Motivational profiles for physical activity among adults with type 2 diabetes and their relationships with physical activity behavior

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ABSTRACT

Using self-determination theory, the aim of this study was to examine motivational profiles toward physical activity among adults with type 2 diabetes and how these profiles predict physical activity. In total, 381 adults with type 2 diabetes (188 or 49.3% women, M age = 61.39, SD = 7.29) completed a questionnaire assessing their physical activity motivation and behavior. First, results of a multiple regression analysis showed that intrinsic and identified motives were positively associated with leisure-time physical activity over the past three months while results of a multivariate analysis of covariance revealed that higher levels of intrinsic and identified motives were associated with observing physical activity recommendations for type 2 diabetes (i.e. practicing 150 min of moderate to vigorous physical activity per week). Then, results of a cluster analysis distinguished four distinct motivational profiles: self-determined, controlled, moderate, and non-self-determined. Participants reporting the highest physical activity participation level and observing physical activity recommendations were more likely to present a self-determined profile. The present study highlights the benefits of using both a variable-centered and a motivational profile approach. They also highlight the importance of examining the type of motivation associated with physical activity practice among adults with type 2 diabetes since autonomous forms of motivation positively influence both the frequency of leisure-time physical activity and the observance of physical activity recommendations for type 2 diabetes.

1. Introduction

Regular physical activity (PA) is crucial in the management of type 2 diabetes (T2D; Colberg et al., 2010; Sigal et al., 2013), as may aid people with T2D in achieving numerous goals, including increased cardiorespiratory fitness, improved glycemic control, decreased insulin resistance, an improved lipid profile, reduced blood pressure, and maintained weight loss (Chudyk & Petrella, 2011; Colberg et al., 2010; Snowling & Hopkins, 2006). However, despite the universally acknowledged benefits of PA for T2D management, much of the diabetic population cannot meet the guideline of 150 min of moderate-to-
vigorous PA (MVPA) per week, as proposed by the Canadian (Canadian Diabetes Association, 2013) and American (Sigal, Kenny, Wasserman, Castaneda-Sceppa, & White, 2006) Diabetes Associations. For instance, in Canada, statistics indicate that less than 35% of the adult T2D population currently meets the PA guideline (Health Canada, 2002; Plotnikoff et al., 2011).

Based on these trends, it has become critical to determine why so few adults with T2D regularly practice PA, despite ample documentation of the beneficial effects on health. Therefore, it seems relevant to identify motivations to practice PA and why individuals choose to practice PA, because among the barriers to PA identified by individuals with T2D, a lack of motivation and pleasure is frequently mentioned (Barrett, Plotnikoff, Courneya, & Raine, 2007). A highly promising theoretical approach to determining how motivation influences PA participation is self-determination theory (SDT; Deci & Ryan, 1985, 2000). SDT adopts a multi-dimensional approach to explaining why some individuals and not others engage in positive and adaptive health behaviors by examining the extent to which a person’s motivation for a particular behavior is autonomous or controlled. Based on the level of autonomy and personal choice associated with one’s behavior, the SDT proposes conceptualizing motivation along a continuum ranging from amotivation to controlled motivation to autonomous motivation. Amotivation concerns a lack of intention to act. Amotivated people will act without feeling any motivation, or they will demonstrate a lack of intention to act. For instance, amotivated individuals might say that they avoid PA because they find it uninteresting. Controlled motivation is less self-determined, including external and introjected regulations. External regulation refers to acting to satisfy an external demand, such as to appease a spouse or a physician, or to receive a reward. A person who exercises because of his or her doctor’s orders is externally regulated. Introjected regulation involves internalizing a regulation but not accepting it as one’s own, such as acting to avoid guilt or enhance the ego. In this case, individuals act to avoid negative feelings (e.g. guilt) or because they want to prove themselves, while others do so to demonstrate a positive attribute or state. A person practicing PA for introjected motivation may exercise to avoid feeling guilty.

Autonomous motivation is more self-determined, involving identified, integrated, and intrinsic regulations. Identified regulation is further along the self-determination continuum, as actions are volitional and motivated by an appreciation for valued outcomes. Someone who exercises because of the value, usefulness, or importance of exercise is said to engage in identified regulation. Integrated regulation, the most self-determined type of extrinsic motivation, refers to the process of combining meaningfully personal values and identity-relevant commitments. Individuals demonstrating integrated regulation might run because they believe that they are “runners” and therefore, running correlates with their sense of self. Finally, the most autonomous form of motivation is intrinsic motivation, where an activity is inherently enjoyable. Intrinsically motivated exercisers might run, for example, because they enjoy feeling free and gaining energy.

