Running Head: Psychosocial profiles of individuals with T2DM

# Psychological profiles of type 2 diabetes and their association with physical and psychological outcomes: a cluster analysis

**Abstract**

Objectives: This study aimed to identify clusters of participants with Type 2 diabetes mellitus (T2DM) at risk for developing psychological and somatic distress symptoms. Moreover, we investigated whether the different clusters were associated with glycemic control, sleep, and physical activity levels.

Design and main outcome measures: In a cross-sectional design, participants with T2DM (n = 269) completed questionnaires on psychological and somatic distress, sleep disorders and physical activity.

Results: Cluster analyses yielded three groups: a) "high self-confident and low demoralised"; b) "low support and low involvement"; c) "high consequences, high demoralisation and nagging". The groups were distinguished by the social, cognitive, and vital exhaustion variables and significant differences in diabetes-related psychological distress and physical activity. The measure of glycemic control did not differ between clusters. The "high self-confident and low demoralised" group displayed the lowest scores on psychological distress compared to the other clusters.

Conclusions: Results suggest that social cognitive dimensions and affective states play a key role in defining clusters in participants with T2DM. Thus, we need to consider the psychological profiles of participants with T2DM when designing interventions to improve self-management strategies.

Keywords: type 2 diabetes, social cognitive dimensions, cluster analysis, diabetes distress, physical activity

**Introduction**

Type 2 diabetes mellitus (T2DM) is a common chronic disease that presents important personal and economic costs to the community from microvascular (such as retinopathy and neuropathy) and macrovascular complications (such as coronary artery disease, heart disease, nephritis and chronic kidney diseases, cerebrovascular disease and limb amputation). T2DM is managed daily by patients and their families, and self-management is key to achieving glycemic control. Self-management requires adherence to the diet, physical activity, self-monitoring of blood sugar, diabetes medications and behavioural strategies to promote lifestyle changes (International Diabetes Federation, 2009). However, managing T2DM daily is not always easy as individuals must balance self-management behaviours with their preferences or desires for food or activity. Given these challenges, it may come as no surprise that people with T2DM were found to have elevated levels of depressive symptoms (Mc Sharry, Bishop, Moss-Morris, & Kendrick2013; Holt, 2018), anxiety disorders (Smith, Deschenes, & Schmitz, 2018) and sleep complaints (Nefs et al., 2020) when compared to adults from the general population. There is also evidence showing that a high affective load leads to poorer self-management. For example, people with T2DM who report higher psychological distress also report lower glycemic control, lower levels of physical activity and higher T2DM related physical symptoms compared to people with T2DM who report lower levels of distress (Arigo et al., 2020; Snoek, Bremmer & Nermanns, 2015).

Social Cognitive Theory (SCT, Bandura, 1986) considers the unique way individuals acquire and maintain behaviour while also considering the social environment in which individuals perform the behaviour. SCT provides a framework to better understand the behaviour of people with T2DM and inform psychological interventions to support self-management.

Self-efficacy beliefs and outcome expectancies are the primary determinants of the SCT (Bandura, 1997, 2004). Self-efficacy is defined as the belief that one can successfully execute the behaviour required to produce a given outcome (Bandura, 1997). Even highly skilled individuals with abundant (external) resources if they doubt their ability, can perform poorly. Previous studies have found that low self-efficacy is associated with increased psychological distress and low glycemic control (Talbot, Nouwen, Gingras, Gosselin, & Audet, 1997). Self-efficacy can also explain the direct and indirect connection between the psychological distress and glycemic control (Sacco et al. 2007). Outcome expectancies reflect the individual's beliefs of possible consequences of their behaviour. In newly diagnosed people with T2DM positive outcome expectancies towards dietary self-care are linked to better glycemic control overtime (Nouwen et al., 2011).

A unique feature of SCT is its emphasis on social influences and external and internal social reinforcement. In T2DM social support can influence metabolic control through positive effects on adherence (e.g., Glasgow & Toobert, 1988). Further, support from family is vital for adults with T2DM, as it enhances the patient's physical and emotional functioning (Fortmann, Gallo, & Philis-Tsimikas, 2011; Mayberry & Osborn, 2012). The partner, or significant other, may help with the day-to-day management of diabetes and encouragement and support in decision-making (Franks et al., 2012). However, family relationships are not always supportive. Non-supportive family behaviours such as nagging and criticism can reduce people's perceptions of autonomy, which in turn could make them less motivated to cope with T2DM problems, resulting in increased emotional distress (Anderson & Coyne, 1993).

To better tailor behaviour change interventions, researchers have attempted to identify various psychosocial clusters of people with diabetes mellitus (Fisher et al., 2010; Guck et al., 2008; Nouwen, Breton, Law, & Descoteaux, 2007; Nouwen, Gingras, Talbot, & Bouchard, 1997; Skinner et al., 2011). Nouwen and colleagues (1997) guided by SCT found support for a three-cluster conceptualisation: adaptive copers, low support-low involvement, and *spousal over-involvement*. The three profiles were found to be stable (Nouwen, Breton, Urquhart Law, & Descoteaux, 2006) and to be independent of demographic variables, body mass index, duration of diabetes, complexity of treatment, number of complications, social desirability, and major stress levels (Nouwen and coll., 1997; 2007).

