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NARRATIVE REVIEW

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Adapted physical activity interventions and motivational levers: What benefits for type 2 diabetics? A systematic review

Élise Maudet-Coulomb[1,2] | Charles Martin-Krumm[1,3,4] | Cyril Tarquinio[1] | Jean-Christophe Mino[2]

[1]EA 4360 APEMAC, University of Lorraine, Moselle, Metz, France

[2]Bas-Rhin, Siel Bleu Research Institute, Strasbourg, France

[3]School of Practical Psychologists, Institut Catholique de Paris, EA Religion, Culture et Société, Paris, France

[4]Essone, Armed Forces Biomedical Research Institute, Brétigny, France

Correspondence
Élise Maudet-Coulomb, University of Lorraine, EA 4360 APEMAC, Moselle, Metz, France.
Email: elise.coulomb@gmail.com

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Abstract

Background and Aims: Scientific research continues to advance and improve the medical management of type 2 diabetes. However, the importance of lifestyle management remains invaluable in treatment and tertiary prevention of this disease. Day-to-day sedentariness is the fourth most important risk factor for mortality in France. Numerous studies have demonstrated that physical activity is beneficial to people with type 2 diabetes and various recommendations have been made to encourage it. However, it is universally agreed that interventions that promote physical activity, while they may enhance its practice in the short term, do not impact on it over longer periods. It therefore seems essential to focus interventions on an individual's capacity to persist with physical activity in the long term. By looking at the literature, the aim of this review is to synthesize group and supervised physical activity interventions for people with type 2 diabetes using variables based on the following levers: motivation and self-efficacy.

Methods: The PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) methodology examined studies in English or French that are registered in the PubMed, PsycINFO, and SportDiscus databases and were published between 2005 and 2023, according to the following keywords: Motivation OR self-efficacy AND physical activity AND type 2 diabetes AND intervention.

Results and Conclusion: Seven studies out of 1207 were included. Despite the pertinence of the concepts of motivation and self-efficacy and their complementarity in physical activity management programs, few studies have yet proposed a combined intervention for people with type 2 diabetes.

KEYWORDS

interventions, motivation, physical activity, self-efficacy, type 2 diabetes

1 | INTRODUCTION

1.1 | Background

In France, one person in four suffers from a chronic disease; after the age of 65 years,[1] the figure rises to three in four. By 2035, the number of adults with diabetes is projected to be 592 million worldwide.[2] In France in 2015, 5% of the population[3] had diabetes. Limiting the prevalence and progression of the disease is therefore a public health issue.

There is considerable evidence in the literature to suggest the benefits of physical activity (PA) on both limiting the progress of type 2 diabetes (T2D) and encouraging the control of risk factors.[4,5] The World Health Organization defines PA as "any bodily movement produced by skeletal muscles that requires energy expenditure [...] during leisure time, for transport to and from places, or as part of a person's work."[6] The health benefits of PA have led to numerous recommendations.[4,7,8] It is recommended to perform an endurance activity (e.g., brisk walking) at least three times a week at moderate intensity (40%–60% VO_2max) for at least 10 affiliated minutes with a target of 150 min a week. In addition, it is advisable to carry out muscle-strengthening activity at least twice a week at moderate (50% of maximum repetition) to high (75%–80% of maximum repetition) intensity, with three sets of around 10 repetitions per exercise and between five and 10 exercises working the main muscles per session.[4,7,8] An active lifestyle should also be encouraged, by limiting sedentary activities (e.g., watching television) to less than 7 h a day, breaking up sitting time by getting up regularly, and increasing daily PA by walking and taking the stairs rather than the lift.[4] Nonetheless, studies show that the majority of T2D patients remain sedentary.[9,10] For example, a study of a PA program conducted during hospitalization reported a daily sedentary time of T2D individuals of approximately 6 h before hospitalization.[9] Among the factors limiting practice,[11,12] psychology plays an important role. Indeed, several authors have demonstrated a negative effect on PA caused by a lack of motivation, denial of the disease, or psychological pathologies.[13–16] Thus, despite scientific evidence to the contrary and despite the disease prevention policies implemented, the inability of people with T2D to commit to, and persist with PA, remains a major problem: patients either do not practice it or else quickly abandon it, despite medical recommendations or prescriptions. It is therefore not just a question of knowing what to do; the recommendation to "do it for your health" of itself offers insufficient incentive.

In recent years, a new field of research and practice in psychology has brought to the fore certain notions, notably theories concerning motivation and self-efficacy, that may provide levers for both commitment and persistence issues.

The first variable of interest is motivation. This is a complex concept: reference is made to 101 theories relating to this concept.[17] In our review, the options selected allow us to understand the processes involved in the practice of PA and to propose levers for intervention. The theory of self-determination[18] (i.e., quality of motivation and satisfaction of basic psychological needs [BPNs]) is developed in this perspective. If motivation can be considered to be dependent on individuals, an approach based on the theory of self-determination makes it possible to think of it as dependent on the interaction between the individual and their social environment. This would suggest that supervisors in the field of adapted PA have levers at their disposal that could support their patients' motivation. It is therefore clear that they might nurture a conducive climate by creating the conditions for the satisfaction of the three BPNs, that is, the need for autonomy (e.g., to feel free to practice or not), for a sense of competence (e.g., to see oneself progressing in physical practice either in terms of technique linked to the activity itself or in terms of self-knowledge), and for social proximity (e.g., benefitting from the empathy of a supervisor or being part of a group that shares common interests). Numerous studies have investigated the links of these concepts to motivation in the context of health,[19] sedentary behavior,[20] and PA, including the capacity to persist in engaging in PA.[19,21–23]

