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Effect of an 'implementation intention' intervention on adherence to oral anti-diabetic medication in Brazilians with type 2 diabetes

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ABSTRACT

Objective: To evaluate the effects of an implementation intention intervention on adherence to an oral anti-diabetic medication regime, diabetes-related distress and on glycemic control in patients with type 2 diabetes mellitus.
Methods: A randomized, parallel-group, single-center controlled trial was conducted among adults with type 2 diabetes being managed at the primary care level. The intervention group (IG, n = 45) received an 'implementation intention' intervention; the control group (CG, n = 45) received standard care. Primary outcomes were the taking of oral anti-diabetic medication, global adherence and level of glycated hemoglobin. The secondary outcome was diabetes-related distress. Data were gathered at baseline and after 15 weeks.
Results: The IG showed improvements in adherence to an oral anti-diabetic medication regime ($p < 0.0001$), glycemic control ($p < 0.0001$) and diabetes-related distress ($p < 0.0001$) relative to the CG.
Conclusions: The implementation intention intervention enhanced adherence to an oral anti-diabetic medication regime, which had positive effects on blood glucose levels and diabetes-related distress.
Practice implications: Adherence to an oral anti-diabetic medication regime can decrease blood glucose levels and diabetes-related distress and thus reduce complications of type 2 diabetes.

1. Introduction

The evidence indicates that a high proportion of patients with diabetes mellitus (DM) do not take their medication as recommended, i.e. at the prescribed intervals and dose, which has a high clinical and economic impact [1–5]. Discontinuance of drug treatment is a frequent problem in type 2 DM (T2DM) patients [6]; adherence to oral anti-diabetic medication (OAD) regimes ranges between 30% and 89.7% [2,2,3,4,5].

In addition, the management of T2DM is complex and demanding; many patients find it difficult to modify their lifestyle and to achieve important physical and psychological impacts, and so they develop diabetes-related distress (DRD) [7,8]. DRD is negatively associated with adherence to a medication regime and positively associated with level of glycated hemoglobin (A1C) [8–10], but despite these associations there is little evidence on mediators of the relationship between drug adherence and DRD.

To our knowledge there have been no published studies of theory-based interventions aimed at promoting adherence to T2DM drug therapy and providing insight into the relationships between adherence to medication and DRD and blood glucose levels, although theoretical models have helped to identify factors that influence the adoption of a given behavior and can be used to improve the design of an intervention aimed at promoting a specific behavior [11].

The theory of planned behavior (TPB) [12] is one of the motivational theories that have been used to construct strategies

Abbreviations: A1C, glycated hemoglobin; BMI, Body Mass Index; CG, control group; CONSORT, consolidated statement of reporting trials; DCCT, diabetes control and complications trial; DDS, diabetes distress scale; DM, diabetes mellitus; DRD, diabetes-related distress; GEE, generalized estimating equations; IAGAM, Instrument for the Global Evaluation of Medication Adherence; ICTRP, International Clinical Trials Registration Platform; IG, intervention group; IIT, implementation intention theory; Int, intention; NGSP, National Glycohemoglobin Standardization Program; OADs, oral antidiabetic drugs; RCT, randomized controlled trial; ReBEC, Brazilian Clinical Trials Registry; SAS, statistical analysis system; SD, standard deviation; T2DM, type 2 diabetes mellitus; TPB, theory of planned behavior.

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aimed at modifying health-related behaviors. It assumes that intention is the motivational factor that predicts the behavior and represents an individual's willingness or unwillingness to try something and his or her commitment to acting on it [12,13]; however it has been known for decades that in practice there is gap between intention and behavior.

To address this shortcoming of the TPB Gollwitzer [14] proposed a model that specifies two phases needed to achieve execution of a specific behavior: the motivational and the volitional phases. The former involves the evaluation an individual makes about the pros and cons of a given behavior, whilst the latter encompasses the planning required to achieve a previously formulated behavioral objective. The volitional phase involves the planning, initiation and maintenance of a new behavior. In the volitional phase action planning and ability to cope with obstacles start to play a key role in behavior [15]. Gollwitzer's [14] assumption about what is needed to translate a positive intention into behavior has been called the 'implementation intention theory' (IIT). There are reports that intention activation strategies have been used successfully to promote behavioral change in various contexts, including adherence to medication [16,17].

