], included 90 patients; given our methodological

improvement, we expected a better sensitivity and we estimated that the sample size should be one hundred patients. Furthermore, McKillop's meta-analysis of delay discounting and addictive behavior [29] found 46 studies where "multi-item choice task" were used to determine the delay discounting coefficient, 36 of which included less than 100 patients, 21 of which found significant results. Our two predictors of interest were the delay discounting coefficients for gains and losses. Since raw values were skewed, they were log transformed, prior to statistical analyses, to achieve normal distribution, as confirmed by the decrease of the skewedness index [30]. Our main dependent variable was HbA1c. Our two potential mediating variables were the scores of the two adherence questionnaires. Potential confounding variables (i.e. socio-demographic, clinical and psychological data) were identified using T-tests and univariate ANOVAs for categorical variables and Pearson's correlations for continuous variables. These variables were defined as being associated with HbA1c with a *P* value <0.10, which is a standard cut-off value to select potential confounding variables to be included in a multivariate model [31]. To test our primary hypothesis, Pearson's correlations were first computed to look for correlations between delay discounting coefficients and HbA1c. Then, a general linear model examined the association between delay discounting coefficients and HbA1c while adjusting for potential confounding variables. To test our secondary hypothesis, linear regression analyses were conducted to assess each component of the proposed mediation model, which was tested with the bootstrapping method [32]. Bias-corrected 95% confidence intervals were obtained with 20,000 bootstrap resamples. In addition, whenever a significant mediation effect was found, adherence score was included in the general linear model. Consistent with our secondary hypothesis, we expected an attenuation of the association between the delay discounting coefficient and HbA1c when the adherence score was included in the general linear model**.** Statistical significance was set at *P*<0.05, two-sided.

3. Results

Six patients out of 102 who had missing data and 3 who explicitly disclosed not having understood at least one of the discounting tasks were excluded from the analyses. This led to a final study sample of 93 patients suffering from type 2 diabetes (50 men and 43 women) with a mean age of 60.1 years old (standard deviation, SD=8.6). The main socio-demographic and clinical characteristics of the subjects are summarized in Table 1. Patients' mean HbA1C was 8.8% (73 mmol/mol, SD=15). On the first adherence scale, the Girerd Questionnaire, the mean score was 4.57/6 (SD=1.20), on the second one, the SDSCA, the mean score was 53.3% (SD=23%) for the diet subscale.

Table 1 also displays the results of univariate analyses. These analyses aimed at identifying potential confounding variables. The variables associated with HbA1c were: gender, source of recruitment, coronary heart disease, the HbA1c target, the WAI-12 score (therapeutic alliance) and the EPICES score (social deprivation). These variables were selected to be included in multivariate models (see below).

As expected, a hyperbolic curve offered a good fit for most patients. Regarding delay discounting of gains, the mean variance accounted for (R^2) over all the individual participants was .8075. Among the 93 patients of the study population, 3 patients whose total square distance between the fitted hyperbolic function and the observed indifference points for the "gain" task was more than 2 standard deviations above the mean for the square sum were excluded. We also excluded one subject whose coefficient was beyond 2 standard deviations for the "gain" task. Similar criteria led to the exclusion of 2 patients for the "loss" task. These exclusion criteria were used to exclude patients who may not have understood the tasks. The following analyses were thus conducted on 88 participants for the gain task and 91 participants for the loss task.

In accordance with our primary hypothesis, there was a positive correlation between the delay discounting coefficient for gains and HbA1c (r=0.242, P=0.023). In other words, the poorer the glycemic control, the steeper the delay discounting (Figure 1). In contrast, the delay discounting coefficient of losses was not correlated with HbA1c, nor with the coefficient for delay discounting of gains ($p>0.05$). Therefore, we did not pursue further multivariate analyses for this variable. In line with our primary hypothesis, the association between the delay discounting coefficient for gains and HbA1c remained significant after adjustment for potential

confounders (F=4.807, P=0.031, $\eta^2 = 0.058$) with a proportion of explained variance of 5.8%, in a general linear model (Table 2). In line with our second hypothesis (i.e. that adherence would mediate the association between delay discounting and glycemic control), the Girerd Questionnaire score was negatively correlated with HbA1c (Table 1) and the results of the mediation analyses confirmed the partial mediating role of adherence to medication in the relationship between delay discounting and HbA1c ($\beta = 0.048$, 95 CI [0.004-0.131]). Indeed, when including the score of the Girerd Questionnaire score in our general linear model, the association between the delay discounting coefficient and HbA1c was no longer significant (F=3.801, P=0.055, $\eta^2 = 0.047$). Concerning the SDSCA, the diet sub-score was negatively correlated with HbA1c but there was no correlation with k and no evidence for a partial mediation effect (β =0.0034, 95% CI [-0.182; 0.0467]).