Another variable of interest in issues related to engagement or persistence in PA is self-efficacy, of which the links to PA are well established.[24,25] Self-efficacy is defined as "the individual's belief in his or her ability to organize and execute the course of action required to produce desired results."[26] From this perspective, self-efficacy in performing an action influences: (i) its course; (ii) the amount of energy invested in the effort; (iii) perseverance in the action; (iv) resilience; and, of course, (v) the degree of success. Self-efficacy is a measure that can be applied to any field (e.g., PA, diet, and self-awareness). As in the case of support for self-determined motivation, it is possible to conceive interventions that would encourage a person's self-efficacy (i) by identifying previous successful experiences, (ii) by creating the conditions for vicarious learning within a group, (iii) by enabling them to control their physiological and emotional reactions, and finally, (iv) by taking into account the integration of information.[27]

Links are found between the definitions of the two notions (i.e., motivation and self-efficacy). The authors refer to the abilities, skills, and energy required to implement behaviors to achieve results and to set goals. The link between PA and self-efficacy is reinforced by autonomous motivation that is sustained up to 12 months after a PA intervention with people with T2D.[28] If PA is started by choice or desire, then self-efficacy is shown to be a predictor of perseverance. It would therefore seem interesting to combine interventions related to both motivation and self-efficacy to promote the practice and perseverance of PA in people with T2D.

1.2 | Aims

The aim of this paper is to review interventions designed to increase the amount of PA undertaken by people with T2D, based on two particularly promising frameworks theories of motivation and self-efficacy.

2 | METHOD

The recommendations of the PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses)[29,30] protocol were followed.

2.1 | Eligibility criteria and data items

To define the research criteria, the Patient, Problem or Population, Intervention, Comparison, Control or Comparator, Outcomes and Study design (PICOS)[29,30] was used. As T2D occurs mainly in adults, research was restricted to adults.

To be included in this review, the intervention presented in a study must have corresponded to optimal conditions to support the practice of PA in this specific public. These optimal conditions are similar to (1): a group PA practice led by a professional (i.e., an activity to reinforce the motivational aspect of a supervised group practice) and (2) a group intervention in psychology (i.e., on the motivation and/or self-efficacy through—amongst other things—the satisfaction of BPN, positive feedback, dialog on behavioral change, problem-solving or analysis of obstacles linked to PA practice), a type of intervention that results in people being supported in a concrete way in their practice and in its implementation both on a daily basis and over the long term. To homogenize the types of interventions, only those carried out in person were included.

Randomized interventional studies were particularly valued, and studies were included if the control groups were either following a standard PA program (i.e., no motivational intervention), encouraged to practice regular PA independently, following a digital PA program (e.g., mobile app, videos), on a waiting list for the experimental intervention, or not following a specific intervention (i.e., standard care). However, due to the limited number of studies included, nonrandomized interventional studies meeting the eligibility criteria were also included. The primary outcomes sought were related to anthropometric measures and percentage of glycated hemoglobin (HbA1c), the amount of PA (e.g., self-reporting on the amount of PA performed and fitness tests), and psychological measures related to motivation and/or self-efficacy (e.g., self-reporting of quality of motivation, self-efficacy toward PA). Finally, the studies needed to be available in full text.

2.2 | Information sources

The inclusion of studies in this review followed a common search strategy across the three databases used. To explore the different scientific fields of the subject, the search was conducted in three databases: PubMed (Medicine and psychiatry), PsycINFO (Psychology), and SportDiscus (Sport and sports medicine). To focus on recent work, the articles included were between 2005 and 2023 (i.e., an 18-year interval) and were written in English or French.

2.3 | Search and study selection

Initially, a search associating the psychological variable and PA was conducted in each database (e.g., Motivation OR Self-efficacy AND Physical activity). To be more precise, the searches were oriented toward the T2D population (e.g., Motivation OR Self-efficacy AND Physical activity AND type 2 Diabetes). The "intervention" filter was then added (e.g., Motivation OR Self-efficacy AND Physical activity AND type 2 Diabetes AND Intervention). A selection process was performed following precise steps (i.e., identification, screening, eligibility, and inclusion), during which duplicates were removed and articles were selected according to the inclusion criteria listed in Figure 1. The identification step resulted in a total of 1433 references in the three databases (see Figure 1). After removing duplicates, 1275 studies were filtered by title and abstract and 910 were excluded for various reasons: because they did not address the target audience, because the data collection was insufficiently supported from a scientific point of view, because they were observational studies, or because the experimental design was not presented. The remaining 365 references dealt with interventions for people with T2D aiming to increase their level of PA.

2.4 | Data collection process

Data extraction was performed by the first author. The selection of articles was validated at each step by the co-authors (i.e., identification, screening, eligibility, and inclusion).

2.5 | Study selection

At the eligibility stage, articles that did not deal with interventions on the motivational variables of interest in PA for people with T2D and articles that did not involve a group intervention combining PA and face-to-face psychological intervention were excluded ($n = 307$) (cf. Figure 1). Any articles proposing an intervention via mobile health applications, the web, or SMS were excluded. It was also specified that the intervention should concern weekly PA supervised by a professional. If the intervention only offered advice, consultations, discussion groups, or prescriptions, without PA, the article was not selected.