We hypothesized, therefore, that a combination of behavioral strategies aimed at promoting the taking of OADs would improve A1C and DRD levels. Hence the purpose of this study was to evaluate the effects of an implementation intention intervention on adherence to an oral anti-diabetic medication regime, diabetes-related distress and glycemic control in patients with T2DM.

2. Methods

2.1. Research design

This was a single-blinded, randomized controlled trial (RCT) with an intervention group (IG) and control group (CG). The study followed the Consolidated statement of reporting trials (CONSORT) guidelines and was registered with the International Clinical Trials Registration Platform (ICTRP) via Brazilian Clinical Trials Registry (ReBEC - RBR-439f77) [18]. The protocol complied with the Declaration of Helsinki and has been described elsewhere [19].

2.2. Sample/setting

The study was conducted in two primary health care units of the State of São Paulo, Brazil. Eligible patients were adults with T2DM who had been using OADs continuously for at least six months, had a positive intention to take the OADs (score equal to or greater than 4), were literate in Brazilian Portuguese and capable of understanding and following the study instructions. Cognitive status was assessed with a previously published 10-item questionnaire [20]. Individuals were excluded if the administration of their medication was handled by a caregiver, if they used insulin and if they were already being monitored by another health service. Discontinuation criteria included non-attendance **at** any of the scheduled meetings, withdrawal from the study during delivery of the intervention and starting to use insulin at any point during the research.

2.3. Sample size calculation

To calculate the sample size, the Chi-square test was used, since this test was used on a previous study [16]. Considering that the statistical technique applied for chi-square sample size estimation does not allow different comparisons, it was necessary to apply the Bonferroni correction to significance levels to estimate the sample size required for the four comparisons we planned to carry out (between-groups comparisons at each time-point; between-times comparisons for each group); this resulted in a significance level of 0.125 – which was only applied for sample size calculation and not for other tests. In addition, a power of 80% was adopted. The calculation indicated that the minimum sample size required was 88 (44 individuals per group).

2.4. Intervention

The intervention was based on Gollwitzer's IIT [14]. The trial was tailored based on the elaboration of action and coping plans, with their respective overcoming strategies. Participants were asked to fill out, with the help of the main researcher, a form specifying three action plans covering *when, where* and *how* they intended to take their OADs over the next two months.

The design of this action planning form was based on studies of the effect of an 'implementation intention' process on the adoption of health-related behaviors and on similar instruments used in previous studies [14,16,17,21]. The strategies for coping planning included in the intervention were based on the assumption that self-regulatory coping responses were already mentally available to the participants and that they had experience of using such responses. Individuals were encouraged to anticipate obstacles and barriers to taking their medication and formulate strategies to overcome them.

This study lasted 15 weeks (105 days) and had two groups, the IG and CG. The intervention consisted of four face-to-face meetings, which took place at baseline (T_0), 15 days later (T_1), 60 days later (T_3) and on the 105th day of monitoring (T_5), and two phone reinforcements, at T_2 ($T_0 + 30$ days) and T_4 ($T_0 + 75$ days). Data were collected from February to December 2016.

At baseline the study variables of IG participants were measured and blood samples were collected to determine A1C level. At T_1 IG participants returned to the health unit to draw up their action plans and coping strategies, based on how they envisaged they would be able to achieve the desired behavior (taking their OAD regularly). During this session the facilitator encouraged participants to design a plan that was appropriate for their lifestyle and daily routine. Both the action plans and the coping strategies were manually reported on a worksheet and filed for further reference throughout the monitoring process.

The T_3 (60 days after T_0) meeting was focused on strengthening the plans developed at T_1. Each coping strategy and action plans was reviewed and if there had been any change in the participant's medication or routine the plans were adapted as necessary. Finally, at the end of the monitoring period (T_5), the participants returned to the health unit for assessment of outcome variables and collection of blood to assess A1C level. Assessment of A1C level was carried out by a trained collaborator. The telephone reinforcement sessions were based on information from the baseline forms and behavioral strategies drawn up by individual participants.