Guck et al. (2008) tried to replicate the findings from the Nouwen et al., 1997 study using the same Multidimensional Diabetes Scale. Guck et al. (2008) identified 4 clusters. Two of the clusters, *adaptive copers* and *dysfunctional/ spousal overinvolvement*, were the same with the original Nouwen et al., 1997 study. However, Guck et al. (2008) failed to identify the third cluster *low support/low involvement*. Instead, they identified two new clusters: A "low support/low involvement" cluster and a “high positive support/ high nagging” cluster. Both these two new clusters were associated with lower self-efficacy and lower outcome expectancies compared to the other two profiles.

The differences in the population and the statistical analyses used may explain the different results. Nowen et al., 1997 study was conducted with a French-speaking Canadian population, recruited from a diabetes educational setting, with the majority of the sample being men. Further, the cluster analysis was based on K-means. In the replication study, Guck et al. (2008) included participants from a US urban primary care setting, the majority of participants were women, and they used model-based cluster analysis.

It is important to identify a stable, replicable psychosocial taxonomy of diabetes mellitus to refine the psychosocial support provided to people in different profiles. However, it is uncertain whether there is a 3- or 4-cluster solution and a further replication study is needed. We also need to learn more about the role gender and other demographic variables play in those profiles.

Furthermore, the present study aims to extend the previous classifications by considering a construct of affective load. Vital exhaustion is an affective-somatic syndrome characterised by unusual feelings of fatigue and loss of energy increased irritability and demoralisation (Appels, 1990). Vital exhaustion is distinct from depression (van Diest and Appels, 1991; Balog, & Konkoly Thege, 2019). Further, vital exhaustion is associated with sleep disturbances (van Diest and Appels, 1994) and cardiac symptoms such as angina pectoris and unstable angina (Frestad & Prescott, 2017). Moreover, it was predictive of future myocardial infarction (MI) in men and women, independent of the classic risk factors (Balog et al., 2017; Appels, Falger, & Schouten, 1993). Given the important impact of vital exhaustion, we considered vital exhaustion particularly worth of inclusion in preexistent classifications.

In the current study, we aimed to identify an empirically derived classification of psychosocial variables in a group of T2DM. We examined the resulting clusters or groups for differences in demographic (i.e., age, gender and marital status), psychological (i.e., worry and quality of sleep) and disease-related (i.e., duration of diabetes, body mass index, index of severity, and glycemic control) variables.

Given that cluster analysis is a data-driven procedure, any number of clusters could be identified as being the most optimal. However, based on literature and on previous configurations (Nouwen and coll., 1997; 2007) we expected at least two clusters to emerge, active copers (high on self-efficacy, outcome expectancies, social support, positive reinforcement behaviours; low on vital exhaustion, nagging, interference of diabetes in daily life and severity of diabetes) and dysfunctional copers (high vital exhaustion, nagging, interference of diabetes in daily life and severity, low on self-efficacy, outcome expectancies, social support and positive reinforcement behaviours). Further, we hypothesised that the former cluster would show the most optimal profile of external correlates: good quality of sleep, the lowest scores on worries, symptoms related to diabetes, physical symptoms, and the highest scores on physical activity.

**Method**

*Participants and procedure*

The research was carried out following the guidelines of the Ethical Committee of the "Sapienza" University Rome. Inclusion criteria were: diagnosis of T2DM for at least 1 year, according to the 2010 American Diabetes Association (2010) criteria, aged ≥ 18 years old, no concurrent malignant tumour, no vision impairment due to complications, no limited physical activity due to advanced renal failure, or acute complications; and no self-reported severe psychological co-morbidity such as clinical depression.

Participants were recruited directly from the Diabetes Center waiting room at "Sapienza" University Medical Center "Umberto I" Rome. People with diabetes were given a short letter from the centre's directors, informing them that they would be asked to participate in the study. A research assistant then approached each potential participant to explain the study and request their participation. Two hundred and seventy-seven people with T2DM completed the questionnaire. Eight questionnaires were excluded due to missing data on more than 60% of the whole questionnaire or the same responses for all scale items (e.g., all 7s). The final subsample consisted of 269 participants. One hundred and fifty-five (57%) participants were men. The mean diabetes duration was 11.6 years (*SD* =11.4). Participants' mean age was 68.3 years (SD = 9.1), and the majority (74.4%), reported living with a partner.

***Instruments***

*Demographic/medical information.*

Demographic and medical information was collected from participants' medical charts and included the following: date of birth, gender, diagnosis, duration of the disease, age at onset and medication regimen.

*Measures used in cluster analysis.*

*Multidimensional Diabetes Questionnaire (MDQ).* We adapted six sub-scales of the Italian version of the MDQ (Lazzari, Pisanti, Marini, & Fatati, 2009). The questionnaire is divided into three sections.

The first section of the MDQ, focusing on perceptions of diabetes and related social support, is comprised of three scales: (1) perceived interference with daily activities, work, and social and recreational activities caused by diabetes; (2) perceived severity of diabetes; and (3) perceived diabetes-related social support from a significant other, family, friends, or health professionals. Responses were rated on 7-point rating scales (0 to 6), with higher scores indicating higher perceived interference, severity, and social support levels. Confirmatory Factor Analysis (CFA) using 'AMOS' (Analysis of Moment Of Structure) software (version 24, Byrne 2016) showed a reasonable, although not very good fit, $\chi^2$ = 161,27; df = 62; $\chi^2$ /df = 2,6; RMSEA = .08; CFI = .94. Cronbach's alphas for interference, severity, and social support were .91, .82 and .73, respectively.