For the final stage, articles were selected on the basis of the full text; abstracts alone did not provide sufficiently detailed information for inclusion. Thus, 51 articles were excluded on the basis of the criteria developed above. Particular attention was paid to the psychological content of the intervention. In addition to direct intervention in PA (i.e., supervised practice), the study had to propose a direct psychological intervention relating to motivation and/or self-efficacy (e.g., behavior adopted by the supervisor to support the satisfaction of the participants' BPN, discussion groups with a professional on the analysis of the obstacles and levers to the practice of PA, and setting of objectives). Thus, articles proposing motivational interviews and telephone coaching were excluded. In the end, only seven articles met all the criteria for inclusion in the PRISMA review.

2.6 | Characteristics of selected studies

For each included study, the population and sample size, characteristics of the intervention, and characteristics of the control group (if available) were extracted.

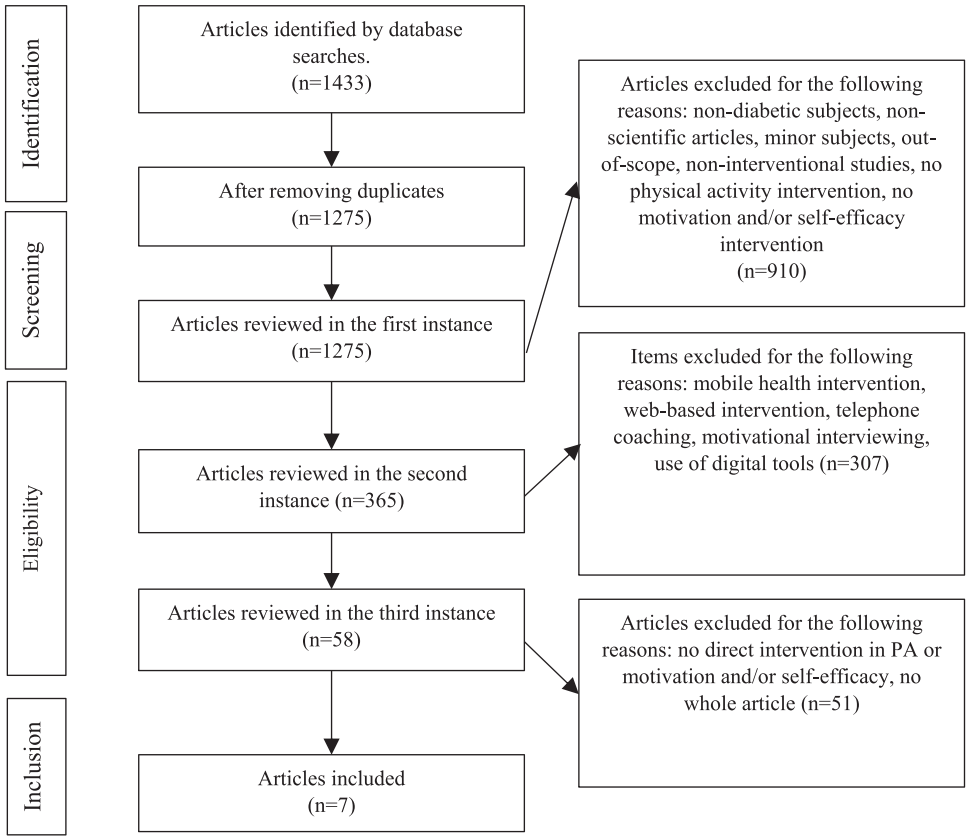

FIGURE 1 Flowchart. PA, physical activity.

The common objective of the included studies was principally to analyze the effects of an intervention to improve health behaviors, including PA, in people with T2D. Some of the studies announced at the outset their intention to address the notions of motivation and/or self-efficacy.[31–34] Five out of seven studies were randomized.[31–33,35,36] One of the inclusion criteria for the studies was the type of provider. In all seven selected studies, the providers were paramedical and PA professionals. These were either adapted PA professionals,[35,37] physiotherapists,[31,34,36] sports science students,[32] or exercise leaders.[33] Management was provided by professionals from different fields and could include a dietitian or nutritionist,[31,34–37] a psychologist,[31,35,37] a cardiac rehabilitation nurse and consultant,[31] a stress management instructor and group facilitator,[36] an instructor,[32] and/or a researcher.[33]

The bulk of the data collected were psychological measures (e.g., motivation, self-efficacy, quality of life, perceived health, vitality, beliefs, health behaviors, etc.) and PA measures (e.g., self-reporting on the amount of PA performed and fitness tests). Motivation measures were varied: support for BPN, quality of motivation, and perceived competence; while self-efficacy could be measured from differing angles which, in the included studies, might be with reference to barriers, walking, exercise, weight, or diet. Weight was reported in all studies. HbA1c, body mass index (BMI), waist circumference, blood glucose levels, medical treatments, and medical history were also all assessed.

