IMPORTANCE of TANGIBLE PHYSICAL CHANGES for QUALITY of LIFE IMPROVEMENTS of TYPE 2 DIABETIC and AT-RISK INDIVIDUALS INVOLVED in EXERCISE INTERVENTION

ABSTRACT - Objectives: 1) To document quality of life (QOL) changes in type 2 diabetes (T2D) and at-risk individuals who took part in the DiabetAction program and 2) to determine if changes in the QOL were associated with program attendance. Methods: QOL (SF-36 questionnaire), physical activity (PA) level, body weight, skinfold thickness, aerobic capacity and handgrip strength were measured before and after the 10-week intervention in 15 T2D and 14 at-risk individuals. Results: Physical and mental components of QOL and 6 out of 8 domains of QOL were significantly improved in T2D and at-risk individuals after the intervention. Four significant correlations were identified: physical functioning domain with skinfolds ($r = -0.56$) and aerobic capacity ($r = 0.49$), social functioning domain with handgrip strength ($r = 0.43$) and the physical health summary measure with body weight ($r = -0.45$). Conclusion: QOL was significantly improved after the DiabetAction program. Also, PA intervention appears to impact QOL to a larger extent when participants experience changes in body composition and fitness.

Keywords: physical activity, DiabetAction, quality of life, exercise intervention

INTRODUCTION

Type 2 diabetes (T2D) is associated with several complications such as coronary heart disease, kidney disease and retinopathy [1], as well as lower health-related quality of life (QOL) [2,3,4]. The adoption of an active lifestyle has been suggested to be a promising strategy to improve QOL [5,6]. Indeed, cross-sectional studies have shown that being physically active is associated with a higher QOL in both the general [7,8,9] and the diabetic population [3]. Longitudinal studies have also showed that increases in leisure physical activity (PA) levels are associated with a stable or an increased QOL in apparently healthy individuals [9,10,11].

To our knowledge, only four studies have investigated changes in QOL in T2D patients after exercise inter-ventions. In one of them, nine diabetic and ten non-diabetic sedentary subjects participated in a 10-week supervised training program [12]. Comparison with a control group showed improvements in aerobic capacity and body composition, without significant changes in physical and mental health QOL measures. Furthermore, no significant associations were observed between changes in the summary measures of the QOL and physiological measures such as aerobic capacity, body mass index and percentage of body fat. Another study examined the impact of a six-month exercise program on QOL [13]. In this study, nine T2D participants had one supervised session per week, while nine subjects were unsupervised. Data revealed that the supervised group significantly improved their QOL after the intervention with no difference with the unsupervised group. In another study,
Holton et al. [14] investigated the effect of a six-week supervised PA program followed by a six-week home-based PA program in 51 T2D patients [14]. Significant improvements in QOL (total psychological well-being, anxiety, positive well-being and energy) were observed after the first six weeks. However, QOL returned to baseline levels at the end of the home-based program and no significant relationship between the changes in aerobic capacity and total psychological well-being was reported. To our knowledge, only one group of researchers studied changes in QOL after a program combining various modalities of exercises [15]. The authors reported no significant improvements in QOL after the intervention in 59.5 ± 2.5 years old T2D subjects. Altogether, these few studies seem to suggest that QOL of T2D individuals could either remain stable or be improved following a PA program; however factors associated with QOL changes remain to be established. In the present study, the DiabetAction program was used to examine this question. Indeed, it is a program designed to introduce individuals with or at-risk for T2D to a wide variety of cardiovascular, resistance, balance and flexibility exercises over a 10-week period [16]. For the purpose of this study, we investigated: 1) changes in QOL after the DiabetAction program in T2D and at-risk individuals and 2) associations between changes in QOL and changes in anthropometric measures, PA, and fitness levels.

The hypothesis that supported the current study was that QOL would improve post-intervention and that the physical components of QOL would correlate to physical changes observed over the course of the program.

