

Development and validation of a questionnaire for assessing the characteristics of diet and physical activity in patients with type 2 diabetes

Rubén Martín Payo¹, Xana González Méndez², Cristina Papín Cano², and Javier Suárez Alvarez¹

¹ Universidad de Oviedo and ² Servicio de Salud del Principado de Asturias

Abstract

Background: The aim of this study was to explore the psychometric properties of the Motiva.Diaf-DM2 questionnaire, which assesses adherence to a healthy diet and physical activity in patients with Type 2 Diabetes (T2D). **Method:** Participants were 206 patients who attended primary care services, with a mean age of 69.63 years (SD = 11.05), with 39.3% of the participants being women. To assess the test-retest reliability of the measure, a random subsample (n = 40) of patients who had another appointment scheduled was selected to fill in the questionnaire once again two weeks after the initial administration. **Results:** The reliability of the scores was found to be appropriate both in terms of internal consistency ($\alpha_{\text{first factor}} = .756$; $\alpha_{\text{second factor}} = .821$) and temporal stability (r first factor = .604; r second factor = .638). The structure of the test is two-dimensional. The scores for the second dimension (adherence to physical activity) are in agreement with the scores for basic psychological needs (r physical activity = .281), resilience (r = .216), and glycated haemoglobin (r = -.182). **Conclusions:** The Motiva.Diaf-DM2 test was shown to have the appropriate reliability and validity to assess adherence to a healthy diet and physical activity in patients diagnosed with T2D.

Keywords: Diabetes mellitus, type 2, motivation, resilience, psychological, psychometrics.

Resumen

Desarrollo y validación de un cuestionario para medir las características de la dieta y la actividad física en pacientes con diabetes tipo 2 diabetes.

Antecedentes: el objetivo de este estudio fue evaluar las propiedades psicométricas del cuestionario Motiv.Diaf-DM2, diseñado para medir la adherencia a las recomendaciones dietéticas y de actividad física en pacientes con diabetes tipo 2. **Método:** participaron 206 pacientes que asistieron a consultas en atención primaria, cuya media de edad era de 69,63 años (DE = 11,05). El 39,3% fueron mujeres. Para evaluar la fiabilidad test-retest se seleccionaron 40 pacientes de la muestra inicial de entre los que tenían otra cita en el centro de salud, a los que se les administró nuevamente el cuestionario dos semanas tras la primera entrega. **Resultados:** se observó que la fiabilidad de las puntuaciones era adecuada en cuanto a consistencia interna ($\alpha_{\text{primer factor}} = .756$; $\alpha_{\text{segundo factor}} = .821$) y estabilidad temporal (r primer factor = .604; r segundo factor = .638). La estructura del test es bidimensional. Las puntuaciones de la segunda dimensión (actividad física) convergen con las puntuaciones de las necesidades psicológicas básicas (r actividad física = .281), resiliencia (r = .216) y hemoglobina glicosilada (r = -.182). **Conclusiones:** Motiva. Diaf-DM2 ha demostrado tener una adecuada fiabilidad y validez para evaluar la adherencia a las recomendaciones relacionadas con la dieta y la actividad física en pacientes con diabetes tipo 2.

Palabras clave: diabetes mellitus, tipo 2, motivación, resiliencia psicológica, psicometría.

Diabetes mellitus is one of the most widespread chronic diseases worldwide (Soriger et al., 2012). The prevalence of this disease has increased in recent decades and is expected to continue, mainly due to behavioural factors, such as obesity and a sedentary lifestyle, as well as hypertension and dyslipidaemia, which in turn contribute to poorer glycaemic control and, consequently, to the worsening of the disease (International Diabetes Federation, 2015). Several indicators have been used to determine glycaemic control, with glycated haemoglobin (HbA1C) being recommended and used for this purpose recently (American Diabetes Association, 2017).

Recent recommendations note the importance of promoting a healthy lifestyle, such as following a healthy diet and performing regular physical activity (Reusch & Manson, 2017). Therefore, identifying unhealthy behaviours related to diet (Evert et al., 2014) and physical activity (De Feo & Schwarz, 2013) is essential specifically to guiding promotional activities and fostering healthy lifestyles in patients diagnosed with T2D. To achieve this, understanding people's motivation to adopt healthy habits and the factors determining these behaviours is of great interest, because people are more likely to engage in and maintain behaviour changes when they are motivated and feel autonomous (Ryan, Patrick, Deci, & Williams, 2008).