4. Conclusions

The main objective of this study was to examine the association between delay discounting of gains and losses and HbA1c in patients with type 2 diabetes. In accordance with our primary hypothesis, we found a positive, statistically significant, correlation between the delay discounting coefficient for gains and HbA1c. Despite the small proportion of explained variance, the relationship between the delay discounting coefficient for gains and HbA1c was a robust one. This association remained significant after adjustment for potential confounding variables in a general linear model. In contrast, we did not find a correlation between the delay discounting coefficient for losses and HbA1c. Concerning our secondary hypothesis, there was evidence for a partial mediation by medication adherence, confirmed by the attenuation of the association between the delay discounting coefficient and HbA1c when including the adherence variable in the general linear model.

Building on previous findings [13], this study examined in more details the relationship between delay discounting and glycated hemoglobin in patients suffering from type 2 diabetes. Compared with this previous study, the present study has several methodological strengths. In Reach & al.'s study, the discounting coefficients were assessed by one multiple-choice question whereas in our study, the discounting coefficients were computed using a state-of-the-art method and all patients undertook discounting tasks for gains and losses, which gave us a broad and precise sense of their delay discounting habits. In addition, adherence was studied with two different questionnaires and subjects were recruited on two different sites. Several potential confounders were taken into account in the statistical analysis.

Apart from these strengths, some limitations should also be mentioned. The first limitation of our study is its cross-sectional design which prevents us from inferring any causal conclusion concerning the association between HbA1c and delay discounting of gains. These associations may be explained by reverse causality or residual confounding. As an example of reverse causality, poor glycemic control may be associated with a pessimistic view of the future, and an increased interest in short term rewards. As an example of residual confounding, patients with high delay discounting coefficients have a higher prevalence of alcohol addiction than the general population [33] and, on the other hand, alcohol consumption is associated to non-adherence [34]. Alcohol consumption was not measured in our study and its potential mediating

or confounding role could thus not be tested. A second limitation is the low explained variance, despite a robust association. However, the explained variance was higher than for most of the other variables considered. Finally, our adherence questionnaires may not be perfectly relevant to describe adherence thoroughly. The Girerd Questionnaire only mentions medication adherence, and the SDSCA, which has a broader scope, has a low internal consistency. In addition, these measures are self-reported and may be influenced by reporting biases such as social desirability.

The association of glycemic control with gain discounting but not with loss discounting might sound counterintuitive since the goal of type 2 diabetes management is more about preventing complications (i.e., a loss of health) than improving health *per se* (i.e., a gain). Behavioral economics has shown that decision-making is strongly influenced by the way problems are formulated [35]. According to the Prospect theory, people make decisions by using a reference point to judge whether a particular outcome is a gain or a loss [35]. Since people usually prefer avoiding losses than making equivalent gains, a well-established tendency referred to as “loss aversion”, positive and negative representations of the outcome may influence decision-making by inducing shifts in the location of the reference point. Loss aversion may contribute to some extent to the well-described “sign effect”, also observed in the present study, according to which delay discounting rates are usually higher for gains than losses [36]. Therefore, an example of framing effect of particular relevance here is “goal framing”, in which the consequences of performing or not performing an act are represented as a gain versus a loss (e.g., "if I follow this treatment, my life will be prolonged" versus " if I do not follow this treatment, my life will be shortened"). The association of glycemic control with gain discounting but not with loss discounting suggest that patients with type 2 diabetes may formalize the problem they face in terms of potential gains rather than potential losses. Although goal framing has been recommended as a communication device to encourage adherence, there is only little if any evidence that the physician’s formulation of the problem may substantially influence the patient’s decision [37]. Patients may indeed represent the goal of treatment as a gain, regardless of physicians’ formulation. According to the Prospect theory [35], they may set their reference point by integrating the inevitable decline of their health over time, thus representing potential treatment benefits as promoting future gains in health (compared to future health) rather than preventing future losses (compared to current health). As a consequence, motivation for

achieving glycemic control might be influenced to a greater extent by gain discounting than loss discounting.