Participants allocated into the CG received standard care from the health professionals at the units where the study was carried out. The CG was a pure group, i.e. they received the standard care offered by the unit they were attending, including capillary measurement of blood glucose level and routine medical and nursing appointments.

2.5. Instrument of characterization of the sample

Socio-demographic and clinical data were collected from all participants at baseline. The participants reported their marital status, educational level, occupation and monthly household income. Data on age, gender, body mass index, comorbidities, duration of diabetes, A1C, number of medicines and number of OADs were extracted from patients' records.

2.6. Primary and secondary outcomes

The primary outcomes were taking of OADs, global adherence to medication regime and A1C level.

Taking of OADs was evaluated using the approach recommended by Ajzen [12], based on a single-item instrument developed used in a prior study [22], to which responses are given using a four-point Likert scale ranging from 1 (rarely or never) up to 4 (every day or almost every day of the week).

Adherence to medication regime was measured using the Instrument for the Global Evaluation of Medication Adherence (IAGAM), which has been used in previous studies [16,22]. This assesses whether the individual is receiving an adequate dose ($\geq$80% of the prescribed dose) or insufficient dose (<80% of the prescribed dose), how careful the individual is about taking medication (use of posology, timing, use of aids to timing intake appropriately and any special precautions applying to the drug prescribed). Patients reported that they were taking at $\geq$ 80% of the prescribed dose *and* exercising appropriate care in taking their medication were deemed 'adherent'; all other patients were deemed 'non-adherent'.

A1C was measured through a laboratory examination. The method used has been certified by the National Glycohemoglobin Standardization Program (NGSP); A1C was measured in up to five days after baseline and after the end of the monitoring. Data on all outcome variables were collected from all participants at baseline and at the end of the monitoring.

Intention to adhere to medication regime and DRD were considered secondary outcomes. Intention was measured using a six-item scale to which responses were given using a five-point Likert scale ranging from 1 (absolutely not) to 5 (yes, definitely) [12,22]. DRD was assessed with a validated Brazilian Portuguese adaptation of the Diabetes Distress Scale (B-DDS) [23]. This instrument consists of 17 items, divided into four domains: Emotional burden (5 items), Physician-related distress (4 items); Regimen-related distress (5 items); Diabetes-related interpersonal distress (3 items). Responses are given using a six-point Likert scale ranging from1 (no problem) to 6 (a very serious problem). Scores are calculated as the averages of scores on individual items and range between 1 and 6; higher scores indicate more severe DRD. Scores < 2.0 points are considered to indicate little or no diabetes distress, scores of 2.0 to 2.9 indicate moderate DRD and scores $\geq$ 3.0 indicate high DRD. The original version of the scale [24] was tested in 683 patients with DM and exhibited a Cronbach's alpha of 0.93, indicating high internal consistency. The Brazilian version has been reported to have a Cronbach's alpha of 0.87, indicating satisfactory internal consistency [23].

2.7. Recruitment, randomization, group allocation and blinding

A list of patients registered with participating health units was used to recruit participants. Patients were telephoned individually to invite them to participate and a meeting at their health unit with the principal researcher was scheduled for those who agreed to do so. At this meeting the principal investigator repeated the invitation to participate and explained what would be involved. Randomization was carried out by a member of the research team who had no contact with the participants. The http://www.randomization.com website and random size blocks method [25] was used to prepare a numerical sequence of 100 participants that was concealed from the investigators. The sequence was longer than the planned sample size to allow for possible losses during the data collection period. Then, each of the numbers was individually sealed in opaque envelopes. At the baseline, the researcher opened the envelope and draw a number to each participant, allocating them into one of the groups. This draw was blind to participants, i.e., they did not know to which group they belonged. Only the main researcher knew in which group each participant was allocated. The T_5 assessments were carried out by a collaborator previously instructed in the research procedures who had not had any previous contact with participants.