Self-Determination Theory (SDT) seeks to understand both adherence to healthy behaviours and the motivation behind it by analysing a person's degree of willpower to perform different actions (Deci & Ryan, 1985; Ryan & Deci, 2000). SDT is widely used to understand the reasons behind certain health-related

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Corresponding author: Rubén Martín Payo
Facultad de Medicina y Ciencias de la Salud
Universidad de Oviedo
33006 Oviedo (Spain)
e-mail: martinruben@uniovi.es

behaviours and how or why they may be changed in adult populations with long-term conditions (Shigaki et al., 2010; Teixeira, Carraca, Markland, Silva, & Ryan, 2012).

This theory has two core ideas. The first idea is that the adaptive self-regulation of healthy behaviours arises from providing greater self-support to three basic psychological needs (BN): autonomy, competence, and relatedness to others (Deci & Ryan, 2012).

The second idea of this theory is that there are various types of motivation or behaviour regulators: autonomous self-regulation or intrinsic motivation, controlled regulation or extrinsic motivation (comprised of four different types of regulation: external, introjected, identified, and integrated), and amotivation (Deci & Ryan, 1985; Ryan & Deci, 2000). These different forms of motivation are represented as a continuum that ranges from non-self-determined behaviour, which corresponds to a lack of motivation to perform an action, to self-determined motivation, which simultaneously corresponds to extrinsic and intrinsic motivation (Deci & Ryan, 1985). It has been observed that BN can be understood as psychological mediators that influence the different types of motivation and thus the implementation of healthy behaviours. People's healthy development and wellbeing is directly related to the fulfilment of these needs (Ryan & Deci, 2000).

Ng et al. (2012) suggest that SDT could be a foundation for the development of health promotion interventions for various physical health outcomes (Teixeira et al., 2012; Leblanc et al., 2014). Additionally, in the last few years, a growing body of research has been supporting the usefulness of SDT in promoting diabetes self-care (Juil, Maindal, Zoffmann, Frydenberg, & Sandbaek, 2011; Miquelon & Castonguay, 2016).

Recently, a new questionnaire based on SDT, designed for adults without dietary and physical activity restrictions, has been validated (Martín-Payo, Suárez-Álvarez, Amieva-Fernández, Duaso, & Álvarez-Gómez, 2016). Despite the existence of other methods to assess diet and physical activity in people with T2D, no method has been found based on SDT, in Spanish, and in a short format that would combine adherence with both these behaviours as well as with the motivation for adhering to and maintaining them. Assessing these factors could guide healthcare professionals in developing effective educational interventions.

Furthermore, previous research on patients with T2D shows a direct relationship between resilience and a healthy lifestyle (Bradshaw et al., 2007) and an inverse relationship between resilience and HbA1C (Bradshaw et al., 2007; Pesantes et al., 2015). Our assumption is that resilience is associated with motivation, and resilient individuals are motivated to develop and maintain healthy behaviours. To test this hypothesis, we measured motivation and resilience using the Motiva.Diaf-DM2 questionnaire (MDDM2).

The aim of this study was to explore the psychometric properties of the MDDM2 questionnaire, which assesses adherence to a healthy diet and physical activity in patients with T2D.

Method

Participants

The participants of the sample were recruited when patients were attending the Primary Healthcare Centres (PHC) of Asturias, Spain, for a scheduled routine diabetes control.

Eligible participants were people with T2D over 18 years old. Patients who had trouble understanding the questionnaire were excluded.

232 patients met the criteria for taking part in the study. A total of 206 patients (88.8%) voluntarily decided to participate in the study. The mean age of the participants was 69.63 years old (SD = 11.05), ranging from 35 to 91 years old. Women accounted for 39.32% of the sample. 58.82% had no education or had only finished primary school, 31.55% had finished secondary school, and 9.62% had college education. The mean number of years after being diagnosed with diabetes was 10.21 (SD = 8.23). 15.8% of the patients used insulin and 75.1% used oral antidiabetic medication. To assess the test-retest reliability of the measure, a random subsample (n = 40) of patients who had another appointment scheduled was selected to fill in the questionnaire once again two weeks after the initial administration.

Instrument

MDDM2 includes socio-demographic questions (age, gender, and level of education), questions regarding T2D (time elapsed since diagnosis, insulin or oral antidiabetic therapy), questions assessing adherence and motivation to each behaviour and questions on the fulfilment of BN, related to either diet or physical activity.

Adherence and motivation to follow a healthy lifestyle in adults with T2D were distributed between 20 items: 14 items assessed adherence to dietary recommendations and 6 items assessed adherence to physical activity recommendations (Table 1).