3 | RESULTS

3.1 | General results

For the five randomized studies,[31–33,35,36] 430 subjects participated in the experimental group, representing a mean of 52.1% of the initial population of each study. On mean, the seven studies included 292.4 people (SD = 386.1) with a minimum of 81 subjects and a maximum of 1156. A total of 2096 subjects were considered in the included studies. The subjects were adults with T2D ($M = 62.6$ years), with a majority of women (62.1%). Three of the seven studies also included people with hypertension, dyslipidemia, coronary heart disease, or metabolic syndrome.[31,33,34] The majority of subjects were inactive or below recommended levels of PA. For the studies that identified this information,[31,33,35,36] the subjects had a mean BMI of 33.1 kg/m^2 and were therefore obese. Their mean HbA1c was 7%.[32,33,37]

All studies offered supervised group PA sessions at least once a week and at most three times a week. In three studies, independent PA sessions were strongly encouraged in addition to supervised sessions.[31–33] These PA interventions were combined with an intervention on motivation and/or self-efficacy. For three of them, a dietary intervention was also proposed.[31,34,36,37] The main format of these complementary interventions was group discussion meetings. For the five randomized studies, the control groups were made up of people who were either on a waiting list[31] or already receiving

the usual care, including encouragement to engage in PA[32,35,36] or to follow online courses on diabetes, PA, diet, stress management, and aging.[33] Program durations varied from a minimum of 2 months to a maximum of 24 months. Only two studies offered a remote evaluation of the intervention at 6 months[38] and 12 months.[34]

3.2 | Results of each study

The results of the seven included studies have been summarized in Table 1. In the first study,[32] the authors proposed to evaluate the effects of a 12-month intervention on self-determined motivation, health behaviors, and health of people with T2D. A total of 108 adults with T2D and coronary heart disease were randomly assigned to two groups (i.e., control and intervention groups). Fifty-seven of them were given a PA program consisting of two 60-min sessions of PA per week. They were strongly advised to complete their training with an additional session carried out independently. The subjects could monitor their PA using a training diary. The intervention was designed to support BPN and was supervised by an instructor and sport science students. The control group was encouraged to continue PA. In addition to measures of adherence, the data assessed were either situational and contextual measures (i.e., BPN satisfaction, type of motivation, perceived competence, perceived health, and vitality), or behavioral (i.e., effort and quality of PA and blood glucose measurement) or medical (i.e., HbA1c and blood glucose levels). After various analyses, the authors demonstrated that the satisfaction of needs (i.e., competence and autonomy) led to an improvement in autonomous motivation and an increase in the amount of PA. The profile of the subjects (i.e., age and gender) seemed to have an effect on the satisfaction of BPN and on the amount of PA at the end of the program. The analysis of the results showed several significantly greater effects in the intervention group when compared to the control group, notably on the satisfaction of BPN, performance in PA, vitality, perceived health, perceived competence, and motivation. However, the intervention had no significant impact on weight over time.

The second study[34] looked at motivation, barriers, and adherence to an intervention designed to increase PA of people with T2D, hypertension, and/or dyslipidemia. These were inactive people who had a BMI of less than 35 kg/m^2. In total, 1156 subjects participated in a group training program supervised by a physiotherapist, for at least 3 h/week for 4 months. Subjects attended training on exercise and diet. A dietitian provided dietary advice up to eight times a year. A motivational dialog was required. All measurements were taken before, after, and at 12 months. The physical condition of the subjects was assessed by means of a submaximal test on an ergocycle. There was no information on the intensity required for the fitness tests. Biological and anthropometric measurements were also collected. Attitudes, experiences, and barriers related to PA and self-reported health were assessed through a qualitative questionnaire. The data were complemented with qualitative and group interviews on attitude, experience of, and barriers to, PA, and self-reported health. The effects of the intervention were observed both immediately after the program and at 1 year, with particular attention given to improvements in the amount of PA, the level of fitness, weight loss, and the reduction of the BMI. Perceived health and motivation were also seen to improve.

The third study[37] aimed to examine the feasibility and effectiveness of a community-based, multidisciplinary educational intervention (described below), designed to improve quality of life and self-management in sedentary, overweight, or obese people with T2D. Psychologists, nutritionists, and professionals in adapted PA were involved in a 9-month program. One and thirty subjects were included and benefitted from the intervention, while a total of 81 people were evaluated before and after. The program proposed three areas of intervention: PA, motivation, and nutrition. All were adapted to the patients' level of PA, motivation, and self-efficacy. Regarding PA, subjects performed 2 weekly supervised group sessions of aerobic, resistance, and moderate- to high-intensity exercise. The motivational intervention proposed by the authors consisted of two group meetings per month focusing on different themes: benefits of diet and PA, home and outdoor training methods, analysis of barriers, and problem-solving in diabetes management. It was conducted by a psychologist trained in motivational interviewing in the context of behavior change. Finally, the nutritional intervention included a group meeting every 3 months that focused on a Mediterranean diet and healthy foods, proper meal distribution for diabetes control, and the prevention and management of hypoglycemia. Data were collected using a study-specific questionnaire assessing perceived health, health behavior, and beliefs and barriers related to PA. A quality of life questionnaire was also proposed as well as a measurement of HbA1c and weight. The analysis of the data showed various positive and significant effects, particularly on biological and anthropometric measurements, perception of health status, health behavior, and PA. As regards HbA1c, there was a significant decrease of 0.4 points. For PA, the data showed that in addition to increased confidence in the benefits of PA and in the role of the trainer, 20 more people engaged in unsupervised PA when the intervention program had finished.