2.8. Statistical analysis

- Statistical analyses were carried out according to SAMPL guidelines [26]. Prevalence ratios are presented along with confidence intervals (95% CI) and *p*-values. No outliers were found. P values below 0.05 were considered statistically significant. All analyses were performed with Statistical Analysis System (SAS), version 9.4.
- Descriptive statistics were used to summarize patients' characteristics at baseline and the Kolmogorov-Smirnov test was used to evaluate the normality of the variables.
- Group comparisons of normally distributed continuous variables were carried out using Student's independent-samples *t*-test. Group comparisons of normally distributed categorical variables were carried out using the
- Chi-squared test. Group comparisons continuous and categorical non-parametric variables were carried out using the Mann-Whitney test and Fisher's exact test, respectively
- Multivariable Generalized Estimating Equations (GEE) regressions were used calculated to assess group and time differences in continuous variable. Estimates of mean differences are reported, along with 95% confidence intervals and *p*-values. Log-binomial GEE models of categorical models were constructed to estimate relative risk, 95% confidence intervals and *p*-values. GEE models are an extension of generalized linear models (GLMs) and can be used to analyze correlated data in cases where the dependent variable is continuous or categorical.

3. Results

A total number of 518 individuals were assessed for eligibility. Of these 252 did not meet the inclusion criteria, 86 refused to participate and 90 could not be contacted by telephone to issue an invitation to participate. After providing written, informed consent the remaining 90 individuals were randomized into the IG or CG, with 45 participants in each group. One individual in each group withdrew from the study (Fig. 1). No participant reported complications or any intervention-related ill effects during the study period.

Table 1 shows the sociodemographic and clinical characteristics of the baseline sample. The majority of the sample (70.8%) was female and the mean age of participants was 61.4 $\pm$ 8.3 years. The mean educational level was 5.9 $\pm$ 4.5 years, and the mean monthly household income was 2.9 $\pm$ 1.9 times the minimum wage. Mean A1C level was 7.2 $\pm$ 0.9. There were no sociodemographic or clinical characteristics between the groups at baseline.

Analysis of data from the IG showed that the intervention increased the frequency with which medication was taken ($p = 0.0010$) and improved global adherence to OADs (dose + care) ($p < 0.0001$), as well as increased the proportion of adherence to OADs. The IG group showed a reduction in A1C level ($p < 0.0001$), indicating better glycemic control, and a decrease in total B-DDS score ($p < 0.0001$) as well as reductions in scores for most B-DDS domains (Table 2).

The comparison between IG and CG is presented in Table 3. The proportion of adherent participants was higher in the IG than the CG ($p < 0.0001$). A significant decrease was observed in the mean differences for the score on the physician-related distress domain ($p<0.0084$). Relative risk was calculated to provide the probability that participants in the IG would have to present higher behavioral scores, better overall adherence and lower A1C levels than participants in the CG. Therefore, the risk through the difference