Each dietary item assessed compliance with habits and recommendations on the consumption of each food group which contributes to a healthy diet. The items were developed based on the recommendations made by various Spanish organisations (Federación Española de Diabetes, 2013; Millán-Reyes, Rioja-Vázquez, & Muñoz-Arias, 2015; Sociedad Española de Endocrinología y Nutrición, 2017). The content validity of the items was assessed by 20 experts (10 experts in nutrition and 10 experts in physical activity). The selection of experts was based on two criteria: (1) having more than 5 years of experience in their field, and (2) being authors of scientific publications in their field. The dietary items were phrased as statements with the following structure: "A healthy diet includes eating..." or "The food must be cooked..." and then the question "Do you tend to follow this advice?" The items on physical activity were phrased using the following structure: "Advice on good health includes [the type, time, and duration of the given physical activity]. Do you tend to follow this advice?" The answers given by the participants were yes/no dichotomies. In addition, a list of 10 response options was provided, so that participants could indicate which reason explained best their behaviour. The first four options were reasons why they did not follow the healthy guidelines (amotivation): "because I did not know this information," "because I do not find it useful," "because it would be a great effort for me," and "for other reasons." The next four questions dealt with following healthy guidelines based on extrinsic regulation: "Yes, because my family/doctor encourages me," "because I feel bad if I don't," "because I know it's good for my health," and "because I have always followed these habits." The last two responses regarded reasons related to intrinsic regulation: "Yes, because I enjoy it" and "because it makes me feel good."

Table 1
Recommendations included in the questionnaire

<ol style="list-style-type: none"> 1. Eat five times a day (breakfast, mid-morning snack, lunch, afternoon snack, and dinner) 2. Eat 2 servings of meat or fish daily. (Examples of a serving of meat could be 150 g of veal, chicken, rabbit, lamb, or pork, or 100 g of duck. Examples of a serving of fish could be 150 g of whitefish, oily fish, octopus, or squid, or 75 g of salt cod) 3. Eat more fish than meat each week 4. Eat at least 1 serving of vegetables per day. (Examples of a serving of vegetables could be 150-200 g of salad, cooked vegetables, 1 large tomato, or 2 carrots) 5. Eat 1 or 2 servings of legumes per week. (Examples of a serving of legumes could be 50 g of lentils or chickpeas, or 300 g of broad beans) 6. Eat 2 or 3 servings of fresh fruit per day. (Examples of a serving of fruit could be 125 g of apples, 180 g of oranges, 100 g of kiwi fruit, 75 g of bananas, 90 g of grapes, etc.) 7. Do not eat more than 2 tablespoons of vegetable oil per day (olive oil, sunflower oil, corn oil, rapeseed oil, or soybean oil) 8. Use saccharin or stevia instead of sugar 9. Eat at the same time of day every day, even when eating out 10. Grill, boil, or bake your food 11. Avoid sugary drinks and tonic water 12. Avoid so-called "sugar-free" foods and food "for diabetics" 13. Avoid commercial sauces, flours, and battered food 14. Season your food with aromatic herbs, lemon, vinegar, onion, garlic, pepper, parsley... 15. Be physically active: take a brisk walk, ride a bicycle, dance, swim, etc. for at least 20 to 60 minutes a day, 3 to 5 days a week 16. Carry out different activities 17. Eat 15 to 30 gr of carbohydrates (bread, fruit, cereal, etc.) for each 30 minutes of physical activity 18. Eat 15 to 30 extra grams of carbohydrates after 60 minutes of moderate to high-intensity physical activity 19. When performing any physical activity, eat high-carbohydrate food to prevent hypoglycaemia 20. When performing any physical activity, wear some form of identification with your personal and medical information in case of an emergency
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Responses to each item were assigned a number from 0 to 5 (0 = amotivation, 1 = external regulation, 2 = introjected regulation, 3 = identified regulation, 4 = integrated regulation, and 5 = intrinsic motivation). Two summary variables were obtained by dividing the mean of the scores for the dietary and physical activity items by the total number of items for each behaviour. These summary variables were "total diet" (TD) and "total physical activity" (TPA), in which 0 = lower adherence to behaviour or amotivation, and 5 = greater adherence or more self-determined behaviour.

To evaluate BN, two indicators, made up of 6 items each, were developed. Each indicator had 2 statements for autonomy, 2 for competence, and 2 for relatedness to others. BN were separately evaluated according to each habit (BN for dietary habits and BN for physical activity). A 5-point Likert scale was used in which 0 = never, 1 = rarely, 2 = sometimes, 3 = usually, and 4 = always. The scores for each item were added together to yield a mean score ranging from 0 to 4 (from no adherence to complete adherence to BN).

Procedure

The survey was administered by collaborating healthcare providers working at the PHC during their regular, scheduled appointments. Patients who voluntarily decided to participate and signed the informed consent were given the self-reported questionnaire. Additionally, patients who had another appointment at the PHC scheduled 2 for weeks later were asked to complete the questionnaire again. The anonymity of the patients was preserved at all times by using an alphanumeric code for each participant which consisted of three letters and six digits.