The main objective of the fourth included study[35] was to analyze the effects of a PA intervention combined with a motivational intervention for people with T2D. The 159 people included in the study chose whether to participate in the experimental or control group. In contrast to the previous study, no nutritional intervention was performed. A total of 69 people participated in a 9-month program of 1 h of group PA, two to three times a week, supervised by an adapted PA professional. This program was complemented by 12 group meetings on the theme of motivation to engage in PA, led by a psychologist. Topics included the virtues of, and recommendations, for PA, training methods, barrier analysis, and problem-solving. The psychologist adopted a behavior change style (i.e., taking into account the person's attitude, perceived social norms, intention to adopt a behavior, and perceived control). The control group (n = 90) received the usual PA recommendations. To compare the two groups, physical condition tests were conducted, together with anthropometric and biological measurements and a questionnaire on the

TABLE 1 Table of characteristics.

References	Randomization	Sample size/population	Description of the intervention	Type of stakeholder	Time	Scales/measures	Outcomes	Effect size
Gallagher et al.[31] Australia	Yes	*N* = 148 People with a body mass index between 27 and 39 kg/m^2 with coronary heart disease and/or T2D, able to engage in regular PA.	**HEELP group (*n* = 83):** Supervised PA, minimum twice 60 min/week. Pedometer and encouragement to do PA at home, 30–60 min per day. Information and support sessions, four 90-min sessions. Themes: Health consequences of being overweight, health benefits of weight loss, cognitive behavior change strategies, problem-solving to overcome barriers and self-management strategies; notebooks to develop problem-solving skills, encourage motivation and gain a sense of mastery in weight reduction; principles of behavioral and cognitive behavioral therapy, guided by social learning theory and aiming to promote self-efficacy for weight reduction. **Usual care (*n* = 65):** Waiting list	Dietitian Psychologist Physiotherapists Nurse Cardiac rehabilitation consultant	16 weeks	Weight Height BMI The 6-min walk test[39,40] Semi-structured interview based on the GPAQ[41] Self-efficacy for Weight Loss Questionnaire[38] Personal history Medical treatments, family history, smoking. Age Sex Nationality Marital status Place of residence Employment status	*Analysis experimental versus control groups* **Weight** **BMI** **Waist circumference** **Amount of PA** **Walking distance** **Weight loss self-efficacy**	NA NA NA NA NA NA
Halvari et al.[32] Norway	Yes	*N* = 108 Adults with T2D and coronary heart disease.	**PA intervention group (*n* = 57):** Two sessions of PA per week of 60 min + 1 session of self-directed PA (recommendation). Diary for self-training. Training designed to support BPN (choice of training times, choice of PA for self-training, focus on mastery of PA appropriate to skill and ability level, encouragement to do high-intensity PA, encouragement to keep a training diary, positive feedback, participation of all beneficiaries, learning each other's names). **Control group (*n* = 51):** Encouragement to continue PA.	Instructors Students in sport science	12 months	Health-Care Climate[42] BPN Satisfaction in Exercise Scale[43] 18-item Treatment Self-regulation Scale for PA[44] (modified for context) 4-item Perceived Competence Scales[45] (adapted to PA and blood glucose measurement respectively) 10-item Scale[46] (adapted to PA performance and blood glucose measurement)	*Analysis experimental versus control groups* **Total need satisfaction in PA** **Autonomous motivation for PA** **Controlled motivation for PA** **Perceived competence for PA** **Perceived competence for**	*d* = 0.72 *d* = 0.52 *d* = 0.36 *d* = 0.46 *d* = 0.23 *d* = 0.57 *d* = 0.46 *d* = 0.25 *d* = 0.41 *d* = −0.28 *d* = −0.10

TABLE 1 (Continued)

References	Randomization	Sample size/population	Description of the intervention	Type of stakeholder	Time	Scales/measures	Outcomes	Effect size
						The Short From Health Survey 36[47] (only 2 questions) Two questions from a Swedish study assessing perceived health[48] 6-item Subjective Vitality Scale[49] Weight HbA1c Blood sugars	**blood sugar testing** **Performance of PA** **Performance of blood sugar testing** **Vitality** **Perceived health** **Glucose control** **Body weight**	
Olson and McAuley[33] USA	Yes	*N* = 116 T2D or people with metabolic syndrome, between 50 and 75 years of age, with no contraindications to PA, who are not physically active for more than 30 min twice a week.	**PA group (*n* = 58):** Walking on the spot, three times a week then decrease to once a week every fortnight. Assigned independent aerobic exercise (walking), encouragement to increase as time goes on (third and fourth week, two independent sessions per week. Week 5, four times a week. Week 7, no more supervised sessions). Writing a diary at home. Four 1-h theory-based group workshops. Behavior modification strategies based on social cognitive theories. Focus on self-efficacy and self-regulation related to PA. Goal setting and monitoring. **Online education group (*n* = 58):** One-hour online courses on diabetes and health (1) glucose and its importance, (2) glucose and insulin, (3) weight control, (4) diet and nutrition, (5) PA, (6) prevention of diabetes complications, (7) stress management, and (8) healthy aging). Videos, readings, activities, and questions.	Researchers Exercise leaders	8 weeks	Size Weight BMI Medical history, medical treatments, demographic data Accelerometer (Actigraph; Model GT1Mor GT3X). Barriers-specific Self-Efficacy Scale[50] Self-efficacy walking scale[51] Self-efficacy scale for obstacles, walking and exercise[52] 12-item PA Self-Regulation Scale[53]	*Analysis experimental group* **Walking Self-Efficacy (W2)** **Walking Self-Efficacy (M2)** **Walking Self-Efficacy (M6)** **Barriers Self-Efficacy (W2)** **Barriers Self-Efficacy (M2)** **Barriers Self-Efficacy (M6)** **Exercise Self-Efficacy (W2)** **Exercise Self-Efficacy (M2)** Exercise Self-Efficacy (M6) **Self-Regulation (M2)** **Self-Regulation (M6)** **Moderate to Vigorous PA (M2)** **Moderate to Vigorous PA (M6)**	*d* = 0.68 *d* = 0.96 *d* = 0.74 *d* = 0.42 *d* = 0.20 *d* = −0.15 *d* = 0.26 *d* = 0.32 *d* = −0.04 *d* = 1.48 *d* = 0.73 *d* = 0.76 *d* = 0.35