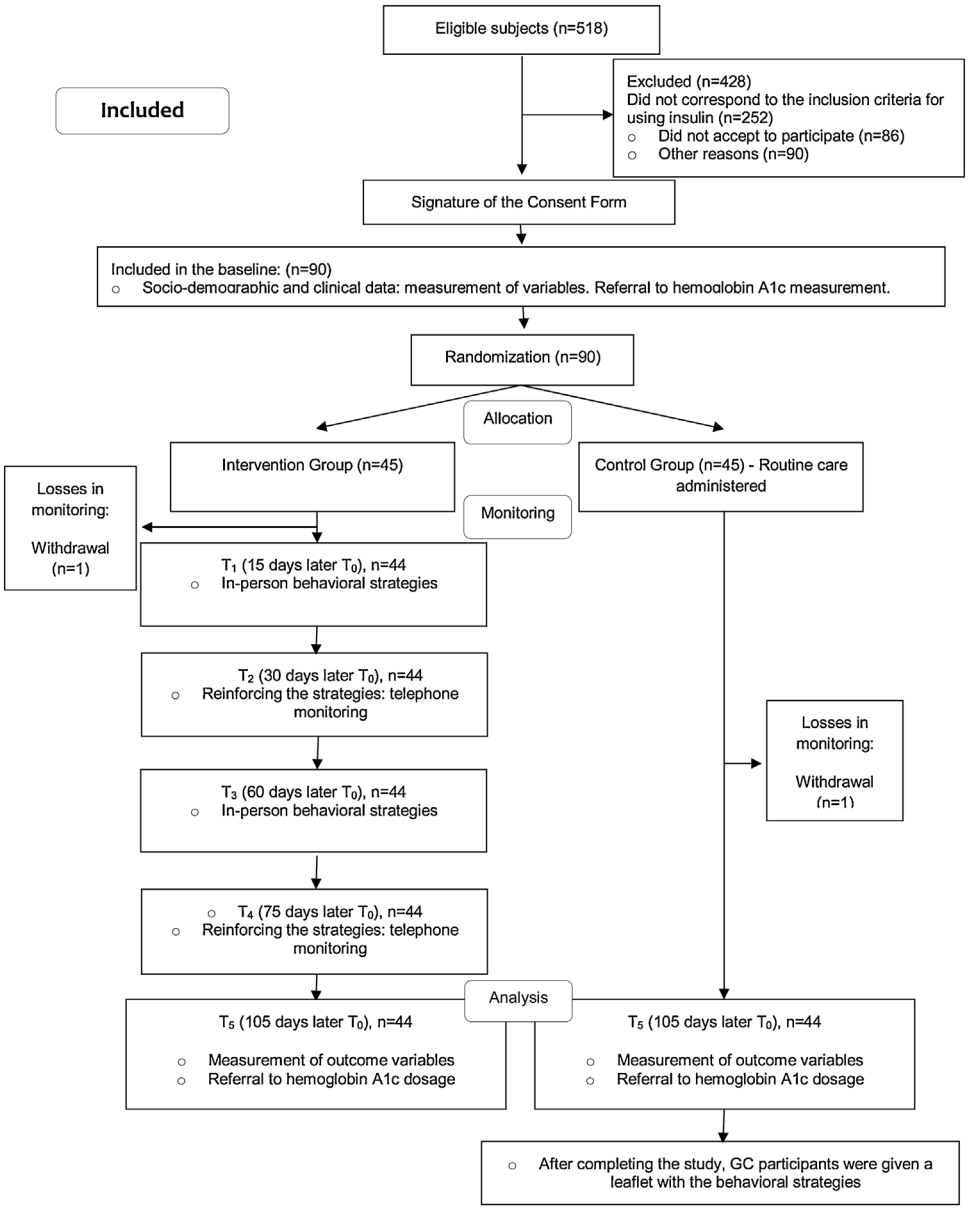

Fig. 1. Diagram of the monitoring of T2DM individuals participating in the study.

between the groups at baseline and at the end of follow-up was calculated. At T_5 the probability of the IG achieving behavior was 1.24 times higher than the probability of the CG achieving the behavior, i.e., after the intervention the IG was more likely to perform the behavior than the CG.

Although a significant decrease in A1C levels was not observed among groups, it should be noted that the GEE analysis showed that IG had a greater risk of changes in the A1C ($p = 0.0243$) at baseline. However, in T_5 it was possible to observe a relevant decrease in comparison to CG, but with no statistical significance (Table 3).

4. Discussion and conclusion

4.1. Discussion

This study evaluated the effectiveness of an action planning and coping strategy-based intervention designed to promote adherence to OADs in Brazilian patients with T2DM. We also analyzed the relationships between adherence to medication and blood glucose levels and DRD. The sociodemographic and baseline clinical profiles of our sample were consistent with data from previous evaluations of adherence to medication [16,22]. The low educational level of our sample reflects the generally low level of education in the Brazilian adult population and can be a barrier to effective training in self-management of care and to effort to induce behavioral changes that will promote physical and emotional health [27,28].

Nevertheless, the sociodemographic and clinical characteristics of the participants in the IG did not prove a barrier to improvements in adherence to medication, glycemic control and emotional distress. This finding contradicts previous studies and might be due to the use of individualized plans tailored to the daily routine of each patient. In other words the key to the success of our intervention was that participants were encouraged to use specific, theory-based strategies to overcome

Table 1
Sociodemographic and clinical characteristics in the baseline of individuals randomized into the intervention or control groups.