Resilience and HbA1C were included to explore whether they are related to any of the MDDM2 items by using, respectively, the Spanish version of the Brief Resilient Coping Scale (Limonero et al., 2014) and the medical records of the participants.

The present study was approved by the Regional Ethics Committee.

Data analysis

A descriptive analysis was first carried out to outline the participant's motivations to follow the dietary and physical activity guidelines. Subsequently, an exploratory factor analysis was performed using the Robust Unweighted Least Squares (RULS) as the estimation method, and the polychoric correlation matrix as the starting matrix. The number of factors was determined using the Parallel Analysis method, an optimal implementation method with 5,000 resamples (Timmerman & Lorenzo-Seva, 2011), and in accordance with adjustment rates, using the Goodness of Fit Index (GFI > .90), the Comparative Fit Index (CFA > .90), the Root Mean Square of Residuals (RMSR < .08), and the Root Mean Square Error of Approximation (RMSEA < .08). Internal consistency was estimated using Cronbach's alpha for ordinal information. Test-retest reliability was assessed using the Pearson correlation. Test scores were correlated with the scores measuring BN regarding diet and physical activity, the Brief Resilient Coping Scale, and HbA1C. Data were analysed using SPSS v.24.0.

Results

Descriptive analysis of items

Table 2 shows the percentage of participants who were motivated to follow dietary recommendations. More than 35% of the participants reported being intrinsically motivated to follow advice on the consumption of legumes, fresh fruit, and healthy seasonings (recommendations 5, 6, and 14, respectively), whereas more than 75% reported they were not motivated to follow advice on physical activity (recommendations 16, 17, 18, and 20).

Table 2
Percentage of participants who are motivated to follow dietary recommendations

Items	Un	(N)	Ex	(N)	Int	(N)	Id	(N)	Ing	(N)	Intr	(N)
1	36.9	(76)	5.8	(12)	4.4	(9)	31.6	(65)	7.8	(16)	13.6	(28)
2	39.3	(81)	4.4	(9)	0.5	(1)	22.7	(46)	10.3	(21)	22.2	(45)
3	43.9	(90)	1.0	(2)	1.0	(2)	20.5	(42)	10.7	(22)	22.9	(47)
4	15.0	(31)	3.4	(7)	0.5	(1)	35.4	(73)	13.6	(28)	32.0	(66)
5	4.4	(9)	3.9	(8)	0.5	(1)	28.2	(58)	27.2	(56)	35.9	(74)
6	12.7	(26)	2.0	(4)	0.5	(1)	29.3	(60)	11.7	(24)	43.9	(90)
7	15.2	(31)	4.4	(9)	0.5	(1)	34.8	(71)	23.5	(48)	21.6	(44)
8	32.4	(66)	3.4	(7)	1.0	(2)	44.1	(90)	2.5	(5)	16.7	(34)
9	23.8	(49)	2.9	(6)	2.9	(6)	17	(35)	20.9	(43)	32.5	(67)
10	21.0	(43)	4.9	(10)	0	(0)	29.8	(61)	12.2	(25)	32.2	(66)
11	13.6	(28)	1.9	(4)	4.9	(10)	42.7	(88)	7.3	(15)	29.6	(61)
12	37.8	(74)	0.5	(1)	1.0	(2)	17.3	(34)	9.7	(19)	33.7	(66)
13	37.1	(76)	3.4	(7)	1.5	(3)	28.8	(59)	8.3	(17)	21.0	(43)
14	7.4	(15)	3.9	(8)	1.0	(2)	13.2	(27)	30.9	(63)	43.6	(89)
15	21.5	(44)	2.4	(5)	2.9	(6)	44.9	(92)	5.9	(12)	22.4	(46)
16	76.6	(157)	1.0	(2)	1.5	(3)	9.8	(20)	2.9	(6)	8.3	(17)
17	79.5	(163)	2.0	(4)	3.4	(7)	7.3	(15)	2.0	(4)	5.9	(12)
18	76.1	(156)	0.5	(1)	3.9	(8)	12.7	(26)	2.4	(5)	4.4	(9)
19	59.3	(121)	3.9	(8)	2.9	(6)	20.6	(42)	1.5	(3)	11.8	(24)
20	80.8	(164)	3.0	(6)	0.5	(1)	5.9	(12)	2.0	(4)	7.9	(16)

Note: Un = Amotivated; Ex = External; Int = Introjected; Id = Identified; Ing = Integrated; Intr = Intrinsic