1.1. Research using SDT to examine motivation to practice PA among adults with T2D

To date, many research studies have examined the relationship between motivation and PA in the general population, demonstrating consistent support for a positive relationship
between autonomous motives and several PA outcomes, including PA frequency and duration (Teixeira, Carraça, Markland, Silva, & Ryan, 2012). Conversely, few studies have looked at the association between motivation and PA in the T2D adult population, but the ones that have demonstrated a positive association between autonomous motivations and various positive PA outcomes (Healey, 2013; Sweet et al., 2009). For instance, using a sample of adults with T2D involved in a randomized exercise trial, Sweet et al. (2009) found that practicing PA for autonomous motives was positively associated with practicing PA more frequently six months later. Healey (2013) found similar results with a sample of 63 adults with T2D assigned to an exercise intervention group promoting psychological needs satisfaction; after 12 months, the intervention had produced significant in PA frequency by means of increasing psychological needs satisfaction, which promoted autonomous motivation. Fortier et al. (2012) showed that as adults with T2D progressed over time through various stages of change associated with PA behavior (from being inactive to regularly active), their autonomous motives to practice PA also significantly increased.

Hence, prior research conducted on T2D adults suggests that autonomous motives to practice PA are associated with positive PA outcomes (e.g. PA frequency and adherence over time). However, prior SDT-based studies conducted among T2D adults in the PA domain have not investigated separately each type of motivation (including controlled) and their respective impact on PA behavior. For instance, Sweet et al. (2009) and Healey (2013) used a global score of autonomous motivation (the first authors measured only intrinsic and identified motivation, while the second evaluated only integrated and identified motivation), while Fortier et al. (2012) used a global score of autonomous and controlled motivation to predict PA behavior. Thus, research assessing simultaneously all types of motivations (both self-determined and controlled) when exploring PA motivation among adults with T2D is needed, and the present study addresses this issue. Moreover, although prior SDT-based studies conducted among T2D adults in the PA domain have evaluated the impact of PA motivation on specific markers of PA behavior (e.g. frequency), no study has yet examined the relationship between why adults with T2D practice PA and the extent to which they observe the recommended guideline of 150 min of MVPA per week. The study herein aims to overcome this limitation by examining to what extent PA motivation influences the observance of PA guidelines among adults with T2D, which is the minimum amount of PA required to produce a significant impact on T2D adults’ health as recommended by the Canadian Diabetes Association (2013).

1.2. Using SDT-based motivational profiles in the PA domain

The great majority of research conducted with SDT in the PA domain among adults from the general and T2D populations has used a variable-centered approach by examining the effects of each motivational regulation on various outcomes. While this approach is technically correct, it does not consider the different motivational configurations that may be present in a given individual. This represents a limitation of this research, as it is common for individuals to report a combination of multiple motivational regulations for a given domain at the same time (Deci & Ryan, 2002; Patrick, 2014; Vallerand, 1997). One way to better account for individual motivational configurations is to use a person-centered
approach by assessing how different types of motivations are combined to form motivational profiles (Pintrich, 2003; Vansteenkiste, Sierens, Soenens, Luycx, & Lens, 2009).

In line with the aforementioned concerns, researchers have begun studying SDT-based motivational profiles using a cluster analysis. To date, a limited number of SDT-based profile studies, specific to the PA domain, have analyzed motivational profiles using this technique within the general adult population (Friederichs, Bolman, Oenema, & Lechner, 2015; Guerin & Fortier, 2012; Matsumoto & Takenaka, 2004; Stephan, Boiché, & Le Scanff, 2010; Ullrich-French & Cox, 2009). These studies constantly demonstrated similar, multiple-cluster (three to five) solutions and also revealed that more autonomous profiles (i.e. profiles characterized by high scores on autonomous forms of motivation, as well as low scores on controlled forms of motivation and amotivation) are associated with more positive PA outcomes, including PA participation level, PA enjoyment, PA maintenance, and PA intention and commitment. However, so far, only one study has examined PA motivational profiles and their consequence on PA behavior among adults with T2D. In this specific study, Gourlan, Trouilloud, and Boiché (2015) found three motivational profiles: self-determined (“i.e. high scores on intrinsic, integrated, and identified regulations; low scores on other regulations”), High Combined (“i.e. high scores on motivations ranging from intrinsic to external regulation, moderate level on amotivation”), and moderate (“i.e. moderate scores on all regulations”). Their results further demonstrated that, compared to participants from the moderate profile, participants from the High Combined and self-determined profiles reported longer PA practice, measured by overall number of hours/week participants spent practicing PA over the past 12 months.