Patients' characteristics	Total (n = 88)	Intervention (n = 44)	Control (n = 44)	p-value
Age (years), Mean (SD)	61.4 (8.3)	61.1 (8.9)	61.8 (7.8)	0.68*
Female (n), (%)	62 (70.4)	30 (68.2)	32 (72.7)	0.64‡
Marital status (n), (%)				
Living with a partner	57 (64.8)	29 (65.9)	28 (63.6)	
Living without a partner	31 (35.2)	15 (34.1)	16 (36.4)	0.82‡
Education (years), Mean (SD)	5.9 (4.5)	6.4 (4.9)	5.3 (4.1)	0.42§
Occupation (n), (%)				
Works	24 (27.3)	17 (38.6)	9 (20.4)	
Does not work	64 (72.7)	27 (61.4)	35 (79.6)	0.06‡
Monthly household income, Mean (SD)†	2.9 (1.9)	3.0 (1.7)	2.8 (2.2)	0.43§
IMC¶ kg/m^2, Mean (SD)	29.6 (6.1)	29.8 (5.7)	29.4 (6.5)	0.45§
Associate clinical conditions, Mean (SD)	2.2 (0.9)	2.2 (0.9)	2.1 (0.9)	0.61§
Hypertension (n), (%)	72 (81.8)	34 (77.2)	38 (86.4)	0.27‡
Dyslipidemia (n), (%)	65 (73.9)	32 (72.7)	33 (75.0)	0.80‡
Cardiovascular problems (n), (%)	20 (22.8)	11 (25.0)	9 (20.4)	0.61‡
Time of T2DM (months), Mean (DP)	86.5 (76.1)	81.6 (80.1)	91.4 (72.3)	0.21§
A1c, Mean (SD)	7.2 (0.9)	7.3 (0.8)	7.2 (1.0)	0.40§
Number of medications used, Mean (SD)	5 (1.7)	5.2 (1.8)	4.8 (1.7)	0.30§
Number of oral antidiabetics, Mean (SD)	1.5 (0.6)	1.5 (0.6)	1.4 (0.5)	0.89§

Note: † Quotation: 1 Minimum wage (MW) = R$ 880.00 (USD 216.21); US$ 1.00 = R$ 4.07 in 02.15.2016; ¶body mass index; ‡ p-value obtained through Chi-square test; * p-value obtained through unpaired Student's t test; § p-value obtained through Mann-Whitney test.

Table 2
Summary of the outcomes measured in the study over time: baseline and 105-day monitoring.

Outcomes	Intervention Group			Control Group		
Quantitative Variables	*Baseline*	*105th day of monitoring*	Mean difference (95% CI) *p-value*	*Baseline*	*105th day of monitoring*	Mean difference (95% CI) *p-value*
			T_5 - T_0 (IG)			T_5 - T_0 (CG)
Taking OADs proportion (≥80%), mean (SD)	23 (52.3)	41 (93.2)	**12.46 (9.95; 14.97) <0.0001**	25 (56.8)	28 (63.6)	2.20 (−0.48; 4.88) 0.1074
Intention (≥4), mean (SD)	4.3 (0.4)	4.6 (0.4)	**0.29 (0.16; 0.43) <0.0001**	4.2 (0.4)	4.1 (0.3)	−0.07 (−0.17; 0.04) 0.2017
A1c (%), mean (SD)	7.3 (0.8)	6.8 (0.7)	**−0.50 (-0.63; −0.38) <0.0001**	7.2 (1.0)	7.1 (1.1)	−0.06 (−0.12; 0.01) 0.0969
DDS, mean (SD)	2.4 (1.0)	2.0 (0.7)	**−0.45 (-0.61; −0.29) <0.0001**	2.2 (0.8)	2.2 (0.8)	0.02 (0.11; −0.15) 0.7555
Emotional burden, mean (SD)	2.9 (1.1)	2.5 (0.9)	**−0.35 (-0.57; −0.14) 0.0012**	2.7 (1.2)	2.6 (1.1)	−0.10 (−0.31; 0.12) 0.3753
Physician-related distress, mean (SD)	1.9 (1.3)	1.4 (0.6)	**−0.49 (-0.78; -0.21) 0.0006**	1.7 (1.2)	1.9 (1.1)	0.16 (−0.07; 0.40) 0.1658
Regimen-related distress, mean (SD)	2.8 (1.3)	2.2 (1.0)	**−0.67 (-0.89; −0.46) <0.0001**	2.4 (1.1)	2.5 (1.0)	0.10 (−0.11; 0.30) 0.3585
Diabetes related interpersonal distress, mean (SD)	1.7 (1.2)	1.5 (1.0)	**−0.18 (-0.37; 0.00) 0.0554**	1.4 (0.8)	1.3 (0.6)	−0.11 (−0.28; 0.06) 0.2222
Categorical Variables			Relative risk (95% CI) *p-value*			Relative Risk (95% CI) *p-value*
			T_5-T_0 (IG)			T_5 - T_0 (CG)
Behavior (n) (% - every day or almost every day)§	30 (68.2)	41 (93.2)	**1.37 (1.14; 1.65) 0.0010**	33 (75.0)	33 (75.0)	1.00 (0.81; 1.23) 1.0000
Global evaluation of the adherence (n) (% - be adherent)[a]	12 (27.3)	39 (88.6)	**3.45 (2.06; 5.79) <0.0001**	16 (36.4)	20 (45.4)	1.25 (0.88; 1.77) 0.2068