Dimensions of adherence to healthy habits

The Kaiser-Meyer-Olkin index test (KMO = .709) and the Bartlett statistic ($p < .001$) showed that the data matrix is appropriate for factoring. Given the presence of kurtosis in half of the items (2, 3, 9, 10, 12, 13, 16, 17, 18, and 20), a polychoric correlation matrix was used as the starting matrix. Except for item 1, which had a factor loading of .27, all items had factorial weights > .30. Values between .30 and .50 are commonly accepted in the literature (Izquierdo, Olea, & Abad, 2014) and, consequently, no items were eliminated. The Parallel Analysis method, with 5,000 resamples, recommended extracting only two factors. As seen in Table 3, adjustment indices showed that the questionnaire had a reasonably satisfactory adjustment for a two-dimensional structure. The first factor consists of behaviours related to dietary habits, while the second factor consists of behaviours related to physical activity habits. The inter-factor correlation was .404.

Reliability of adherence scores for healthy habits

Internal consistency was assessed using Cronbach’s alpha for ordinal data, which was satisfactory: $\alpha = .756$ for the first factor and $\alpha = .821$ for the second factor. In addition, test-retest reliability was evaluated in a subsample of 40 participants using the test-retest Pearson correlation. The coefficients were .604 and .638 for each factor, respectively. These results showed that adherence scores for healthy behaviour had an appropriate reliability in terms of internal consistency and temporal stability.

Basic psychological needs and resilience

The dimension of BN regarding diet showed an appropriate level of reliability ($\alpha = .75$; Pearson test-retest = .645, $p < .001$).

Table 3
Factor analysis of the adherence scale for healthy behaviour

Adherence items*	Factorial weights	
	Factor 1	Factor 2
1	.272	
2	.383	
3	.314	
4	.513	
5	.602	
6	.375	
7	.313	
8	.273	
9	.431	
10	.471	
11	.473	
12	.309	
13	.238	
14	.603	
15		.424
16		.593
17		.881
18		.778
19		.685
20		.691
Adjustment indices	GFI = .942; CFI = .929; RMSEA = .061; RMSR = .076	
Percentage of variance explained	22.4%	12.1%
Score reliability	$\alpha = .756$; Test-retest = .604	$\alpha = .821$; Test-retest = .638

Although the residual fit index is higher than it should be (RMSR = .143), the general fit index is very high (GFI = .963), which shows a relatively adequate adjustment of a one-dimensional structure, with the first factor explaining 57.48% of the total variance.

The dimension of BN related to physical activity also showed an appropriate level of reliability of the scores ($\alpha = .815$; Pearson test-retest = .62, $p < .001$) and relatively appropriate construct validity (GFI = .927; RMSR = .177). The variance explained was 52.91%.

The resilience measure also showed appropriate reliability ($\alpha = .880$) and appropriate construct validity (GFI = .99; RMSR = .03). The variance explained was 72.72%.

As shown in Table 4, resilience had a statistically significant correlation with dietary BN ($r = .398$; $p < .001$) and physical activity BN ($r = .505$; $p < .001$). These results were in consonance with our expectations and show the appropriate convergent validity of the instruments.

The scores for the second dimension (adherence to physical activity) are in consonance with the BN ($r = .281$; $p < .001$) and resilience ($r = .216$; $p = .004$). In addition, a relatively moderate relationship was found with glycated haemoglobin ($r = -.182$; $p < .001$) (Table 4).

Discussion

The results of this study confirm the psychometric properties of MDDM2, a new instrument for measuring the compliance of T2D patients with a healthy diet and physical activity. MDDM2 paves the way for studying the relationship between adherence to healthy behaviours and the BN related to healthy behaviours. This research is innovative in many ways. Firstly, this new instrument could fill a gap in the scientific literature and could thus provide a new measure for assessing adherence to healthy behaviours in T2D. Secondly, the target population are mainly clinical patients attending PHC. Using this sample substantially increases the potential benefits and practical implications of this research. Finally, this study includes both psychological and biochemical markers. Using both types of measure provides a more comprehensive and realistic understanding of the situation and, at the same time, increases the validity of the evidence provided in addition to the self-reported information.

Results showed that the psychometric properties of the instrument are appropriate in terms of internal consistency and test-retest reliability. The structure of the measure is two-dimensional and the scores for the second dimension (adherence to physical activity) are in consonance with other measurements of BN and resilience. In addition, a moderate relationship with HbA_{1c} was also found. In short, the measure has been shown to have appropriate reliability and evidence to evaluate adherence to healthy behaviour in patients with T2D.