METHODS

To participate in this study, subjects had to meet at least one of the following conditions: 1) diagnosis of T2D or insulin resistance by an attending physician, 2) obesity (body mass index ≥ 30 kg/m²) or 3) a family history of T2D (mother, father, sister or brother). They also had to participate in less than two structured PA sessions per month prior to the program and be aged between 40 and 65 years old. The exclusion criteria were an inability to speak French or English, pregnancy and/or a medical condition that can be deteriorated by aerobic capacity such as uncontrolled diabetes or blood pressure problems and general mental health. The domain results are then aggregated in physical and mental summary measures [18]. When interpreting the findings, it is important to keep in mind that 1) higher scores indicate a higher QOL and 2) the SF-36 questionnaire documents the QOL of the previous four weeks. The validated English (Canada), Spanish (Mexico) and French (Canada) SF-36 questionnaires (version 1) [17] were used according to the language preference of the participants.

Participants were interviewed in person using either the French or English version of the Modifiable Activity Questionnaire to evaluate their PA level [19]. The average PA practice (minutes/week) of the last 12 months was calculated to identify the baseline level. The post-intervention PA levels were calculated from the average PA practice during the previous three months while excluding activities performed during group sessions.

The body weight (TFB-521; Tanita Corporation, Tokyo, Japan) and skinfold thickness (biceps, triceps, subscapular, iliac crest and calf; Harpenden skinfold caliper; John Bull, British Indicators Ltd., St-Albans, England) were measured following recommendations by the Canadian Society for Exercise Physiology [20]. To assess aerobic capacity, the participants performed a one-mile walking test [21] on an indoor track using a heart rate monitor [Polar T31 (transmitter) and Beat (receiver); Polar Electro, Kempele, Finland]. Handgrip strength was measured using a Jamar dynamometer (Sammons Preston, Bolingbrook, USA) according to a standard procedure [20].

The 10-week exercise program (DiabetAction) was held in 2006, with recruitment performed three months prior to the interventions that began, according to the groups, in February, April or September. It included one supervised weekly group session at the Université de Montréal Sports Center (Montreal, Canada) combined with an individual home training program.

Each supervised group session was composed of the following: 1) a 15-minute lecture on health tips (PA, diabetes, nutrition, etc.), 2) 60 minutes of PA and 3) a 15-minute period for participants to review their previous week’s PA and plan their home training for the week to come. Each 60-minute supervised PA session included 3-5 minutes of warm-up, 25-30 minutes of aerobic exercises at a light/moderate intensity (e.g., walking, circuit training or pool exercises) and 3-5 minutes of cool-
down. Six muscular exercises targeting major muscle groups (quadriceps, hamstrings, chest, abdominals and upper and lower back muscles) were then performed for 15 to 20 minutes. Muscular exercises were composed of 1-2 sets of 12-20 repetitions using elastic bands, stability balls, and body weight, training room equipment or water resistance. Additionally, 10 minutes of exercises targeting balance and flexibility were performed at the end of each supervised training session. More details regarding the DiabetAction intervention have been published previously [16].

Statistical analysis
The data presented are means (standard deviations), unless otherwise specified. Participants who completed at least 50% of the training sessions and performed a post-intervention evaluation were included in the analyses. The effect sizes, a standard unit of measurement that can be used to present before and after changes obtained with a one-group situation [22], were calculated by subtracting the initial mean value from the final mean value and then dividing by the pooled standard deviation [23]. Effect sizes are considered negligible if < 0.2, small if between 0.2 and 0.5, moderate if between 0.5 and 0.8 and important if > 0.8 [23]. Two-by-two ANOVAs for repeated measures were conducted using the time of measurement (baseline vs. post-intervention QOL measures) as the within-participant factor. Bivariate correlations were performed to examine the association between absolute changes in the measures of QOL and in PA practice, anthropometric values and fitness levels. Analyses were carried out using the SPSS 14.0 Statistical Software Program. The level of significance was set at 0.05.

RESULTS
Out of the 39 participants who took part in the baseline evaluation, 10 attended less than 50% of the supervised weekly group sessions or did not take part in the post-intervention evaluation. The reasons reported were the following: travel (n = 1), conflict with work (n = 2), busy schedule (n = 2), medical recommendations (n = 2) and unknown/personal reasons (n = 3). Consequently, analyses were performed on 29 participants, except for the handgrip strength and aerobic capacity due to maximal exercise testing contraindications (n = 26 and 21, respectively). Participants were 51 years old on average and the number of T2D and at-risk individuals was 15 and 14, respectively (9 women and 6 men and 11 women and 3 men, respectively). On average, the participants attended 8.2 ± 2.0 out of 10 group sessions.