Overall, the results from prior research on PA motivational profiles conducted among adults from the general and T2D populations within the PA domain show that identifying individuals as high or low in PA motivation is insufficient, thus supporting the profiling approach. Findings of this research also provide valuable information on adult motivational profiles (see Gourlan and colleagues’ work for a resume of the overall motivational profiles currently identified in the PA domain) Gourlan et al., 2015) and their consequences on PA behavior or attitude. However, more studies are currently needed to investigate T2D adults’ motivational profiles and their relationship with PA behavior, as only one study (Gourlan et al., 2015) has examined this concern. In addition, Gourlan et al. (2015) study has some limitations. First, the results relied exclusively on a highly homogeneous sample of T2D patients, which were all recruited from the same diabetes care center, limiting the generalizability of the findings. Second, the authors did not use standardized scores when they examined participants’ motivational profiles. As such, comparing the profiles they found with those obtained in prior research is more difficult (Hair, Black, Babin, & Anderson, 2009). Finally, the authors did not a priori report the results of each motivational regulation on PA behavior, obtained by means of a variable-centered approach. Considering these limits, additional research: (1) using more heterogeneous samples to facilitate the generalizability of the results (i.e. using a sample that simultaneously includes both adults with T2D who visit and do not visit a diabetes care center, as some of the participants will be less encouraged in their PA practice because they presumably receive less advice on their T2D management), (2) using standardized scores to build the motivational profiles, and (3) reporting the results of both a variable- and person-centered approach – is needed. Notably, there are important benefits for using both a variable-centered and a motivational profile approach. More specifically, using a
variable-centered approach (i.e. examining the effects of each motivational regulation on PA behavior) undeniably contributes to the prediction of PA practice. However, it has some limitation since, when observing only the impact of one motivation, other types of motivation are not taken into account. More precisely, it is possible that one engages in PA for several motives at the same time (e.g. practicing PA because it is fun but also because one’s feel guilty when she or he is not active). Alternatively, a person-centered approach provides information on the overall pattern or combination of motives associated with PA practice and how this pattern influences one’s PA behavior. Thus, using simultaneously these two approaches provides a more accurate portrait of T2D adults’ motivation toward PA and its impact on PA behavior.

1.3. Objectives of the present study

The aim of this study was twofold: to investigate separately each type of motivation (including controlled ones) and their respective impact on PA behavior among adults with T2D and to create PA motivational profiles among adults with T2D using a cluster analysis, as well as examine how these profiles predict PA behavior. Cluster analysis provides motivational profiles based on similarities between participants’ scores on various types of motivation. Simply put, participants with significantly higher scores on autonomous forms of motivation (intrinsic, integrated and identified) would be most likely placed within a different group from participants having significantly higher scores on controlled forms of motivation (introjected, extrinsic, and amotivation).

In the present study, PA behavior was assessed by means of the participation level in leisure-time PA over the past 3 months, as well as by the weekly practice of at least 150 min of MVPA for 20–30 min per session. In other words, along with their most recent experience with PA practice, participants were also asked until what extent they were currently observing PA guidelines for T2D management. Regarding the first objective, it was hypothesized that forms of motivation that are more autonomous would be associated with a higher participation level in leisure-time PA over the past three months. It was also expected that participants who report meeting PA recommendations for T2D would also display higher levels of autonomous than controlled motivation. Regarding the second objective, it was assumed that at least three motivational profiles would emerge and they would be similar to those found by Gourlan et al. (2015). It was expected that participants who score higher on participation level in leisure-time PA over the past three months would display a more self-determined profile. It was also anticipated that, among participants who report meeting PA recommendations for T2D, there would be more individuals presenting an autonomous profile.

2. Methods

2.1. Participants and procedure

Data were obtained from a mail survey conducted among adults with T2D aged between 18 and 75 years. Participants were recruited through Diabetes Quebec, a non-profit association that informs and supports people with diabetes. All participants were asked for written informed consent to take part in the study. A total of 3000 adults with T2D...
were solicited randomly across Quebec’s 17 administrative regions to participate in the study \((N = 1522\) women, mean age = 64.73, SD = 8.45). A total of 493 accepted the invitation and returned their surveys, which correspond to a response rate of 16.4%. However, the current analyses are based on 381 participants’ data. This sample size’s reduction was due to a number of issues. First, 8 participants were excluded given that they indicated being diagnosed with type 1 diabetes and 48 were left out given that they were aged over 75 years. Among the residual participants, 397 had completed all measures required for the study. Additionally, as cluster analysis is sensitive to outliers, 16 cases were found aberrant and not representative. Therefore, they were identified as multivariate outliers and were excluded from the analyses (Hair et al., 2009). Thus, the final sample comprised 381 participants (193 men and 188 women). These participants ranged in age from 18 to 75 years \((M = 61.39, SD = 7.29)\), had been diagnosed with T2D for approximately 9.70 years \((SD = 8.02)\), and had a mean BMI of 31.01 \((SD = 6.53)\).

2.2. Measures

After providing their informed consent to participate in the study, participants were asked to specify their age, gender, type of diabetes (I or II), number of years since T2D diagnosis, as well as their height and weight, which allowed us to calculate their body mass index (BMI).