The second section is consisted of 13 items and includes two subscales : (1) positive reinforcment behaviours (eight items, e.g., "My spouse (or significant other) congratulates me when I follow my diet.") and misguided support "nagging" behaviours (five items, e.g., "My spouse (or significant other) hassles me about exercise.")~~about various self-care activities directed toward the patient by significant others~~. Patients recorded their responses on 7-point (0 = Never to 6 = Always) Likert scales with higher scores indicating higher levels of positive and misguided reinforcment behaviours. CFA indicated that the two-factor model fit the data adequately $\chi^2$ = 137,51; df = 51; $\chi^2$ /df = 2.7; RMSEA = .09; CFI = .94. Cronbach's alphas were .91 and .87 for perceived positive reinforcement behaviours and misguided reinforcment behaviours, respectively.

In the third section, participants responded to 6 items using a 0 (not at all important) to 100 (very important) format. The items form~~ed~~ a scale: outcome expectancies of the effects of diabetes self-care behaviours on glycaemic control and on the prevention of complications (e.g., "To what extent do you think that following your diet is important for controlling your diabetes ?"). CFA indicated that the one-factor model fit the data in a satisfactory way, $\chi^2$ = 19,48; df = 9; $\chi^2$ /df = 1.9; RMSEA = .07; CFI = .97. ' 'Cronbach's alpha was .76.

*Diabetes Self Efficacy*[1]. Following Bandura's approach in measuring situation-specific beliefs, a diabetes-specific self-efficacy measure was administered. This was an Italian translated version of the Self-Efficacy for Diabetes Scale originally developed by Lorig et al.

[1] We used this scale rather than the MDQ self-efficacy subscale, because this scale is more comprehensive and is composed by items more situation-specific than the MDQ self-efficacy subscale (e.g., "How safe / able to do half an hour of moderate physical activity every day?" vs “How confident are you in your ability to exercise regularly?”)

(1996). The scale was translated into Italian for the study. Two health psychologists translated the measure. Five participants with T2DM assessed a consensual version to evaluate its usability, feasibility and clarity. The resulting version was back-translated and compared with the original. The measure assesses participants' confidence in their abilities to perform specific behaviours in diabetes-related situations (e.g., "How safe / to be able to do half an hour of moderate physical activity every day?"). The measure consists of eleven items rated on a ten-point Likert scale ranging from "Not at all confident" to "Totally confident". CFA indicated that the one-factor model fit the data adequately, $\chi^2$ = 52,16; df = 19; $\chi^2$ /df = 2.7; RMSEA = .09; CFI = .93. ' 'Cronbach's alpha was .81.

*Vital exhaustion.* Vital exhaustion was assessed by an Italian translated version of the 21-item Maastricht Questionnaire (Appels, Hoppener, & Mulder, 1987). Also, in this case, the scale was back-translated and compared with the original. Each item (e.g., "Do you lately feel more listless than before ") is rated according to a three-point scale (No = 0; I do not know =1; Yes =2), and a scale score is obtained by summing the answers. Thus, the minimum score is 0 and the maximum 42, a high score indicates a severe level of vital exhaustion. CFA indicated that the one-factor model fit the data adequately, $\chi^2$ = 339,20; df = 179; $\chi^2$ /df = 1.9; RMSEA = .06; CFI = .91. Cronbach's alpha for this sample was .89.

*Additional measures.*

*Sleep disorders.* The Sleep Disorder Questionnaire (SDQ, Violani, Devoto, Lucidi, Lombardo, & Russo, 2004) is a brief (18 questions) self-report categorical questionnaire, ~~consisting of 18 questions,~~ which evaluates the presence of insomnia according to the Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association, 2002, 2013) and the quantitative criteria for insomnia (Lichstein, Durrence, Taylor, Bush, &

Riedel, 2003). Adequate convergent validity has been demonstrated via correlations with Pittsburgh Sleep Quality Index scores, a well-established measure of insomnia (Cohen's kappa = .78; Violani, et al., 2004). SDQ allows three groups to be defined: Good sleepers (participants reporting no sleep complaints); Subcriterial (participants complaining of sleep problems without satisfying the DSM-IV-TR criteria); and Chronic insomnia (participants reporting clinically significant symptoms of insomnia).

*Psychological distress.* The Medical Outcomes Study health distress scale (Lorig et al., 1996) is a four-item scale that assessed psychological distress caused by illness. This self-assessment questionnaire was back-translated into Italian and adapted for this study. A higher score on this scale indicates high health distress. CFA indicated that the one-factor model fit the data in a very satisfactory way, $\chi^2$ = 2,20; df = 2; $\chi^2$ /df = 1.0; RMSEA = .03; CFI = .96. Cronbach's alpha was .90.

*Diabetes somatic symptoms.* We measured somatic symptoms related to diabetes through a modified version of the Spanish hyperglycemia and hypoglycemia scales (Piette, 1999). These instruments were back-translated into Italian and adapted for this study. The questionnaire consists of 13 items. Respondents indicate~~d~~ to what extent they ~~had~~ experienced each symptom over the past week, for example "In the past week, did you ever have decreased appetite?", "In the past week, did you ever have morning headaches?". Answers are provided on a three-point scale (No = 0; I do not know =1; Yes =2) and a scale score is obtained by summing the answers: higher score indicating more hyper and hypoglycemia symptoms. CFA indicated that the one-factor model fit the data adequately, $\chi^2$ = 98,58; df = 65; $\chi^2$ /df = 1.5; RMSEA = .04; CFI = .93. Cronbach's alpha was .72.