Measures of QOL at baseline and post-intervention are presented in Table I. Between-participant effects were significant for physical functioning [F (1, 27) = 4.85, p = 0.04], role limitations due to physical problems [F (1, 27) = 6.65, p = 0.02], general health [F (1, 27) = 4.93, p = 0.03] and physical component summary measure [F (1, 27) = 8.89, p = 0.01]. Within-participant effects were significant for the physical component summary measure [F (1, 27) = 4.14, p = 0.05], mental component summary measure [F (1, 27) = 7.74, p = 0.01], physical functioning [F (1, 27) = 10.99, p < 0.01], bodily pain [F (1, 27) = 6.77, p = 0.01], vitality [F (1, 27) = 6.68, p = 0.01], social functioning [F (1, 27) = 4.27, p = 0.05], role limitations due to emotional problems [F (1, 27) = 6.66, p = 0.003] and mental health [F (1, 27) = 10.69, p = 0.003]. No significant interaction between the time of measurement and diabetes status (presence/absence of T2D) was ob-

### Table I

<table>
<thead>
<tr>
<th>Quality of life</th>
<th>At-risk individuals + (n = 14)</th>
<th>Type 2 diabetic individuals + (n = 15)</th>
<th>Effect sizes* (n = 29)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Domains</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical functioning</td>
<td>86.8 (16.5)*</td>
<td>94.6 (5.0)*</td>
<td>0.47</td>
</tr>
<tr>
<td>Role limitations due to physical problems</td>
<td>92.9 (15.3)*</td>
<td>92.9 (20.6)</td>
<td>0.37</td>
</tr>
<tr>
<td>Bodily pain</td>
<td>72.8 (22.9)</td>
<td>76.8 (24.1)*</td>
<td>0.59</td>
</tr>
<tr>
<td>General health</td>
<td>71.7 (15.3)*</td>
<td>80.2 (11.2)</td>
<td>0.35</td>
</tr>
<tr>
<td>Vitality</td>
<td>70.0 (12.4)</td>
<td>76.8 (24.1)*</td>
<td>0.47</td>
</tr>
<tr>
<td>Social functioning</td>
<td>81.3 (21.2)</td>
<td>89.3 (14.6)</td>
<td>0.41</td>
</tr>
<tr>
<td>Role limitation due to emotional problems</td>
<td>78.6 (36.1)</td>
<td>92.9 (19.3)*</td>
<td>0.53</td>
</tr>
<tr>
<td>Mental health</td>
<td>70.6 (16.8)</td>
<td>80.6 (13.0)*</td>
<td>0.67</td>
</tr>
<tr>
<td><strong>Summary measures</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical component</td>
<td>52.1 (6.6)*</td>
<td>52.9 (4.4)*</td>
<td>0.39</td>
</tr>
<tr>
<td>Mental component</td>
<td>48.7 (9.0)</td>
<td>53.9 (6.4)*</td>
<td>0.60</td>
</tr>
</tbody>
</table>

* Mean values (standard deviation)  * Effect size values  * Significantly different from Type 2 diabetic individuals at baseline (p-value < 0.05)

*Significantly different from baseline values (p-value < 0.05)
served for any of the QOL domains and summary measures. Moderate effect sizes were noted for bodily pain, role limitations due to emotional problems and mental health.

Correlations between changes in QOL, PA levels, anthropometric measures and fitness levels are presented in Table II. Significant correlations were observed for physical functioning and skinfolds ($r = -0.56$), physical functioning and aerobic capacity ($r = 0.49$), social functioning and handgrip strength ($r = 0.43$), and physical health and body weight ($r = -0.45$).

**DISCUSSION**

A major finding of this study was that the participants had a significantly higher QOL after the DiabetAction program. Moreover, those changes in QOL were similar for T2D patients and at-risk individuals. We also observed that improvements in QOL were significantly correlated with improvements in fitness levels and body composition.