HbA_{1c} was included as an external validity criterion because this parameter is a direct indicator of a healthy diet and physical activity (Huang et al., 2016). In accordance with previous studies, an inverse relationship was demonstrated between adherence to physical activity and HbA_{1c} (García, Cox, & Rice, 2017). The relationship of HbA_{1c} with a healthy diet was also inverse and, although it was not a significant one, it is important to consider it together with physical activity. As has been noted in a recent systematic review, physical activity advice is only associated with HbA_{1c} reduction when accompanied by a dietary co-intervention (Umpierre et al., 2011). Some authors have suggested that the variables described by the SDT model do not completely explain the changes needed to develop interventions aimed at modifying behaviour, and that some personal aspects must also be considered (Hurkmans et al., 2010; Weman-Josefsson, Lindwall, & Ivarsson, 2015). This may explain the results observed in this study in relation to diet, which were accounted for in the MDDM2 study design by including other personal and anthropometric variables. Nevertheless, previous studies have applied the SDT model to T2D (Koponen, Simonsen, Laamanen, & Suominen, 2015). The components, BN and level of motivation, could be used in the intervention design, as a way to measure the objectives and outcomes of the intervention. Some authors suggest that the SDT model could be an effective theoretical framework to encourage patients to self-manage T2D, increase their intrinsic motivation, and improve their adherence related to changes in lifestyle and glycaemic control (Fleming et al., 2013). For example, Koponen et al. (2015) emphasise the role of healthcare in supporting autonomous motivation and perceived competence in order to attain adequate glycaemic control. In addition, Nouwen et al. (2011) reported that changes in dietary self-care in T2D patients were predicted by changes in controlled motivation, and also improved autonomy support and autonomous motivation.

Another benefit of clinically implementing the MDDM2 questionnaire is its potential ability to estimate the duration of a given behaviour. Knowing the motivation may help predict the duration of the behaviour that is being integrated in the educational intervention, such as physical activity (Duncan, Hall, Wilson, & Jenny, 2010). MDDM2 measures BN and motivation separately, and thus these measurements may be taken into account when designing interventions or used as outcomes of interventions.

The appropriate psychometric properties of the MDDM2 questionnaire are also noted by the direct relationship between resilience and BN. Previous research demonstrates that resilience training programs make an important contribution to increasing positive life outcomes in patients with T2D in terms of diet and physical activity (Bradshaw et al., 2007). In line with previous research, an inverse relationship was observed between resilience

Table 4
Correlations between adherence to healthy behaviour, basic psychological needs, resilience, and HbA_{1c}

	Adherence to diet (<i>r</i>)	<i>p</i>	Adherence to physical activity (<i>r</i>)	<i>p</i>	BN: diet (<i>r</i>)	<i>p</i>	BN: physical activity (<i>r</i>)	<i>p</i>
BN: diet	.094	.245	.02	.83			.34	<.001
BN: physical activity	.06	.51	.281	<.001	.34	<.001		
HbA _{1c}	-.007	.7	-.182	<.001	-.04	.576	-.113	.16
Resilience	.04	.6	.216	.004	.398	<.001	.505	<.001

and HbA1C (Bradshaw et al., 2007; Pesantes et al., 2015). It is reasonable to assume that people who are resilient and worried about their health take further steps to maintain and improve it. The findings of this study should be carefully considered. Further progress in the development of future research is needed to establish the relationship between resilience and HbA1C.

One limitation of the study is that the sample may not be representative. Culture and society determine behaviours. Therefore, the items of MDDM2 should be revised even if the questionnaire is to be used in other Spanish-speaking areas, such as Latin America.

Confirming the psychometric properties of the MDDM2 questionnaire has important clinical implications for behavioural interventions, for assessing both habits and their approach, as well as the design and implementation of education.

Firstly, independently measuring adherence to behaviour recommendations facilitates the specific detection of people's needs in order to better approach them and, therefore, take steps to ensure that health professionals develop effective educational interventions. Secondly, knowing the degree of BN fulfilment can guide the design of educational interventions, since educators could focus their efforts on improving and reinforcing behaviour from the lowest to the greatest degrees of adherence, respectively. Finally, since the questionnaire identifies the motivations of patients to adhere to a healthy behaviour, it enables the prediction of the duration that the behaviour will last for and, thus, guide the type of clinical follow-up that health professionals must provide. In conclusion, MDDM2 is an instrument with appropriate psychometric properties for evaluating adherence to healthy behaviours in patients with T2D.