*Physical Activity Level*. The short version of the International Physical Activity

Questionnaire (Craig et al., 2003) assesses activity completed in the last seven days. This questionnaire was back-translated into Italian and adapted for this study. Participants reported how long (i.e., hours and minutes per day) and frequently (i.e., days in the last seven days) they were engaged in vigorous, moderate, and walking intensity physical activity. Then, following the suggestions of Craig et al. (2003), the weekly minutes spent doing physical activity at each intensity was multiplied by the metabolic equivalent (MET) values 8.0, 4.0, and 3.3, respectively, and the resulting MET scores were summed as a single continuous variable (MET-minutes/week).

*Glycemic control.* We assessed glycated haemoglobin levels (HbA1c), an indicator of the participant's average blood glucose level over the previous 60–90 days. Values were obtained from medical records. Higher numbers (HbA1c > .8) reflect a lower glycemic control (American Diabetes Association, 2020).

*Data Analyses.*

Data were examined by cluster analysis and univariate factorial analyses of variance. Cluster analysis represents a methodological tool that can be used to identify subgroups of individuals in a given data set. It uses information about the level, variability, and shape of the profiles to classify individuals into homogeneous subgroups. Members of one subgroup share commonalities in the subgroup-defining constructs but differ from members of other groups (Clatworthy, Buick, Hankins, Weinman, & Horne, 2005). A sequential combination of hierarchical methods (e.g., Ward) and nonhierarchical methods (e.g., k-means) was used to identify subgroups (Clatworthy, Hankins, Buick, Weinman, & Horne, 2007). Ward's method, as implemented in the SPSS (version 22) software package, was used to evaluate the optimal number of clusters in the data and to produce the initial seed points for the subsequent k-means procedure, which determined the final case located in the separate subgroups. The k-means clustering is an iterative partitioning procedure that reproduces the k number of non-overlapping subgroups through minimising the sum of the squared distances from the subgroup centroid means. The k-means was implemented using the SPSS procedure QUICK CLUSTER (Steinley & Brusco, 2011).

Furthermore, we tested whether differences among the clusters could be explained in terms of differences in primary demographic (gender, age and marital status) and clinical-related variables (duration of diabetes, body mass index and glycemic control). Finally, the other variables (i.e., psychological distress, diabetes somatic symptoms, and quality of sleep) were used to validate the obtained clusters externally.

**Results**

*Preliminary correlational analyses.*

Concerning the zero-order correlations, a close inspection of Table 1 has revealed three aspects.

------ Insert Table 1 more or less here--------

The first regards the relationships between demographic characteristics and cluster variables. Female patients reported lower social support ($r = -.18$; $p < .01$), lower positive reinforcement behaviours ($r = -.24$; $p < .01$), lower diabetes self-efficacy ($r = -.12$; $p < .05$) and higher vital exhaustion ($r = .31$; $p < .001$) than male patients. Age was negatively related with diabetes self-efficacy ($r = -.19$; $p < .01$), and outcome expectancies ($r = -.16$; $p < .05$) and positively related with vital exhaustion ($r = .21$; $p < .01$). Diabetes duration presents positive associations with interference ($r = .24$; $p < .000$), severity ($r = .27$; $p < .000$), and vital exhaustion ($r = .13; p < .05$). Body max index correlated negatively with self-efficacy ($r = -.21; p < .01$), and positively with vital exhaustion ($r = .16; p < .01$). Finally, glycemic index correlated positively with interference ($r = .15; p < .05$), severity ($r = .22; p < .01$), and vital exhaustion ($r = .16; p < .05$).

The second feature concerns the relationships among cluster dimensions. The interference scale correlated positively with severity ($r = .41; p < .001$), misguided support behaviours ($r = .27; p < .001$), and vital exhaustion ($r = .46; p < .001$). Severity presented positive associations with social support ($r = .23; p < .001$), misguided support behaviours ($r = .22; p < .001$), and vital exhaustion ($r = .34; p < .001$). Social support revealed positive relationships with both positive reinforcement behaviours ($r = .70; p < .001$) and misguided support behaviours ($r = .35; p < .001$). Positive reinforcement behaviours showed positive associations with misguided support behaviours ($r = .48; p < .001$), diabetes self-efficacy ($r = .16; p < .05$) and outcome expectancies ($r = .17; p < .05$). Diabetes self-efficacy was significantly associated with outcome expectancies ($r = .31; p < .001$) and vital exhaustion ($r = -.33; p < .001$). Finally, these last two variables showed a moderated negative association ($r = -.23; p < .005$).

The third issue regards the pattern of associations between the cluster variables ~~on the one hand,~~ and the external validation variables ~~on the other hand~~. Physical activity correlated positively with social support ($r = .15; p < .05$), diabetes self-efficacy ($r = .38; p < .001$), and correlated negatively with vital exhaustion ($r = -.15; p < .05$). Psychological distress was significantly associated with interference ($r = .40; p < .001$), severity ($r = .44; p < .001$), diabetes self-efficacy ($r = -.27; p < .001$), outcome expectancies ($r = -.19; p < .01$), and vital exhaustion ($r = .59; p < .001$). Finally, diabetes somatic symptoms showed significant correlations with interference ($r = .32; p < .001$), social support ($r = -.13; p < .05$), positive reinforcement behaviours (r = -.17; p < .05) and vital exhaustion (r = .51; p < .001).