2.2.1. Motivation toward PA

The Behavioral Regulation in Exercise Questionnaire-version 2 (BREQ-2) (Markland & Tobin, 2004) was used to measure PA motives. It includes five subscales assessing intrinsic (e.g. “I enjoy my exercise sessions”; \(n = 4\)), identified (e.g. “It’s important to me to exercise regularly”; \(n = 4\)), introjected (e.g. “I feel guilty when I don’t exercise”; \(n = 3\)), and external (e.g. “I feel under pressure from my family/friends to exercise”; \(n = 4\)) regulations, as well as amotivation (e.g. “I don’t see why I should have to exercise”; \(n = 4\)). Each item is rated on a 5-point scale ranging from 0 = “not true for me” to 4 = “very true for me.” A reliability analysis revealed internal consistency values ranging from .72 to .94 for the various regulations (Table 1).

2.2.2. PA behavior

A single question developed by Godin, Jobin, and Bouillon (1986; Godin & Shephard, 1985) was used to examine the participation level in leisure-time PA over the past three months. This question has been found to be a reliable and valid measure of PA, to be significantly correlated with objective validity criterions and that it has a reliability indicator for test–retest of 0.64 (Godin et al., 1986). This question was framed as follows: “Within the past three months, how often did you participate in one or more physical activities of moderate to vigorous intensity, during 20–30 min per session, during your leisure time?” Response options to this question included: (0) not at all, (1) approximately once a month, (2) approximately two or three times a month, (3) approximately once a week, (4) approximately twice a week, (5) approximately three times a week, (6) approximately four times a week, and (7) five times or more per week. Even though this variable could be considered ordinal or categorical, we chose to consider it as continuous, as recommended by Pasta (2009) and as done in prior research by Boudreau and Godin (2009,
Table 1. Descriptive statistics, Cronbach’s alpha and correlation matrix of the sample (N = 381).

|                          | α   | M     | SD   | 1   | 2     | 3     | 4     | 5     | 6     | 7     |
|--------------------------|-----|-------|------|-----|-------|-------|-------|-------|-------|-------|
| 1. Age                   | .84 | 61.39 | 7.29 | –   | –     | –     | –     | –     | –     | –     |
| 2. BMI                   | .72 | 31.01 | 6.53 | –   | –0.17 | –0.15 | –     | –     | –     | –     |
| 3. Intrinsic motivation  | .94 | 2.71  | 1.16 | 0.07| –     | –     | –     | –     | –     | –     |
| 4. Identified motivation | .83 | 2.64  | 0.76 | –0.02| –0.07 | 0.73  | –     | –     | –     | –     |
| 5. Introjected motivation| .72 | 1.03  | 1.07 | –0.02| 0.12  | –0.07 | 0.17  | –     | –     | –     |
| 6. External motivation   | .84 | 0.63  | 0.94 | –0.04| 0.16  | –0.22 | –0.09 | 0.57  | –     | –     |
| 7. Amotivation           | .76 | 0.33  | 0.60 | 0.02 | 0.13  | –0.46 | –0.45 | 0.23  | 0.46  | –     |
| 8. PA practice           | .76 | 2.96  | 2.64 | 0.05 | –0.20 | 0.40  | 0.37  | –0.17 | –0.30 | –0.39 |

Note: PA practice: level of participation in leisure-time PA over the past three months.

*p < 0.05.

**p < 0.01.

***p < 0.001.
In addition to their level of participation in leisure-time PA over the past three months, participants were questioned about their observance of PA recommendations for T2D. More precisely, they were asked to indicate whether they were currently practicing at least 150 min of MVPA per week for 20–30 min per session. The response options for this question were either “Yes” or “No.” Participants also indicated since how long (in months) they were observing these PA guidelines.

2.3. Data analysis

Data were screened for missing values, multivariate outliers, and normality (Tabachnick & Fidell, 2012). All variables were distributed normally. In total, 16 cases, identified as multivariate outliers, were excluded from the study. Following data cleaning, a series of analyses were performed. First, a hierarchical multiple regression, adjusting for the effects of gender, age, and BMI, was conducted to examine the respective impact of each form of motivation on level of participation in leisure-time PA over the past three months. Second, a multivariate analysis of covariance (MANCOVA), again controlling for gender, age, and BMI, was performed to verify until what extent each form of motivation predicted participants’ current observance of PA recommendations for T2D. Third, a cluster analysis using a two-step procedure (Gore, 2000) was used to isolate meaningful motivation subgroups based on regulation scores. Prior to this analysis, the motivational regulation scores were transformed into z-scores (Hair et al., 2009). In the first step, a hierarchical cluster analysis was carried out using Ward’s method on squared Euclidian distances. Subsequently, the number of clusters was determined with the agglomeration schedule coefficient and the dendrogram. Then, in the second-step, K-means clustering was implemented to confirm the cluster solution. Fourth, a one-way analysis of covariance (ANCOVA), controlling for the effects of gender, age, and BMI, was conducted to examine how each cluster solution, or motivational profile, was associated with a significantly different level of participation in leisure-time PA over the past three months. Finally, a chi-square analysis was conducted to verify how each motivational profile predicted the current observance of PA recommendations for T2D.