References

- American Diabetes Association (2014). Diagnosis and classification of diabetes mellitus. *Diabetes Care*, 40 (Suppl 1), S11-S24. doi: 10.2337/dc14-S081
- Bradshaw, B.G., Richardson, G.E., Kumpfer, K., Carlson, J., Stanchfield, J., Overall, J., et al. (2007). Determining the efficacy of a resiliency training approach in adults with T2D. *The Diabetes Educator*, 33(4), 650-659.
- De Feo, P., & Schwarz, P. (2013). Is physical exercise a core therapeutical element for most patients with T2D? *Diabetes Care*, 36 (Suppl 2):S149-S154. doi: 10.2337/dcS13-2024
- Deci, E., & Ryan, R.M. (1985). The general Causality Orientations Scale: Self-Determination in personality. *Journal of Research in Personality*, 19(2), 109-134. [https://doi.org/10.1016/0092-6566\(85\)90023-6](https://doi.org/10.1016/0092-6566(85)90023-6)
- Deci, E.L., & Ryan, R.M. (2012). Self-determination theory in health care and its relations to motivational interviewing: A few comments. *The International Journal of Behavioral Nutrition and Physical Activity*, 9, 24. doi: 10.1186/1479-5868-9-24
- Duncan, L.R., Hall, C.R., Wilson, P.M., & Jenny, O. (2010). Exercise motivation: A cross-sectional analysis examining its relationships with frequency, intensity, and duration of exercise. *The International Journal of Behavioral Nutrition and Physical Activity*, 7, 7. doi: 10.1186/1479-5868-7-7
- Evert, A.B., Boucher, J.L., Cypress, M., Dunbar, S.A., Franz, M.J., Mayer-Davis, E.J., et al. (2014). Nutrition therapy recommendations for the management of adults with diabetes. *Diabetes Care*, 37 (Suppl. 1), S120-S143. doi: 10.2337/dc14-S120
- Federación Española de Diabetes (2013). *Tengo diabetes tipo 2 ¿Qué puedo hacer?* [I have T2D. What can I do?]. Retrieved from http://docsafedownload.net/fedesp/bddocs/2guia_tipo2.pdf
- Fleming, S.E., Boyd, A., Ballejos, M., Kynast-Gales, S.A., Malemute, C.L., Armstrong Shultz, J., et al. (2013). Goal setting with T2D: A hermeneutic analysis of the experiences of diabetes educators. *The Diabetes Educator*, 39(6), 811-819. doi: 10.1177/0145721713504471
- García, J.M., Cox, D., & Rice, D.J. (2017). Association of physiological and psychological health outcomes with physical activity and sedentary behavior in adults with T2D. *BMJ Open Diabetes Research & Care*, 5(1), e000306. doi: 10.1136/bmjdr-2016-000306
- Gourlan, M., Trouilloud, D., & Boiché, J. (2016). Motivational profiles for physical activity practice in adults with T2D: A self-determination theory perspective. *Behavioral Medicine*, 42(4), 227-237. doi: 10.1080/08964289.2014.1001810
- Huang, X.L., Pan, J.H., Chen, D., Chen, J., Chen, F., & Hu, T.T. (2016). Efficacy of lifestyle interventions in patients with T2D: A systematic review and meta-analysis. *European Journal of Internal Medicine*, 27, 37-47. doi: 10.1016/j.ejim.2015.11.016
- Hurkmans, E.J., Maes, S., de Gucht, V., Knittle, K., Peeters, A.J., Ronday, H.K., et al. (2010). Motivation as a determinant of physical activity in patients with rheumatoid arthritis. *Arthritis Care & Research*, 62(3), 371-377. doi: 10.1002/acr.20106
- International Diabetes Federation (2015). *IDF Diabetes Atlas 7TH Edition*. Retrieved from <http://www.diabetesatlas.org>
- Juul, L., Mairdal, H.T., Zoffmann, V., Frydenberg, M., & Sandbaek, A. (2011). A cluster randomised pragmatic trial applying Self-determination theory to T2D care in general practice. *BMC Family Practice*, 12, 130. doi: 10.1186/1471-2296-12-130
- Koponen, A.M., Simonsen, N., Laamanen, R., & Suominen, S. (2015). Health-care climate, perceived self-care competence, and glycemic control among patients with T2D in primary care. *Health Psychology Open*, 2(1), 2055102915579778. doi: 10.1177/2055102915579778
- Leblanc, V., Bégin, C., Hudon, A.M., Royer, M.M., Corneau, L., Dodin, S., et al. (2011). Gender differences in the long-term effects of a nutritional intervention program promoting the Mediterranean diet: Changes in dietary intakes, eating behaviors, anthropometric and metabolic variables. *Nutrition Journal*, 13, 107. doi: 10.1186/1475-2891-13-107
- Limonero, J.T., Tomás-Sábado, J., Gómez-Romero, M.J., Mate-Méndez, J., Sinclair, V.G., Wallston, K.A., et al. (2014). Evidence for validity of the brief resilient coping scale in a young Spanish sample. *The Spanish Journal of Psychology*, 17, E34. doi: 10.1017/sjp.2014.35
- Martín-Payo, R., Suárez-Álvarez, J., Amieva-Fernández, M.E., Duaso, M.J., & Álvarez-Gómez, E. (2016). Adherence to healthy diet and physical activity in clinical patients. *Psicothema*, 28(4), 457-464.
- Miquelon, P., & Castonguay, A. (2016). Motives for participation in physical activity and observance of physical activity recommendations among adults with T2D. *Canadian Journal of Diabetes*, 40(5), 399-405. doi: 10.1016/j.cjcd.2016.02.009
- Millán-Reyes, M.J., Rioja-Vázquez, R., & Muñoz-Arias, S. (2015). *Educación diabetológica y cuidados de enfermería en las personas con diabetes en el ámbito extrahospitalario* [Diabetes education and nursing care for people with diabetes in the out-of-hospital setting]. Retrieved from <http://www.semesandalucia.es/wp-content/uploads/2015/07/educacion-diabetes-enfermeria.pdf>
- Ng, J.Y., Ntoumanis, N., Thøgersen-Ntoumani, C., Deci, E.L., Ryan, R.M., Duda, J.L., et al. (2012). Self-determination theory applied to health contexts: A meta-analysis. *Perspectives on Psychological Science*, 7(4), 325-340. doi: 10.1177/1745691612447309
- Nouwen, A., Ford, T., Balan, A.T., Twisk, J., Ruggiero, L., & White, D. (2011). Longitudinal motivational predictors of dietary self-care and diabetes control in adults with newly diagnosed T2D mellitus. *Health Psychology*, 30(6), 771-779. doi: 10.1037/a0024500
- Pesantes, M.A., Lazo-Porras, M., Abu Dabrh, A.M., Avila-Ramírez, J.R., Caycho, M., Villamonte, G.Y., et al. (2015). Resilience in vulnerable populations with T2D mellitus and hypertension: A systematic review and meta-analysis. *The Canadian Journal of Cardiology*, 31(9), 1180-1188. doi: 10.1016/j.cjca.2015.06.003