*Cluster analysis.*

Standardisation was necessary since measurement scales and means and standard deviations differed substantially between variables (Hair & Black, 2006). Ward's minimum variance was used as the grouping method. Squared Euclidean distance was used as the proximity measure in clustering the data; the tree diagram indicated a three-cluster solution. Furthermore, we decided to consider three clusters also based on Schwarz's Bayesian inference criterion (BIC). In a model selection application, the optimal fitted model is identified by the minimum value of BIC. In our analyses, the three-factor solution provided the lowest value.

------ Insert Table 2 more or less here--------

In order to verify that the three clusters reflected distinct subtypes within our sample, the analyses were repeated three times with randomly selected 60% samples. Chi-square analyses indicated that the majority of participants were classified in the same cluster each time, with $X^2$ values varying between 82.17 (df = 4) and 205.73 (df = 4), p < 0.000.

A one-way multivariate analysis of variance (MANOVA), followed by ONE WAY tests, confirmed that the three clusters differed on all eight variables, Wilks's lambda = 0.10; F(16, 328) = 42.9, *p* = .000. The means by cluster are shown in Table 2 and Figure 1 (z scores are used for all variables to ensure that the scale used is comparable for all psychosocial variables).

------ Insert Figure 1 more or less here--------

**Patients profiles.**

*High self-confident and low demoralised. (Cluster One).* The first patient profile contained 46% of the sample. One-way analyses of variance (ANOVAs) yielded significant differences between the three clusters on perceived diabetes self-efficacy, $F(2, 171) = 12.46$, $p < .0001$, perceived outcome expectancies, $F(2, 171) = 11.22$, $p < .0001$, and vital exhaustion $F(2, 171) = 27.45$, $p < .0001$. Tukey-Kramer tests (i.e., adjusted for unequal group sizes) showed that cluster I patients perceived themselves as having highest confidence in their ability to carry out diabetes self-care behaviours, and reported the highest score on the self-evaluative dimension that carrying out such self-care behaviours would lead to better control of diabetes; than patients of two other clusters. Notably, they had the lowest rating of ~~feelings of~~ fatigue, loss of energy and demoralisation ($F(2, 171) = 27.45$, $p < .0001$) when compared to the other two clusters.

*Low support and low involvement (Cluster Two).* This profile comprised 30% of the sample. It was characterised by lowest perceptions of diabetes-related social support $F(2, 171) = 130.62$, $p < .0001$, lowest positive reinforcement behaviours from ~~spouses and~~ significant others $F(2, 171) = 109.77$, $p < .0001$, and lowest misguided ‘nagging’ support behaviours from significant others $F(2, 171) = 32.59$, $p < .0001$; compared to the other two clusters.

*High consequences, high demoralisation and nagging (Cluster Three).* The third cluster (24%) was the smallest group and differed markedly from the rest of the sample in several ways. Cluster III participants reported significantly more interference of diabetes in daily life $F(2, 171) = 101.84$, $p < .0001$, and perceived the disease as more severe $F(2, 171) = 23.58$, $p < .0001$. Further, they had the significantly highest rating of vital exhaustion than the other two clusters. Finally, participants in this cluster reported significantly the highest score on misguided ('nagging') support behaviours from significant others.

*Possible confounds.*

A 3 X 2 (Cluster x Gender) chi-square analysis indicated significant cluster differences for gender, $X^2$ (2, $N$ = 174) = 7.44, $p$ = 0.024. ~~Inspection of the~~ Table 3 shows that the ratio of men to women was higher in Cluster 1 (57 *vs* 49; Adjusted residual = 2.6) and lower in Cluster 2 (25 *vs* 32; Adjusted residual = -2.3). Two one-way ANOVAs showed no statistical significant differences among the clusters regarding age and marital status (F(2, 167) = 0.81, p = .45 and F(2, 171) = 1.03, p = .36, respectively).

------ Insert Table 3 more or less here--------

To check possible confounds regarding the duration of diabetes, body mass index, and metabolic control ($HbA_{1c}$), a one-way MANOVA was computed. Results were ~~found to be~~ not-significant, Wilks's lambda = .90, F(8, 278) = 1.9, *ns.* Subsequently, univariate ANOVAs indicated a weak difference between the clusters regarding the body mass index. Patients included in cluster 1 (high self-confident/low demoralised) scored lower body max index than patients included in the cluster 3 (high consequences and high demoralisation and nagging).

*Cluster Validation.*

As indicated by $X^2$ –analysis for categorical data, these three clusters did differ on sleep quality distribution ($X^2$ (4) = 10.6; P < .05). As can be seen in Table 4, good sleepers were relatively overrepresented in the high self-confident and low demoralised cluster (35 vs 26; Adjusted residual = 3,1); whereas insomniacs were relatively overrepresented in high consequences, demoralisation and nagging group (10 vs 7; Adjusted residual = 1,5).

------ Insert Table 4 more or less here--------

A MANOVA was conducted with cluster membership as the independent variable and psychological distress, somatic symptoms of diabetes, and physical activity as dependent variables. Based upon Wilks'Lambda, statistically significant multivariate cluster differences were found ($F(6, 296) = 8.45$, $P < .001$, $\eta^2 = .15$). Subsequent ANOVAs showed significant cluster differences for all dependent variables (see Table 4). Participants included in cluster 1 (high self-confident and low demoralised) had lower scores in psychological distress and symptoms of diabetes compared to participants included in cluster 3 (high consequences, demoralisation and nagging). For physical activity, the high self-confident and low demoralised group scored higher than low support - low involvement group.