These results are of great interest from a clinical perspective, since DiabetAction lasted only 10 weeks and required only one group meeting per week. As previously indicated, this program was designed to initiate sedentary T2D and at-risk individuals to different types of cardiovascular, resistance, balance and flexibility exercises. Therefore, our results indicate that a 10-week period, including only 10 group sessions, can be sufficient to improve QOL in T2D patients and at-risk individuals.

In line with previous studies [2,3,4], T2D participants in our sample had a lower baseline QOL compared to at-risk individuals. This difference was statistically significant for physical health and three out of the four QOL domains associated with the physical aspect of QOL. In addition to the fact that both summary measures and six out of eight domains significantly improved post-intervention, it is interesting to note that all effect sizes were between 0.35 and 0.67; indicating that there was a small (physical functioning, role limitations due to physical problems, general health, vitality and social functioning domains, and physical component summary measure) or a moderate (bodily pain domain, role limitations due to emotional problems, mental health domain and summary score) treatment effect after this short and low constraint training program. Examining the parameters that have a moderate effect size indicates that the exercise intervention was not increasing the body pain to a level detrimental for the QOL and was even improving it. Moreover, individuals who took part in the intervention mainly showed improvements in the mental components of the QOL.

The improved QOL in the present study is in agreement with previous studies showing that exercise supervision or group intervention is an important factor to consider for QOL improvements. Indeed, Alam et al. [15] showed that the QOL was significantly improved after a six-month aerobic exercise program in a group having one weekly supervised session, while no effects of the treatment were measured in the unsupervised group. In another study, positive changes in the QOL were reported following a 6-week (3 sessions/week) supervised PA program. However, after the second portion of the program that consisted of an unsupervised 6-week home training program, QOL returned to baseline values [13]. Compared to these studies, results obtained with the DiabetAction program are interesting because the intervention required only 10 supervised group sessions, which were combined with an unsuper-

### TABLE II

<table>
<thead>
<tr>
<th>Health-related quality of life changes</th>
<th>Physical activity level change (min)</th>
<th>Number of group sessions attended (#/10)</th>
<th>Body weight change (kg)</th>
<th>Skinfold thickness change (mm)</th>
<th>Aerobic capacity change ($O_2$/L/min)</th>
<th>Handgrip strength change (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Domains</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Physical functioning</td>
<td>0.32</td>
<td>0.14</td>
<td>-0.24</td>
<td>-0.56*</td>
<td>0.49*</td>
<td>0.01</td>
</tr>
<tr>
<td>Role limitations due to physical problems</td>
<td>0.19</td>
<td>-0.05</td>
<td>-0.20</td>
<td>0.09</td>
<td>0.01</td>
<td>0.02</td>
</tr>
<tr>
<td>Bodily pain</td>
<td>0.16</td>
<td>0.10</td>
<td>-0.19</td>
<td>-0.20</td>
<td>0.42</td>
<td>0.14</td>
</tr>
<tr>
<td>General health</td>
<td>0.18</td>
<td>0.14</td>
<td>-0.32</td>
<td>-0.18</td>
<td>0.09</td>
<td>0.18</td>
</tr>
<tr>
<td>Vitality</td>
<td>0.25</td>
<td>-0.19</td>
<td>-0.28</td>
<td>-0.09</td>
<td>0.42</td>
<td>-0.31</td>
</tr>
<tr>
<td>Social functioning</td>
<td>0.21</td>
<td>0.06</td>
<td>-0.28</td>
<td>-0.23</td>
<td>0.02</td>
<td>0.43*</td>
</tr>
<tr>
<td>Role limitations due to emotional problems</td>
<td>0.01</td>
<td>0.13</td>
<td>-0.25</td>
<td>-0.06</td>
<td>0.41</td>
<td>0.06</td>
</tr>
<tr>
<td>Mental health</td>
<td>0.20</td>
<td>-0.04</td>
<td>0.13</td>
<td>-0.03</td>
<td>0.30</td>
<td>-0.07</td>
</tr>
<tr>
<td><strong>Summary</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical health</td>
<td>0.24</td>
<td>0.08</td>
<td>-0.45*</td>
<td>-0.23</td>
<td>0.19</td>
<td>0.09</td>
</tr>
<tr>
<td>Mental health</td>
<td>0.11</td>
<td>&lt; 0.01</td>
<td>0.32</td>
<td>-0.03</td>
<td>0.17</td>
<td>0.04</td>
</tr>
</tbody>
</table>

* $p$ value < 0.05
vised home training program to increase PA levels. Therefore, from a cost-efficiency perspective, it could be beneficial to combine supervised and unsupervised sessions, such as in the DiabetAction program in order to optimize QOL.