Note: Intra-group comparisons and times were analyzed through: quantitative variable (*Generalized Estimating Equations (GEE)); categorical variable (*log-binomial models in GEE modeling).
§ Risk of presenting the result "Everyday or almost every day" estimated.
[a] Risk of being adherent estimated.

barriers to adherence, whereas the traditional approach to improving adherence to a medication regime involves simplifying the regime [29,30].

We observed a 0.5% reduction in A1C levels in the IG over the 15 weeks of monitoring. A previous study showed that a 1% reduction in A1C levels was associated with a 25% reduction in microvascular complications and a 16% reduction in myocardial infarctions [31]. Further analysis indicated that reductions in A1C levels were associated with a 21% reduction in the risk of diabetes-related deaths, a 14% reduction in myocardial infarction and a 37% reduction in microvascular complications [32]. The use of behavioral strategies to promote adherence to an OAD regime can, therefore, be considered an innovative and highly effective strategy for improving management of glycemic levels and thus reducing the incidence of long-term complications.

In addition, studies have shown that there is a negative relationship between adherence to drug treatment and distress and that poor adherence to a medication regime may interfere with metabolic control [9,10,33]. Our findings indicate that the application of behavioral strategies, as well as increasing adherence to OAD regime, also reduced DRD levels. This may be due to the way in which the intervention involves participants in drawing up a personalized plan to achieve adherence to their medication regime and helps to motivate them to follow it. Both self-confidence to taking OADs and the patient's monitoring in intervals between medical appointments may have collaborated to this

Table 3
Outcomes comparison between times and between intervention and control groups in the *baseline* (T_0) and 15 weeks (T_5) after application of intention activation strategies.

Outcome variables Quantitative	IG - CG (T_0) Mean difference (95% CI) *p-value*	IG - CG (T_5) Mean difference (95% CI) *p-value*
Taking OADs proportion	−1.00 (−5.17; 3.17) 0.6387	**9.26 (5.16; 13.36) <0.0001**
Intention mean	0.10 (−0.06; 0.26) 0.2300	**0.46 (0.30; 0.62) <0.0001**
A1c	0.11 (−0.28; 0.50) 0.5668	−0.33 (−0.71; 0.05) 0.0853
DDS	0.25 (−0.13; 0.64) 0.2010	−0.22 (−0.52; 0.08) 0.1571
Emotional burden	0.12 (−0.35; 0.60) 0.6133	−0.14 (−0.55; 0.27) 0.5136
Physician-related distress	0.16 (−0.36; 0.68) 0.5466	**−0.50 (−0.87;−0.13) 0.0084**
Regimen-related distress	0.45 (−0.04; 0.95) 0.0711	−0.31 (−0.73; 0.10) 0.1404
Interpersonal distress	0.25 (−0.19; 0.69) 0.2624	0.17 (−0.17; 0.51) 0.3131
Categorical	Relative Risk (95% CI) *p-value*	Relative Risk (95% CI) *p-value*
Behavior[§]	0.91 (0.70; 1.18) 0.4797	**1.24 (1.03; 1.50) 0.0239**
Global evaluation of the adherence[a]	0.69 (0.36; 1.31) 0.2541	**1.90 (1.35; 2.68) 0.0003**
Classified A1c[b]	**1.65 (1.07; 2.54) 0.0243**	0.83 (0.48; 1.43) 0.5105