**Discussion**

This study explored how social-cognitive dimensions and affective variables (such as vital exhaustion) integrate into forming distinct and meaningful profiles, and investigated whether these profiles differ on demographics, disease and psychological variables. Three clusters were identified and accounted for 65% of participants. First, the high self-confident and low demoralised profile consisted predominantly of individuals who perceived themselves as "powerful agents" in following the lifelong, complex, and multi-component treatment regimen that includes regulation of diet and regular exercise. Second, the low support and low involvement profile consisted of individuals who reported the lowest levels of diabetes-related social support and reinforcement behaviours from spouses and significant others. Finally, the third profile consisted almost entirely of participants who reported the highest levels of interference, severity, vital exhaustion and misguided support behaviours from significant others than the other two profiles.

Regarding possible confounds, we only found a weak difference between profile I and II regarding gender: compared to the high self-confident and low demoralised cluster, the low support and low involvement profile consisted of more women. This finding aligns with

Nouwen and colleagues' (1997) classification and with studies on vital exhaustion (Brezinka, Dusseldorp & Maes, 1998). It is also interesting to note that there were more men in profile I and more women in profile II. In line with previous studies (Augustus and Sorkin, 2010; August, Kelly, and Markey, 2016) these results might reflect differential perceptions of partner involvement in diabetes management between men and women: women are more likely to perceive lower levels of social support by their partner.

Our results indicated that high self-confident/low demoralised cluster contained people who seem to have fewer difficulties adjusting to diabetes. This profile was different from the adaptive coper clusters identified by previous studies (Guck et al. 2008, Nouwen et al., 1997; 2006) characterised by less interference and less perceived severity of diabetes. In our classification, the adaptive profile was characterised by high scores of perceived ability to carry out diabetes self-care behaviours, and of perceptions that carrying out such self-care behaviours would lead to better control of diabetes. Moreover, in our adaptive profile individuals reported the lowest score of vital exhaustion compare to people included in the other clusters. Thus, the differences with previous studies may be because we considered a measure of affective load in our sample. It seems that the profile of "adaptive coper" that arises from the present study is characterised by "internal signals": both self-perceived capabilities to cope with diabetes and its consequences and perceiving of being less affected by emotional loads.

The second profile low support-low involvement somewhat resembled the previously obtained clusters in other populations of T2DM (Guck et al. 2008, Nouwen et al., 1997; 2007). As in the Canadian and US group of patients, individuals included in cluster II in our study perceived that their spouses or significant others were not very supportive of their diabetes and provided fewer diabetes-related positive reinforcement behaviours and more misguided support behaviours than perceived by clusters I and III patients.

In the third profile, participants received higher levels of severity, interference, vital exhaustion and misguided support behaviours from their partner or significant other. Unsurprisingly they experienced more severe symptoms of psychological distress and diabetes somatic symptoms than those in the profile I ("high self-confident and low demoralised"). Moreover, people included in profile III displayed a trend of experiencing sleep disorders than those in profile I.

Unlike previous studies (Guck et al. 2008, Nouwen et al., 1997; 2007), we did not find the cluster: "dysfunctional/spousal over-involvement profile". Also in this case the difference could be due to the use of a measure of affective states (i.e., vital exhaustion) in our study. Consistent with past research (e.g., August, Franks, Rook & Stephens, 2020 ) affective states could mediate the relationships between social support dimensions and adherence/psychological well-being variables in people with T2DM and play a key role in defining clusters in patients with T2DM.

In sum, the results of this study demonstrate that people with T2DM can be profiled and these profiles are associated with health behaviours and diabetes management variables. Screening for negative patterns of social support, i.e. nagging behaviour, overinvolvement may become a useful tool to identify those people who may be at risk of poor outcomes. For example, participants included in profile II (low involvement and low support) showed lower levels of physical activity than patients had in cluster I (high self-confident and low demoralised). These findings are in line with previous studies that have shown that social support is significantly associated with self-management of physical activity (Molloy, Dixon, Hamer, & Sniehotta, 2010), a positive impact on healthy diet, improved psychological well-being (Pamungkas et al., 2017) and improved glycemic control (Pamungkas et al., 2017; Shao et al., 2017). This means that interventions could target people with profile II characteristics and this group could especially benefit from social support elements that facilitate action by (re)activating intentions, promoting planning and monitoring of the behaviour (Molloy, et al., 2010).

For individuals in profiles II and III, it is unlikely that an emotion-focused educational programme would be successful without the promotion of social cognitive dimensions (Chew et al., 2018). This may be achieved through a therapeutic approach that includes patients' beliefs, addresses both participants' emotional and cognitional needs and involves their spouses or significant others. For example, aspects of social cognitive theory (outcome expectancies, self-efficacy and social support) have been shown as useful components when designing physical activity interventions (Heiss & Petosam 2016; Gleeson-Kreig, 2006; Dutton et al., 2009), nutrition education (Miller et al., 2002), A1C management (Jiang et al., 2019) or diabetes self-care activities (Ghoreishi et al., 2019; Borhaninojad et al., 2017) in adults with T2DM. Further the findings of this study showed a significant negative role of affective modes, i.e. vital exhaustion. The negative role of vital exhaustion has been extensively studied in cardiovascular disease (e.g. Kopp et al., 1998, Frestad & Prescott, 2017, Cohen et al., 2017) and to a lesser extent on T2DM (Strikweda et al., 2021). Family support could play an important protective role against vital exhaustion (Tselebis et al., 2009) and a stress management intervention could reduce vital exhaustion (Koertge et al., 2007).