Poor adherence is one of the biggest issues when taking care of patients suffering from chronic diseases such as type 2 diabetes. However, validated interventions to help patients with their adherence have shown limited efficacy at best. Although discount rates for an individual are relatively stable over time, they can be lowered in certain situations [38]. Should our results be replicated in a prospective study with a larger sample, thus increasing confidence in a causal relationship, interventions targeting delay discounting could be assessed in type 2 diabetes patients to try to improve glycemic control. Importantly, the implementation of these interventions in clinical setting would not need any measure of delay discounting.

For instance, the delay discounting rate can be lowered by promoting imagination of future events [39], as it helps to increase the subjective value of delayed, but larger rewards such as health. Intervention studies might test whether encouraging patients to imagine themselves in a future without the complications of type 2 diabetes would be helpful to improve adherence and glycemic control. It is also possible to imagine that individuals with elevated delay discounting and poor adherence might benefit from contingency management interventions that provide some immediate incentive for compliance, as suggested by a review of reinforcement interventions, such as monetary rewards in chronic diseases, and specifically in diabetes, which shows these intervention can be highly effective in improving patient behaviors and outcomes [40]. Some studies have also shown that magnitude of delay discounting can be altered in certain populations [41] while others have successfully trained patients in “tolerance to delay” [42].

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Figure 1: Delay discounting curves for HbA1c quartiles

Subjective values of a gain of €10 as a function of delay. The median delay discounting curves are presented for each quartile of HbA1C (e.g.: the subjective value of a gain of 10€ in 30 days is equivalent to a gain of 7€ now for the first quartile, about 3€ now for the second and third quartile and about 1.5€ now for the fourth quartile).

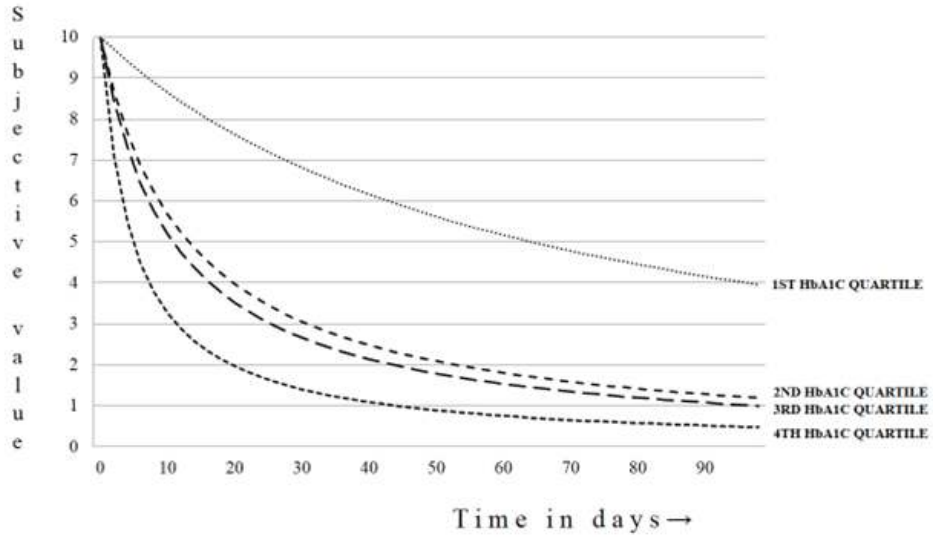

Table 1: Socio-demographic characteristics of patients and univariate analyses

			HbA1c	
		N (%)	**Mean ± SD**	***P***
Gender	Men	50 (53.8)	9.07 ± 2.02	0.032
	Women	43 (46.2)	8.48 ± 1.50	
Hospital	Pitié-Salpêtrière	65 (69.9)	8.96 ± 2.02	0.107
	Hotel-Dieu	28 (30.1)	8.43 ± 1.15	
Source of recruitment	Consultation + Day Hospital (Pitié-Salpêtrière)	30 (32.3)	8.10 ± 1.77	0.002
	Week Hospital (Pitié-Salpêtrière)	26 (28.0)	9.63 ± 1.66	
	Week Hospital (Hotel-Dieu)	23 (24.7)	8.31 ± 0.97	
	Full time Hospital (both hospitals)	14 (15.1)	9.54 ± 1.81	
Marital Status	Married	62 (66.7)	8.77 ± 1.60	0.76
	Divorced	14 (15.1)	8.56 ± 2.09	
	Single	12 (12.9)	8.70 ± 1.48	
	Widow(er)	5 (5.4)	8.80 ± 1.81	
Education	Level 1	13 (14.0)	8.58 ± 1.56	0.318
	Level 2	6 (6.5)	10.51 ± 2.74	
	Level 3	13 (14.0)	8.70 ± 2.24	
	Level 4	8 (8.6)	8.93 ± 1.39	
	Level 5	9 (9.7)	9.29 ± 1.65	
	Level 6	16 (17.2)	8.58 ± 1.68	