3. Results

3.1. Descriptive analysis

Descriptive statistics and a correlation matrix for the final sample (N = 381) are presented in Table 1. Participants presented higher mean scores on autonomous than controlled forms of motivation toward PA. Results further indicated the mean level of leisure-time PA over the past three months was 2.96 (SD = 2.64, range = 0–7). Thus, participants reported practicing MVPA for 20–30 min per session, approximately once a week over the past three months. In total, 142 (37.3%) participants reported that they were currently observing PA guidelines for T2D management and the mean period for which they had maintained this behavior was 5.99 months (SD = 1.89, range = 0–7). Inversely, 239 (62.7%) participants reported that they were not currently observing PA guidelines for T2D management.
3.2. Respective impact of motivation types on PA behavior

Prior to conducting a hierarchical multiple regression, results of one-way analysis of variance (ANOVA) and correlational analyses demonstrated that age ($r = .05, p = 0.34$) and gender [$F (1, 379) = 3.03, p = 0.08$] did not need to be included as control variables in the analysis while BMI ($r = −.20, p < 0.001$) did. Therefore, hierarchical multiple regression was controlling for BMI, but not for age and gender. Results of the hierarchical multiple regression (see Table 2) demonstrated that intrinsic ($\beta = .14, p < 0.05$) and identified ($\beta = .19, p < 0.01$) motivation were positively associated with leisure-time PA over the past three months while the opposite was true for extrinsic regulation ($\beta = −.12, p < 0.05$) and amotivation ($\beta = −.15, p < 0.01$). A MANCOVA was then conducted to examine the effect of each type of motivation on the observance of PA recommendations for T2D. As Box’s M test was significant ($p < 0.05$), the Pillai’s Trace was used. The results (see Table 3) revealed that PA groups (i.e. one group currently observing and another group not currently observing PA recommendations for T2D) had a significant effect on combined PA motivations, $F (5, 373) = 20.27, p < 0.001$; Pillai’s Trace = 0.21, $\eta_p^2 = 0.21$. Follow-up analyses using univariate $F$-values and post-hoc tests indicated significant differences between PA groups on all forms of motivation, with the exception of introjected regulation ($p = 0.54$). More specifically, the observance of PA guidelines was associated with higher levels of intrinsic ($p < 0.001$) and identified ($p < 0.001$) motivation. Alternatively, the non-observance of PA guidelines was associated with higher levels of extrinsic motivation ($p < 0.001$) and amotivation ($p < 0.001$).

3.3. Cluster analysis: two-step procedure

The results of the hierarchical cluster analysis showed one drastic increase in the agglomeration schedule, demonstrating that only one solution matched the data. More specifically, compared to the three previous changes in the agglomeration schedule (9.16%, 8.45%, and 12.77%), a large increase was found when four clusters merged to three (22.76%). Thus, the four-cluster solution was deemed suitable, given that large increases imply the merging of dissimilar clusters (Wang & Biddle, 2001). Following the hierarchical cluster analysis, $k$-means clustering was used to confirm the four-cluster solution. The composition of the final cluster solution was examined according to gender and age.

Table 2. Multiple regression of motivation and BMI on the level of participation in leisure-time PA over the past three months ($N = 381$).

| Step 1 | $B$ | $SE$ | $R^2$ var = .038, $F (1, 379) = 14.93, p < 0.001$ |
|--------|-----|------|-----------------------------------------------|
| BMI    | −.08| .02  | −2.00*** [−0.12, −0.04]                        |

| Step 2 | $B$ | $SE$ | $R^2$ var = .22, $F (5, 374) = 21.84, p < 0.001$ |
|--------|-----|------|-------------------------------------------------|
| BMI    | −.05| .02  | −.11 −2.44* [−0.08, −0.01]                      |
| Intrinsic motivation | .32 | .16 | .14 2.03* [0.01, 0.63]                           |
| Identified motivation | .66 | .25 | .19 2.62** [0.16, 1.15]                          |
| Introjected motivation | −.19 | .14 | −.08 −1.33 [−0.47, 0.09]                        |
| External motivation | −.34 | .17 | −.12 −2.04* [−0.67, −0.01]                     |
| Amotivation | −.66 | .25 | −.15 −2.64** [−1.16, −0.17]                     |

Note: $R^2 = .26, F (5, 374) = 21.372, p < 0.001$.