*Limitations and future research*

The profiles identified in the present study did not represent all patients. 35% of patients were not reliably classified in one of the three clusters. In line with some authors'arguments (e.g., Bergman, 1988), it cannot reasonably be expected that a small number of clusters can represent *all* possible patterns that might result from the complex interactions involved in psychosocial adjustment to diabetes. Another possible drawback of this study is its reliance on cross-sectional data. Therefore, we cannot draw causal inferences from this research or the stability of the three profiles over time. To establish causality between psychosocial dimensions and illness dimensions and test the stability of the profiles over time, longitudinal multi-waves studies are required.

Overall, this study shows that social cognitive dimensions and affective loads may influence the psychosocial adjustment of people with T2DM, and provides some direction for designing a multifaceted intervention that addresses social cognitive and affective variables in tandem.

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Table 1. Descriptives and Pearson zero-order correlation coefficients of the variables (n = 269).

| | (1) | (2) | (3) | (4) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **(1) GENDER** | - | | | | | | | | | | | | . | | |
| **(2) AGE** | -.05 | - | | | | | | | | | | | | | |
| **(3) BMI** | .10 | -.09 | - | | | | | | | | | | | | |
| **(4) YDD** | .03 | .24** | .11 | - | | | | | | | | | | | |
| **(6) HbA1c** | .08 | .04 | .19* | .27** | - | | | | | | | | | | |
| **(7) I** | .07 | .08 | .06 | .24** | .15* | - | | | | | | | | | |
| **(8) S** | .08 | .06 | .04 | .27** | .22** | .41*** | - | | | | | | | | |
| **(9) SS** | -.18** | .07 | -.10 | -.02 | -.02 | .09 | .23*** | - | | | | | | | |
| **(10) PRB** | -.24* | .12 | -.04 | .01 | -.11 | .10 | .11 | .70*** | - | | | | | | |
| **(11) MSB** | -.07 | .09 | .08 | -.03 | -.02 | .27*** | .22*** | .35*** | .48*** | - | | | | | |
| **(12) SE** | -.12* | -.19* | -.21** | -.10 | -.08 | -.09 | -.11 | .06 | .16* | -.02 | - | | | | |
| **(13) OE** | .04 | -.16 | -.10 | .03 | -.06 | -.09 | -.11 | .04 | .17* | -.02 | .31*** | - | | | |
| **(14) VE** | 31*** | .21** | .16** | .13* | .16* | .46*** | .34*** | -.13 | -.11 | .09 | -.33*** | -.23*** | - | | |
| **(15) PA** | -.06 | -.17* | -.29** | -.10 | .01 | -.08 | -.02 | .15* | .11 | -.01 | .38*** | .06 | -.15* | - | |
| **(16) PS** | .18* | -.01 | .07 | .20** | .15* | .40*** | .44*** | -.06 | -.09 | .08 | -.27*** | -.19** | .59*** | -.10 | - |
| **(17) DSS** | .21** | .04 | .08 | .11 | .22** | .32*** | .09 | -.13* | -.17* | -.06 | -.11 | -.06 | .51*** | -.13* | .31*** |

**G: Gender (1 = M; 2 = F); AGE; BMI: Body Mass Index; YDD: Years since Diabetes Diagnosis (Years); HbA1c; I: Interference; S: Severity; SS: Social Support; PRB: Positive Reinforcement Behaviours; MRB: Misguided Support Behaviours; SE: Self-Efficacy; OE: Outcome Expectancies; VE: Vital Exhaustion; PA: Physical Activity; PS: Psychological Distress; DSS: Diabetes Somatic Symptoms.**