Note: Intra-group comparisons and times were analyzed through: quantitative variable (*Generalized Estimating Equations (GEE)*); *categorical variable (*log-binomial models in GEE modeling).
[§] Risk of presenting the result "Everyday or almost every day" estimated.
[a] Risk of being adherent estimated.
[b] Risk of presenting A1c $\geq$ 7.0 estimated.

finding – which point to participant's perception of a better management of the disease.

This study is different from previous research for the following reasons. First, because adherence to an OAD regime was measured through using an instrument (IAGAM) that assesses both intake of medication and the care exercised by the patient in use of medication [16]. The use of this instrument should have maximized the accuracy of our adherence data [16], which is important as adherence to a medication regime is considered a complex behavior, for which there is no established, gold standard method of assessment [34]. Another strong point of this study is the fact the intervention we developed can be considered a health soft technology product, as it promotes a behavioral change and implements an innovative model of care for T2DM.

The regression analysis reinforced the other analyses, showing that even after adjusting for variance in age, gender and educational level, group status (IG or CG) was an important predictor of global adherence. IG participants were more likely to be deemed adherent than CG participants. A third strength of the study is that it was carried out in the primary health care sector, which is where most treatment and monitoring of patients with T2DM is carried out in Brazil. Intensive glucose control over 5 years is an important factor for prevention complications [35].

Although this study provides new evidence on the importance of promoting strategies for improving adherence to OAD regimes, it has some limitations. First, the inclusion criteria did not include a minimum A1C level, leading to a relatively low mean value at baseline (7.2%). Second, although the sample size was sufficient to assess the primary outcomes it was not large enough to detect changes in A1C level at the end of the monitoring period. Third, it might have been useful to follow patients for longer in order to collect more longitudinal A1C data and determine whether the intervention had a long-term impact on glycemic control. Finally, we relied on self-reports of adherence to OAD regime. Further research using objective measures of adherence and a longer monitoring period is needed to demonstrate the effectiveness of our theory-based intervention.

4.2. Conclusion

This study demonstrated that our action planning and coping strategy-based intervention improved adherence to an OAD regime, based on a measure of the frequency of drug intake and an instrument designed to evaluate overall adherence. The intervention also reduced DRD and A1C levels. Group comparisons at the end of the follow-up period revealed higher levels of adherence to medication regime and lower levels of DRD in the IG than the CG.

4.3. Practice implications

Making the planning of strategies a collaboration between health professionals and the patient can increase commitment to use of OADs and further reduce levels of DRD. The low cost of our intervention and the ease with which it can be delivered means it should have wide application. Furthermore, it can be developed among different levels of the health care system, to promote behavioral change and engage people in their pharmacological treatment. The intervention should be evaluated through randomized clinical trials using objective measures of medication intake. Further research into the relationship between adherence to a medication regime and other variables would also be useful.

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Informed consent and patient details

We confirm all patient/personal identifiers have been removed or disguised so the patient/person(s) described are not identifiable and cannot be identified through the details of the story.

Authors' contributions

DDT, TMSJ and MEC: led the initial conceptual development of the study. Subsequent study conception and design. DDT data collection; DDT, TMSJ, FFJ and MEC: contributed to discussion, wrote manuscript, reviewed/edited manuscript; MRMGCS, RCMR, MHML: contributed to discussion, wrote manuscript, reviewed/edited manuscript. All authors were involved in drafting the article and revising it critically for important intellectual content, and all authors approved the final version to be published

Declaration of Competing Interest

None.

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