*p < 0.05.

**p < 0.01.

***p < 0.001.
using a chi-squared test of independence and an ANOVA, respectively. The results showed that the proportion of males and females was not different across motivational profiles, $\chi^2 (3, n = 381) = 2.37, p = 0.50$ and demonstrated that motivational profiles were not different in terms of age, $F (3, 377) = 2.12, p = 0.10$. Moreover, A multivariate analysis of variance (see Table 4) was performed to examine how each type of motivation varies across motivational profiles. Results reported a significant effect of cluster membership on the six motivational constructs, $F (18, 3255) = 291.67, p < 0.001$; Pillai’s Trace = 1.85, $\eta^2_p = 0.62$. Post-hoc test indicated significant differences between the clusters (all $p < 0.05$) on all behavioral regulations, except for: (a) introjection, which was similar between the moderate and the non-self-determined clusters ($p = 0.06$) and for (b) external regulation and amotivation which were similar between the self-determined and the moderate profiles ($p = 1.00$).

The four motivational profiles are displayed in Figure 1. Based on previously described PA motivational profiles, clusters were labeled: self-determined, moderate, controlled, and non-self-determined. The self-determined cluster comprised 42.8% ($n = 163$) of participants, who displayed the highest scores on intrinsic motivation and identified regulation. They also displayed the lowest scores on external regulation and amotivation. The moderate cluster comprised 28.9% of participants ($n = 110$). These participants presented moderated scores (within 1 standard deviation of the mean) on every type of motivation. The controlled cluster comprised 15.7% of participants ($n = 60$), who presented low intrinsic and identified scores. Conversely, they showed the highest scores on introjected and external regulation. Finally, the non-self-determined cluster comprised 12.6% of participants ($n = 48$), who presented the highest scores on amotivation, while exhibiting moderate scores on introjected and external regulation and the lowest scores on intrinsic motivation and identified regulation.

### 3.4. Consequences of motivational profiles on PA behavior

First, a one-way ANCOVA, controlling for the effects of BMI, was conducted to examine how each cluster solution or motivational profile was associated with different PA practice
Table 4. Types of motivation by motivational profiles, results of univariate F-values, $\eta^2_p$, and post-hoc tests ($N = 381$).

| PA motivation |  (1) Self-determined $N = 163$ (42.78%) | (2) Moderate $N = 110$ (28.87%) | (3) Controlled $N = 60$ (15.75%) | (4) Non Self-determined $N = 48$ (12.60%) | Multivariate F-value | Eta² | Multivariate test (Pillai) |
|---------------|-----------------------------------------|---------------------------------|---------------------------------|---------------------------------|----------------------|-----|--------------------------|
| Intrinsic     | Mean (SE)                               | Mean (SE)                       | Mean (SE)                       | Mean (SE)                       | 198.13*** 0.60       |     | (15; 1125) = 1.71       |
| Identified    | 3.70 (.05)                              | 2.03 (.07)                      | 2.50 (.09)                      | 1.12 (.10)                      | 198.13*** 0.60       |     | (15; 1125) = 1.71       |
| Introjected   | 3.13 (.04)                              | 2.30 (.05)                      | 2.90 (.07)                      | 1.44 (.07)                      | 154.64*** 0.54       |     | (15; 1125) = 1.71       |
| External      | 0.81 (.06)                              | 0.41 (.07)                      | 2.68 (.10)                      | 1.13 (.11)                      | 122.77*** 0.49       |     | (15; 1125) = 1.71       |
| Amotivation   | 0.07 (.03)                              | 0.11 (.04)                      | 0.51 (.05)                      | 1.47 (.06)                      | 174.68*** 0.58       |     | (15; 1125) = 1.71       |

1$p < 0.10; *p < 0.05; **p < 0.01; ***p < 0.001.$
levels over the past three months. Following recommendations from Tabachnick and Fidell (2007), the $F_{\text{max}}$ variance ratio was used to assess homogeneity of variance. According to these authors, a maximum variance ratio (obtained by dividing the greatest variance between groups by the least variance between groups) of 10 is acceptable for a size ratio of 4 to 1 between the largest and smallest groups. In the present case, the largest group was 3.4 times bigger than the smallest group and the variance ratio was 5.3, which respect the maximum variance ratio (i.e. 10) proposed by Tabachnick and Fidell (2012). Therefore, homogeneity of variance was assumed, allowing the use of the ANCOVA. The results are presented in Table 5 and first indicated that cluster membership significantly explained 17.9% of the PA practice level variance, controlling for BMI, $F (3, 376) = 27.29, p < 0.001$. Using a Bonferroni correction, the results of post-hoc tests showed that, compared to participants from other clusters, participants from the self-determined ($M = 3.91$) displayed the highest score on PA behavior, followed by the moderate ($M = 3.06$), the controlled ($M = 2.02$) and the non-self-determined ($M = 0.94$) clusters.