(Continues)

TABLE 1 (Continued)

References	Randomization	Sample size/population	Description of the intervention	Type of stakeholder	Time	Scales/measures	Outcomes	Effect size
Roessler and Ibsen[34] Denmark	No	*N* = 1156 People with T2D, dyslipidemia, and/or hypertension, inactive. With a BMI < 35, able to perform supervised PA sessions.	Supervised group physical training of at least 3 h per week. Exercise and diet training program. Dietary counseling up to eight times a year. Motivational dialog based on Prochaska and DiClemente's[54] principles of behavior change.	Physiotherapists Dietitians	4 months	Physical condition tests (submaximal) Weight Height BMI Waist circumference Blood pressure Qualitative and group interviews Qualitative questionnaire on attitude, experiences and barriers to PA, and self-reported health.	*Analysis before versus after intervention* **Physical condition after and at 1 year** Fitness level after program and at 1 year Weight after program and at 1 year BMI after program and at 1 year Motivation Perceived health	NA NA NA NA NA NA
Gallè et al.[35] Italy	Yes	*N* = 159 T2D diagnosed for at least one year, between 50 and 70. Living in a community. Without major complications. Without contraindications to PA.	**Intervention group (*n* = 69):** One hour of PA, two to three times a week nonconsecutively. Maximum 10 people per session. Twelve 1-h group meetings around motivation for PA. Minimum of two weeks between each meeting. Discussions on the benefits and risks of PA, PA recommendations for T2D patients, presentation of home and outdoor training methods, and analysis of barriers and problem-solving. The psychologist sought to change participants' beliefs and attitudes about PA by considering the elements that promote behavior change, namely, the individual's attitude, perceived social norms, intention to adopt the behavior, and perceived control over the change process. **Control group (*n* = 90):** Usual PA recommendations.	Psychologists Exercise professionals with expertise in adapted PA	9 months	Senior fitness test[55,56] Weight BMI Waist circumference HbA1c IPAQ[57]	*Analysis experimental vs control groups* **Physical parameters** **BMI** **HbA1c** **Waist circumference** **Amount of PA**	NA NA NA NA NA

TABLE 1 (Continued)

References	Randomization	Sample size/population	Description of the intervention	Type of stakeholder	Time	Scales/measures	Outcomes	Effect size
Toobert et al.[36] USA	Yes	*N* = 279 Postmenopausal women with T2D for at least 6 months.	**Intervention group (*n* = 163):** Set personal lifestyle change goals at the start of the intervention. Ongoing support from peers and professionals to achieve their goals throughout the treatment program. Two-and-a-half-day nonresidential retreat, followed by weekly 4-h meetings (1-h meal sharing, 1-h PA; 1-h stress management, 1-h support group) with encouragement to increase PA gradually, motivational techniques. After 6 months in the program: randomized to two maintenance conditions: (1) a program of weekly lay-peer facilitated meetings (*n* = 80) or (2) four meetings over 18 months with project staff to complete a personalized computer-assisted program (*n* = 80). This personalized support condition was designed to improve the use of social and environmental resources for healthy lifestyle changes. **Control group (*n* = 116):** Usual care.	Dietitian Physiotherapists Stress management instructor Professional and nonprofessional support group facilitator	12 mont-hs	Food Frequency Questionnaire[58] CHAMPS Activities Questionnaire for Older Adults[59] Self-monitoring form for stress management designed for this study. Balanced Inventory of Desirable Responding[60] The Brief Chronic Illness Resources Survey[61] The Diabetes Problem-Solving Interview[62] Confidence in Overcoming Challenges to Self-Care[63] The Sallis Self-Efficacy Scale for Diet and Exercise Behavior[64] The Center for Epidemiologic Studies Depression Scale[65] The Perceived Stress Scale[66] The Diabetes Distress Scale[67] Age Weight Waist-to-hip ratio BMI Smoking status Medical treatments, diabetes-related complications, number of comorbidities income, education level, lifestyle.	*Analysis experimental versus control groups* **Energy expenditure from PA** **Problem-solving** **Self-efficacy for diet and exercise**	NA NA NA
Gallè et al.[37] Italy	No	*N* = 130 (81 before/after) T2D diagnosed for at least 1 year, inactive. Without major complications, no contraindications to PA.	**Motivational program:** Group meetings twice a month, focusing on the benefits of diet and PA, suggestions for home and outdoor training methods, analysis of barriers, and problem-solving in diabetes management.	Psychologists Qualified nutritionists Exercise professionals with expertise in adapted PA	9 months	Study-specific questionnaire consisting of three parts: health perception, health behavior, and beliefs and barriers to activity The Short Form Health Survey 12[68]	*Analysis before vs after intervention* **HbA1C** **Weight** **Perception of health**	NA NA NA NA NA NA NA

(Continues)

TABLE 1 (Continued)

References	Randomization	Sample size/population	Description of the intervention	Type of stakeholder	Time	Scales/measures	Outcomes	Effect size
		Overweight or obese, between 50 and 70 years old, living in a community.	**Nutritional program:** Quarterly group meetings, highlighting the benefits of the Mediterranean diet, healthy food choices, adequate daily meal distribution in diabetes control, and role of diet in diabetes control. Details on prevention and management of hypoglycemic. **PA program:** Group sessions of 1 h, twice a week, nonconsecutive. Aerobic, moderate to vigorous resistance exercise. Interventions tailored to activity level, motivation, and self-efficacy.			HbA1c Weight	**Quality of life** **Health behaviors** **Physical fitness** Perception of physical barriers	

Note: Bold indicates significance.