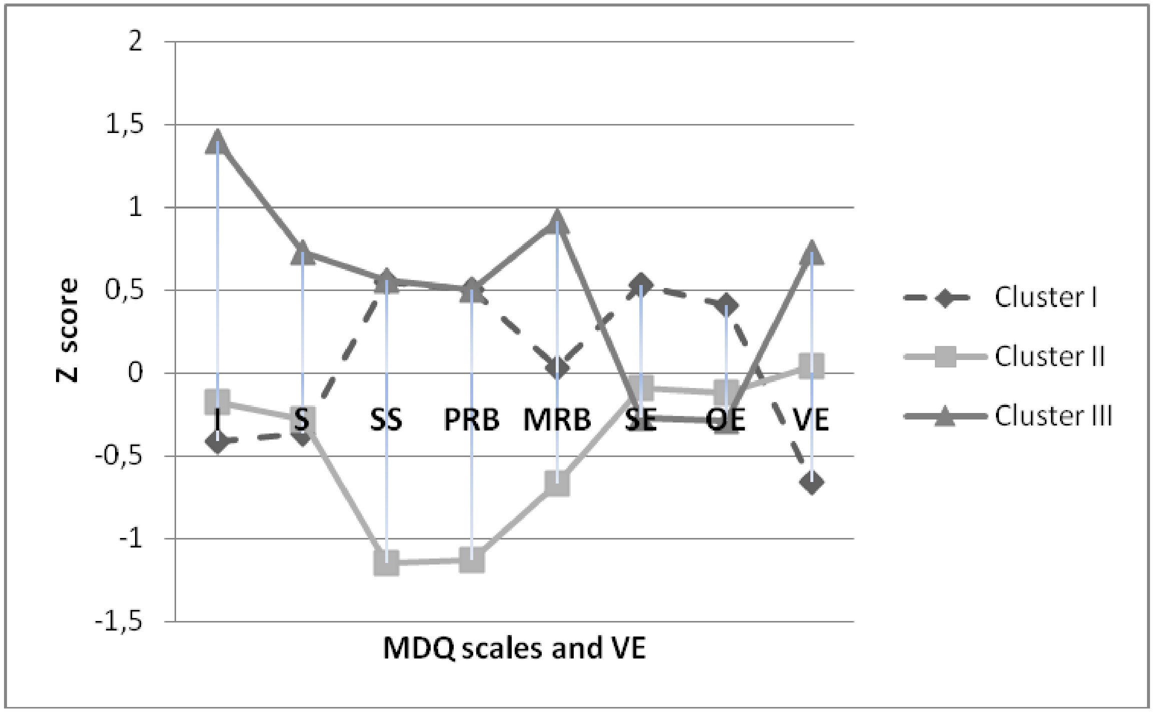
*** *p* < .05.**
**** < .01.**
***** p < .001**

**Table 2. Mean scale scores by profiles, ANOVA and Bonferroni test results**

| Variables | Mean score by profiles | | | | |
|---|---|---|---|---|---|
| | I<br>n = 80 | II<br>n = 52 | III<br>n = 42 | F | Results of Bonferroni tests |
| **I** | -0,41 | -0,18 | 1,40 | 101,84** | III > I; III > II |
| **S** | -0,37 | -0,28 | 0,73 | 23,58** | III > I; III > II |
| **SS** | 0,55 | -1,15 | 0,56 | 130,62** | II < I; II < III; |
| **PRB** | 0,50 | -1,13 | 0,50 | 109,77** | II < I; II < III; |
| **MRB** | 0,03 | -0,67 | 0,92 | 32,59** | II < I < III |
| **SE** | 0,53 | -0,09 | -0,27 | 12,46** | I > II; I > III |
| **OE** | 0,41 | -0,12 | -0,29 | 11,22** | I > II; I > III |
| **VE** | -0,66 | 0,04 | 0,73 | 46,09** | III > II > I |

**I, Interference; S, Severity; SS, Social Support; PRB, Positive Reinforcement Behaviours; MRB, Misguided Support Behaviours; SE, Self-Efficacy, OE, Outcome Expectancies; VE, Vital Exhaustion**
*** *p* < .05; ** p < .01; *** p < .001**

**Figure I. Mean Z scores for patient profiles on the Multidimensional Diabetes Questionnaire (MDQ) scales and Vital Exhaustion.**




**I, Interference; S, Severity; SS, Social Support; PRB, Positive Reinforcement Behaviours; MRB, Misguided Support Behaviours; SE, Self-Efficacy, OE, Outcome Expectancies; VE, Vital Exhaustion**

**Table 3 Potential Confounding Variables Related to Cluster Differences**

| Variables | Mean score by profile | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | I<br>n = 80 | | II<br>n = 52 | | III<br>n = 42 | | F | Results of Bonferroni tests |
| **AGE** | 66,88 | | 67,73 | | 69,02 | | 0,81 | |
| **BMI** | 26,47 | | 27,74 | | 28,57 | | 3,97* | III > I = II |
| **DD** | 11,14 | | 13,13 | | 14,38 | | 1,20 | |
| **HbA1c** | 6,99 | | 7,11 | | 6,96 | | 0,17 | |
| **GENDER** | Observed N | Expected N | Observed N | Expected N | Observed N | Expected N | $X^2$ | *df* |
| Male | 57,00 | 48,74 | 25,00 | 31,68 | 24,00 | 25,59 | 7,44* | 2 |
| Female | 23,00 | 31,26 | 27,00 | 20,32 | 18,00 | 16,41 | | |

**Table 4 Validation of the k-means Cluster Solution**

| Variables | Mean score by profile | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | I<br>n = 80 | | II<br>n = 52 | | III<br>n = 42 | | F | Results of Bonferroni tests |
| **PA** | 6,09 | | 3,64 | | 4,91 | | 4,20* | I > II |
| **PD** | 2,84 | | 5,54 | | 8,67 | | 24,80** | I < III |
| **DSS** | 4,52 | | 5,68 | | 6,76 | | 3,44* | I < III |
| **SLEEP** | Observed N | Expected N | Observed N | Expected N | Observed N | Expected N | $X^2$ | *df* |
| Good Sleepers | 35,00 | 25,62 | 14,00 | 18,15 | 9,00 | 14,23 | 10,59* | 4 |
| Subcriterial | 28,00 | 34,01 | 28,00 | 24,09 | 21,00 | 18,90 | | |
| Insomiacs | 9,00 | 12,37 | 9,00 | 8,76 | 10,00 | 6,87 | | |

**PA, Physical Activity; W, Worries; SD, Symptoms of Diabetes; PS, Physical Symptoms; Sleep.**
***$p < .01$.**
****$p < .001$.**