Then, the relationship between motivational profiles and the current observance of PA guidelines for T2D management was examined by means of a Chi-square test (see Table 6). At first, the results revealed that the chi-square value was significant, $\chi^2 (df = 381, N = 381) = 64.56, p < 0.001$, indicating that the observance of PA guidelines varied among the motivational profiles. Notably, the results also showed a relatively strong association between the motivational profiles and PA guidelines observance, Cramer’s $V = .41, p < 0.001$ (Rea & Parker, 1992). Then, a closer look indicated a significantly higher proportion of participants with a self-determined profile in the group currently observing PA guidelines than in the group not currently observing these guidelines. As well, in the group not currently observing PA guidelines, there was a significantly higher proportion of participants with a moderate, and non-self-determined profile.

Figure 1. Motivational profiles toward PA.
4. Discussion

A first objective of this study was to investigate separately each type of motivation and its respective impact on PA behavior among adults with T2D. A second objective was to create PA motivational profiles among adults with T2D using a cluster analysis, as well as to examine how these profiles predict PA behavior. Along with their most recent experience with PA practice, evaluated by their participation in leisure-time PA over the past three months, participants were also asked to what extent they were currently observing PA guidelines for T2D management, assessed by their weekly practice of at least 150 min of MVPA for 20–30 min per session.
4.1. Impact of motivation types on PA behavior

The results show that intrinsic and identified motives positively predicted the level of participation in leisure-time PA over the past three months while the opposite was true for extrinsic motives and amotivation. These findings stress the importance of both intrinsic and extrinsic motives in the prediction of adults with T2D’s PA practice over the last three months. They are also consistent with those previously found among T2D adults (Healey, 2013; Senécal, Nouwen, & White, 2000; Sweet et al., 2009; Williams, McGregor, Zeldman, Freedman, & Deci, 2004). Furthermore, the findings also show that the weekly observance of PA guidelines was associated with higher levels of intrinsic and identified motivation, while the non-observance of PA guidelines was associated with higher levels of extrinsic motivation and amotivation among participants. These results highlight the importance of PA motives when it comes to the observance of PA guidelines among T2D adults and are consistent with those found in the few studies that have yet examined this issue (Miquelon & Castonguay, 2016).

4.2. PA motivational profiles

Four motivational profiles emerged from our results: self-determined, controlled, moderate, and non-self-determined. According to these results, participants from the self-determined cluster prominently practice PA for pleasure; moreover, its consequences (e.g. being healthy) are highly valued. Participants from the controlled cluster mainly practice PA for introjected (e.g. guilt) or external (e.g. because their doctor urged them) reasons. Participants from the moderate cluster practice PA moderately for all motives. Finally, participants from the non-self-determined cluster tend to be prominently amotivated toward PA, suggesting that if they do engage in PA, they do so with no motivation.

As our study was conducted among adults with T2D, the points of comparison for our cluster solution are limited. As previously mentioned, to date, only Gourlan et al. (2015) have studied PA motivational profiles among adults with T2D and their results indicated three motivational profiles: high combined, self-determined, and moderate. Comparing the cluster solution obtained by these authors to ours, their “self-determined” and “moderate” profiles can respectively be associated with the same profiles found in this study. However, we did not find a profile that corresponds to these authors’ High Combined profile. Nevertheless, studies conducted among adults from the general population reveal the existence of a profile characterized by higher scores only on controlled forms of motivations (Friederichs et al., 2015; Matsumoto & Takenaka, 2004; Ullrich-French & Cox, 2009) named “controlled,” as well as a profile presenting higher scores only on amotivation (Matsumoto & Takenaka, 2004; Miquelon, Chamberland, & Castonguay, 2016; Ullrich-French & Cox, 2009) named “non-self-determined.” In our view, the differences found between our motivational profiles and the ones obtained by Gourlan and colleagues, which is, so far, the sole study that has surveyed motivational profiles among adults with T2D, highlight the importance of conducting more research on adults with T2D motivational profiles. In addition, a systematic review of PA motivational profiles would be useful for future studies, as it would provide researchers with a more standard list of profiles’ characteristics and labels.
4.3. Consequences of motivational profiles on PA behavior