	Level 7	25 (26.9)	8.64 ± 0.15	
	Level 8	3 (3.2)	7.53 ± 1.81	
Complications	None	41 (44.1)	8.62 ± 1.85	0.767
	≥ 1 complication(s)	52 (55.9)	8.95 ± 1.79	
	1 complication	24 (25.8)	8.90 ± 1.97	0.299
	2 complications	17 (18.3)	8.79 ± 1.45	
	3 complications	9 (9.7)	8.81 ± 1.73	
	4 complications	2 (2.2)	11.5 ± 0.41	
Retinopathy	Yes	35 (37.6)	9.09 ± 1.87	0.229
	No	58 (62.4)	8.63 ± 1.77	
Renal Failure	Yes	14 (15.1)	8.37 ± 1.36	0.339
	No	79 (84.9)	8.88 ± 1.88	
Arteriopathy	Yes	9 (9.7)	9.70 ± 1.82	0.118
	No	84 (90.3)	8.71 ± 1.80	
Coronary Heart Disease	Yes	14 (15.1)	9.74 ± 2.03	0.036
	No	79 (84.9)	8.64 ± 1.73	
Neuropathy	Yes	21 (22.6)	8.72 ± 1.52	0.813
	No	72 (77.4)	8.83 ± 1.90	
Diabetologist	Yes	86 (92.5)	8.71 ± 1.63	0.358
	No	7 (7.5)	9.96 ± 3.30	
Family History of	None	36 (38.7)	8.85 ± 1.77	0.972
	1 second degree relative	8 (8.6)	8.71 ± 2.02	

Type 2 Diabetes	1 first degree relative	28 (30.1)	8.69 ± 1.90	
	> 1 first degree relative	21 (22.6)	8.91 ± 1.88	
Treatment	Diet only	2 (2.2)	8.40 ± 1.27	0.500
	Diet + oral antidiabetic medication	37 (39.8)	8.55 ± 2.15	
	Diet + insulin ± oral antidiabetic medication	54 (58.1)	8.99 ± 1.56	
		Mean ± SD	***r***	***P***
Age (years)		60.1 ± 8.6	-0.072	0.33
Body Mass Index (kg/m²)		31.70 ± 7.3	-0.104	0.319
HbA1c target (%)		6.80 ± 0.6	0.765	<0.001
Diabtetes Duration (years)		14.08 ± 8.1	-0.032	0.758
Hospital Anxiety Scale		7.89 ± 4.3	0.059	0.571
Hospital Depression Scale		5.25 ± 3.9	0.081	0.438
12-item Working Alliance Inventory		70.26 ± 11.8	-0.222	0.032
EPICES (social deprivation)		29.46 ± 19.4	0.256	0.013
Girerd questionnaire		4.57 ± 1.20	-0.363	0.010
SDSCA - Diet		0.53 ± 0.23	-0.247	0.020
SDSCA - Physical Activity		0.32 ± 0.23	-0.112	0.299
Log (k) for gains (N=88)		-2.90 ± 2.62	0.242	0.023
Log (k) for losses (N=91)		-6.13 ± 2.94	-0.044	0.676

SD: Standard Deviation; SDSCA: Summary of Diabetes Self-Care Activities

Table 2: The association between the delay discounting coefficient for gains and HbA1c in a general linear model.

	D	*p*	Partial Eta Squarred
Sex	4,312	,041	,052
Source of recruitment	1,235	,303	,045
CoronaryHeartDisease	1,577	,213	,020
WAI Score (alliance)	2,216	,141	,028
EPICES Score	,014	,906	,000
HbA1c Target	96,619	,000	,553
Log_K_gain_delay	**4,807**	**,031**	**,058**