Abbreviation: BMI, body mass index; BPN, basic psychological need; HbA1c, glycated hemoglobin; HEELP, Healthy Eating and Exercise Lifestyle Program; PA, physical activity; NA, not available; T2D, type 2 diabetes.

amount of PA performed. These measurements, different from those of the previous study, show differences between the experimental and control groups. Physical fitness is significantly different between the two groups. All physical measures were improved in the experimental group, with the exception of flexibility. The control group also showed improvements but only in upper body strength and agility. Regarding physiological measures, both groups significantly improved BMI. The experimental group also improved their HbA1c level and waist circumference although this change was not considered significant. Finally, both groups improved the amount of PA performed, with a significantly greater improvement in the experimental group.

In the fifth study,[33] an 8-week supervised PA intervention offered progressive support for independent practice through a logbook and four group workshops focusing on self-regulation and self-efficacy. The aim of this study was to test the effectiveness of a self-regulation and self-efficacy intervention in increasing PA in people with T2D. One hundred and sixteen people were randomized to the PA group ($n = 58$) and the online course control group ($n = 58$). The latter group could follow online courses concerning diabetes and health. Self-regulation, self-efficacy, the amount of PA, and anthropometric and medical measures were collected. The analysis of the data showed improvements in the postintervention period that were difficult to sustain over time. The level of PA improved after the program as well as at 4 months in the experimental group whose members doubled the amount of time they spent doing moderate to intense PA at the second month. Although this was not maintained at 6 months, the results were still better than those of the control group. The three types of self-efficacy measured (i.e., amount of walking, capacity to face obstacles, and engage in exercise) showed greater improvement in the experimental group. These increases were present mainly during the intervention and tended to decrease afterward. Links between self-regulation, self-efficacy, and PA were established, while self-regulation and self-efficacy were associated with PA after the intervention. Four months after the intervention, only self-regulation was correlated with PA.

The HEELP (Healthy Eating and Exercise Lifestyle) weight loss program was offered to 83 people.[31] To test this 16-week weight reduction intervention, measurements were compared to those of a “waiting list” group ($n = 65$). In total, this study included 148 people with a BMI between 27 and 39 kg/m^2 who had coronary heart disease and/or T2D ($n = 74$). The HEELP program includes a minimum of two 60-min sessions of adapted PA supervised by a sports physiotherapist. Participants were provided with a pedometer to encourage them to carry out PA independently. In addition, four information and support sessions were offered on weight and health, behavior change, problem-solving, and self-management. A notebook was distributed to each person to provide encouragement to problem-solving, motivation, and a sense of control. The intervention aimed to increase self-efficacy in relation to weight reduction. The data collection consisted of physiological, medical, and sociodemographic measures. It was complemented by a fitness test, an interview to assess the amount of PA, and a questionnaire on

self-efficacy and weight loss. While anthropometric and PA measures improved significantly in the HEELP group, there were no significant differences between the two groups for self-efficacy in relation to weight loss. The authors showed a predictive effect of program type on weight change. Furthermore, for the HEELP group, a significant increase in self-efficacy for weight loss *predicted* weight loss.

The last study[36] examines the effects of an intervention aimed at reducing risk factors for coronary heart disease over the long term in postmenopausal women with T2D. Two hundred and seventy-nine women were randomized into two groups including a control group ($n = 116$). The intervention group ($n = 163$) set personal lifestyle change goals at the beginning of the program. The intervention started with a two-and-a-half-day nonresidential retreat. Then, for the first 6 months, participants met for a half-day per week, which included an hour for meals, 1 h of PA, 1 h of stress management, and 1 h of support group. Facilitators at all times encouraged participants to increase PA progressively and to use motivational techniques (i.e., make use of challenges, self-monitoring, or group and individual rewards). Subsequently, the intervention group was randomly split into two maintenance groups. One consisted of weekly meetings with lay peers ($n = 80$). The other comprised four meetings over 18 months with professionals, convened to complete a personalized computer-based program ($n = 80$). Behavioral, psychosocial, demographic, anthropometric, and medical data were collected at various assessment times. In addition to positive results obtained in relation to diet, stress management, and social resources, the intervention had a positive and significantly enhanced effect on the amount of PA, quality of problem-solving, confidence in overcoming challenges, and self-efficacy for diet and exercise.

3.3 | Synthesis of results

The purpose of this literature review was to synthesize the results of PA interventions based on motivational levers for people with T2D, which resulted in the selection of seven studies. In essence, the results reveal several effects of the interventions (see Figure 2). Overall, the studies included in this review showed significant improvements in PA as a result of the proposed interventions. When randomized, the improvements were significantly greater in the experimental groups as compared to the control groups.[32–34,36]

Anthropometric measures (i.e., weight, height, BMI, and waist circumference) also improved[31,34,35,37] as did BMI in both groups, although in one case waist circumference decreased significantly only in the experimental group.[35] The results showed significant differences between the experimental and control groups.[31] Only one study[32] showed no significant improvement in weight measurement. However, in this instance, mean weight in the experimental group decreased, while in the control group it slightly increased.