The modality of training used is also a factor to consider when assessing changes in the QOL. In a recent meta-analysis, Netz et al. [24] reported that even though aerobic training seems to be the most beneficial exercise for the improvement of QOL in older adults, improvements in strength and functional capacity have also been linked to QOL improvements in this population [24]. Consequently, the beneficial changes observed in QOL in T2D and at-risk individuals could be explained in part by the combination of various cardiovascular, resistance, balance and flexibility exercises in the DiabetAction program. However, considering that Tessier et al. [10] found no changes in QOL after 16 weeks of cardiovascular and resistance exercises in older T2D patients, we cannot conclude that combining modalities of training always leads to improvements. Further studies addressing this issue would be necessary to better understand the possible beneficial effects of exercise modality on QOL in at-risk and T2D patients.

Contrarily to published cross-sectional and longitudinal studies reporting that QOL is higher in active individuals when compared to sedentary ones [3, 8, 9, 11, 12], we observed no relationship between changes in the QOL and PA levels (min/week) or attendance to group sessions. Instead, we found that QOL changes were associated with other factors that are influenced by PA practice. We observed that changes in aerobic capacity and handgrip strength were positively associated with changes in physical functioning and social functioning domains, respectively. Furthermore, a decreased body weight and lower skinfold thickness were also related to an increase in physical QOL measures (physical component and physical functioning domains). While it is interesting from a clinical point of view that improvements in fitness levels and body composition can be positively linked to QOL, the significant and positive correlation between handgrip strength and social functioning requires further investigation. The importance of fitness and anthropometric characteristics over PA practice per se for the QOL suggested by our results is in line with work from the group of Stewart et al. [7]. Using a cross-sectional design, they showed that out of ten possible correlations with QOL variables, only one significant correlation between the PA level and QOL was reported [7]. On the other hand, four, five and seven significant correlations were measured between the QOL and aerobic capacity, body mass index and percentage of body fat, respectively [7]. It thus appears that QOL is more associated with fitness and anthropometry than with PA level in cross-sectional and intervention studies. In other words, fitness and anthropometric changes could potentially be considered as potential mediators of the relation between PA changes and QOL changes. In future work conducted with larger sample size, it will be important to better investigate if potential effect modifiers and confounders such as gender of the participant or neurological changes resulting from an increased PA level are of interest.

To our knowledge, we are the first to demonstrate QOL associations with fitness and anthropometry changes over the course of a PA program in a quasi-experimental study. Limitations of the current study however need to be addressed. The absence of a control group and the small sample size limit the external validity of our results. In the absence of a control group, it can not be excluded that social desirability could lead to higher QOL reported, a phenomenon that might be reduced by the fact that the questionnaire used in the current study was self-administered. Moreover, the SF-36 questionnaire represents mainly the QOL of the previous four weeks [14, 18] and does not allow for an investigation of acute changes in the QOL following each PA session. Despite these limitations, the present study is strengthened by the following: 1) participants were from a target population at higher risk of a lower QOL who might benefit from an exercise program due to the risk or presence of T2D; 2) the integration of four modalities of training in an innovative program designed to be workable in real life settings with sedentary individuals with or at-risk for T2D.

CONCLUSION

T2D and at-risk participants improved their QOL after the 10-week DiabetAction program. This study also revealed that changes in aerobic capacity, handgrip strength, body weight and skinfold thickness were associated with improvements in QOL; while changes in PA levels and attendance to group sessions had no impact. It thus appears that going beyond the sole increase in PA practice is necessary to positively impact QOL through an exercise intervention. Following our results, exercise interventions should be designed to improve the fitness and anthropometric profile and not only to increase PA practice for an improved QOL of T2D and at-risk individuals.

ACKNOWLEDGMENT

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CONFLICT OF INTEREST: None to declare.

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