- Reusch, J.E., & Manson, J.E. (2017). Management of T2D in 2017: Getting to goal. *JAMA*, *317*(10), 1015-1016. doi: 10.1001/jama.2017.0241
- Ryan, R.M., & Deci, E.L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *The American Psychologist*, *55*, 68-78.
- Ryan, R., Patrick, H., Deci, E., & Williams, G. (2008). Facilitating health behavior change and its maintenance: Interventions based on self-determination theory. *The European Health Psychologist*, *10*, 2-5.
- Shigaki, C., Kruse, R.L., Mehr, D., Sheldon, K.M., Bin, G.E., Moore, C., et al. (2010). Motivation and diabetes self-management. *Chronic Illness*, *6*(3), 202-214. doi: 10.1177/1742395310375630
- Sociedad Española de Endocrinología y Nutrición (2017). *Diabetes y obesidad: más peligrosas juntas* [Diabetes and obesity: More dangerous together]. Retrieved from <http://www.seen.es/docs/apartados/700/folleto-diabetes.pdf>
- Soriguer, F., Goday, A., Bosch-Comas, A., Bordiú, E., Calle-Pascual, A., Carmena, R., et al. (2012). Prevalence of diabetes mellitus and impaired glucose regulation in Spain: The Di@bet.es Study. *Diabetologia*, *55*(1), 88-93. doi: 10.1007/s00125-011-2336-9
- Teixeira, P.J., Carraça, E.V., Markland, D., Silva, M.N., & Ryan R.M. (2012). Exercise, physical activity, and self-determination theory: A systematic review. *The International Journal of Behavioral Nutrition and Physical Activity*, *9*, 78. doi: 10.1186/1479-5868-9-78
- Timmerman, M.E., & Lorenzo-Seva, U. (2011). Dimensionality assessment of ordered polytomous items with parallel analysis. *Psychological Methods*, *16*(2), 209-220. doi: 10.1037/a0023353
- Umpierre, D., Ribeiro, P.A., Kramer, C.K., Leitao, C.B., Zucatti, A.T., Gross, J.L., et al. (2011). Physical activity advice only or structured exercise training and association with HbA1c levels in T2D: A systematic review and meta-analysis. *JAMA*, *305*(17), 1790-1799. doi: 10.1001/jama.2011.576
- Weman-Josefsson, K., Lindwall, M., & Ivarsson, A. (2015). Need satisfaction, motivational regulations and exercise: Moderation and mediation effects. *The International Journal of Behavioral Nutrition and Physical Activity*, *12*, 67. doi: 10.1186/s12966-015-0226-0