Participants from the self-determined profile displayed the highest score on participation level in leisure-time PA over the past three months, followed by participants from the moderate, controlled, and non-self-determined profiles. However, participants from the non-self-determined and controlled profiles did not differ concerning their level of participation in leisure-time PA over the past three months. Thus, although participants from the controlled profile display lower scores on amotivation than participants from the non-self-determined profile, they did not differ concerning leisure-time PA participation level over the past three months. This finding is important, as it highlights that looking at the effect of only one type of motivation is insufficient when trying to predict PA participation. The influence of other forms of motivation must be considered as well. In other words, it is necessary to look at one’s motivational profile to understand one’s PA practice correctly. Of note is that these results are consistent with those of Gourlan et al. (2015), who found that, compared to participants from the moderate profile, participants from the self-determined profiles reported a longer PA practice, as measured by the overall number of hours/week participants spent practicing PA over the past 12 months. Finally, findings also show that participants observing PA recommendations for T2D self-management were more likely to present a self-determined profile toward PA, while participants not observing these guidelines were more likely to present a moderate, controlled, and non-self-determined profile. These results emphasize the importance of developing a self-determined profile when it comes to observing PA guidelines or practicing MVPA for at least 150 min/week.

5. Conclusions

5.1. Implications of findings

Significant theoretical and practical implications can be drawn from this study. The most important theoretical implication comes from the benefits of using both a variable-centered and motivational profile approach. Indeed, our findings showed that, at a relatively equivalent level of autonomous motivation, a higher level of PA leisure-time participation is reported for participants from the moderate profile than those from the controlled profile. This suggests that although autonomous motives do predict PA leisure-time participation, their impact is nevertheless moderated by the level of controlled motives. Thus, to understand better the role of motivation toward PA practice among adults with T2D, it is important to gain a complete picture of their motives, including how they are combined together. In other words, it is a prerequisite to examine which form of motivation has the most positive impact on PA behavior, but it is not sufficient. As PA is a cornerstone of T2D self-management, the findings herein also lead to practical implications. Certainly, more efforts should be dedicated to educating adults with T2D about the importance of why they choose to engage in PA and maintain its practice. As shown, participants who reported observing PA guidelines on a weekly basis displayed higher scores on intrinsic and identified motives, while those who do not observe these same guidelines presented higher scores on external motives and amotivation. These results highlight the importance of promoting autonomous rather than controlled motives for PA adoption and maintenance among adults with T2D. However, as numerous individuals with T2D might engage
in PA practice because their doctors or health care providers have strongly advised so, educators must consider that doing so could lead adults with T2D to participate to avoid feeling guilty. Nevertheless, as controlled motives can be internalized (Gagné & Deci, 2005) and transformed into autonomous motives over time, it is important to understand that controlled forces might be useful for initially motivating PA behaviors that hold limited immediate intrinsic appeal for many T2D adults. Finally, our results reveal that only participants who have a self-determined profile observe the recommended PA guidelines, known to be associated with fewer health problems among adults with T2D (Colberg et al., 2010; Sigal et al., 2013). These findings encourage practitioners who would like to increase PA practice among adults with T2D to work toward building a self-determined profile.

5.2. Limitations and future research

Some limitations warrant a cautious interpretation of this study’s conclusions. First, a cross-sectional and correlational design was used. It is thus inappropriate to make causal inferences. In addition, the PA behavioral measures were self-reported and no objective measures (e.g. accelerometers) were available to verify the accuracy of PA behavior scores. Therefore, responses could have been biased by social desirability or participants’ tendency to report practicing PA more than they really do. Regarding this later issue, recent studies have shown that individuals indeed tend to indicate that they have engaged in more PA when asked to self-report than when their behavior is evaluated with an objective measure, such as an accelerometer (Dyrstad, Hansen, Holme, & Andersen, 2014; Slootmaker, Schuit, Chinapaw, Seidell, & van Mechelen, 2009; Tucker, Welk, & Beyler, 2011). Future research should thus consider supplying self-reported measures of PA practice with objective tools, such as accelerometers. Moreover, since the BREQ-2 was used to measure PA in the present study, integrated regulation was not assessed and therefore, the entire spectrum of motivations proposed by SDT could not be evaluated. Therefore, future SDT-based research examining adults with T2D’s motivation toward PA should include a measure of integrated regulation. Notwithstanding these concerns and given the actual need to understand better why so few adults with T2D regularly practice PA despite its beneficial effects on their health, our results provide valuable information about the importance of studying the quality of motivation associated with PA behavior or the reasons why T2D adults engage in PA practice.

Note

1. Our response rate of 16.4% is lower than the 50% guideline considered as an acceptable response rate in social research postal survey (Richardson, 2005). We believe that this response rate can be attributed to the mean age (64.73 years old) of the target population and the length of the questionnaire, which included numerous questions, associated with another part of the research project, on participants’ physical and psychological health issues. It is further important to mention that references in psychological research methods indicate that a participation level or a response rate of 20% or less for a one-time mail survey is to be expected (Agency for Healthcare Research and Quality, n.d.; Evans & Rooney, 2013; Kelley, Clark, Brown, & Sitzia, 2003). As the present study used a one-time mail survey and that no recall was performed to favor the anonymity of the responders, a response rate of 20% or less was expected.
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