HbA1c was assessed in three studies.[34,35,37] This measure systematically indicated a significant improvement after the interventions.

Studies that included motivational interventions identified significant improvements using a variety of measures. Indeed, in relation to the satisfaction of BPN, both perceived competence in PA and autonomous motivation were improved.[32] The effect of the intervention on motivation was found to persist 2 months after the intervention,[33] while several direct or indirect links with other variables were also established, notably those between motivation and variables such as health, vitality, behavior, and perceived competence in PA.[32,33] Need satisfaction was also strongly correlated with autonomy support.[32]

Three randomized studies examined measures of self-efficacy.[31,33,36] In one of the studies,[31] self-efficacy in relation to weight loss did not significantly differ in two of the groups, while in another self-efficacy in relation to dieting did significantly differ.[36] Self-efficacy in relation to walking, to obstacles, and to exercise were all significantly improved when compared to the control group.[33,36]

In their analyses, some studies reported both levers and barriers to participation as well as predictors of drop-out. Contrary to what one might think, group PA does not seem to be a major lever for participating in a supervised program.[34] However, the subjects interviewed felt that the availability and advice of professionals provided an important incentive to individual PA.[31] They also

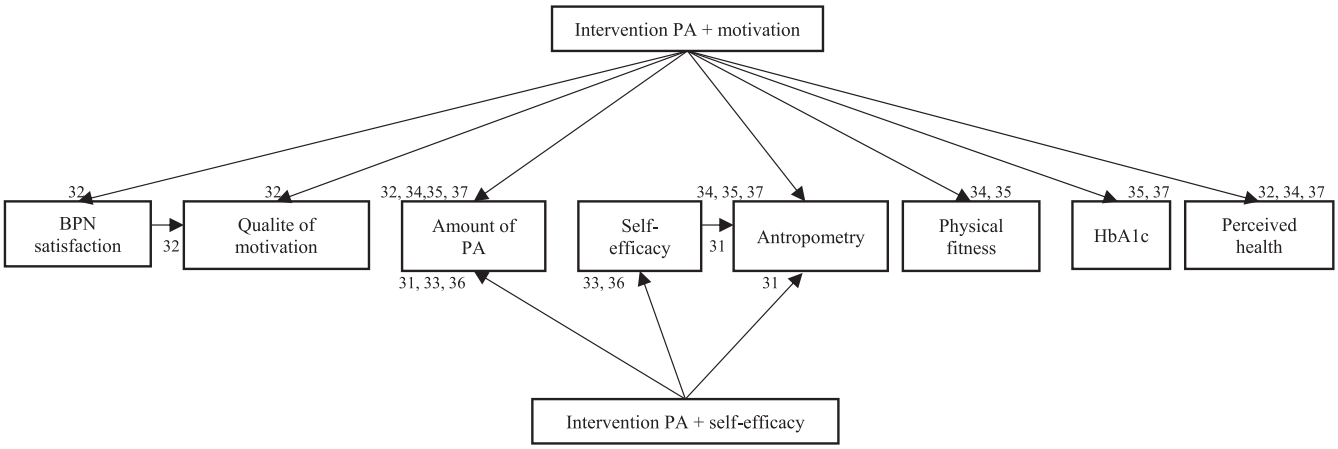

FIGURE 2 Results synthesis. Effect of intervention and link between variables. BPN, basic psychological need; HbA1c, glycated hemoglobin; PA, physical activity; NA, not available.

suggested that participation was favored by the high level of autonomy support provided by the professionals,[32] which in turn encouraged autonomous motivation and the satisfaction of BPN.[34]

4 | DISCUSSION

4.1 | Summary of evidence levels

1. *PA and anthropometric measurements*

Although the methodological elements are disparate, this review shows that interventions combining PA with other approaches focused on motivational levers, encourage T2D patients to adopt a more active lifestyle. Measurement of PA, anthropometric and diabetes-specific parameters, was common to all studies. Whether assessed in terms of a self-reported or an objective amount of exercise, or in terms of ability as measured by fitness testing, PA was positively impacted by the different interventions. These improvements were in general significantly greater than those observed in control groups when data were available. These findings are also applicable to anthropometric (i.e., weight, BMI, and waist circumference) and biological (i.e., HbA1c) measures.

2. *Psychological variables*

a. Motivation and self-determination theory

Assessments of psychological variables, present in the majority of studies, were more diversified. Motivation in the broad sense, regardless of the way it was assessed (i.e., autonomous motivation, satisfaction of BPN, or of perceived skills), was improved by the various interventions, as was perceived health. Furthermore, in several studies,[32,33] various direct and indirect links—established via PA performance and the satisfaction of BPN—have been demonstrated between motivation and other variables such as health, vitality, behavior, perceived competence, and PA. In addition to these links, there was also that between self-efficacy and PA.[33]

b. Self-efficacy

Self-efficacy in relation to walking, exercise, and obstacles was significantly improved in the experimental groups when compared to the control groups. However, only one study[36] found a significant difference between the two groups in self-efficacy in relation to weight loss and dieting. There are several reasons for this, including the number of subjects and therefore the statistical power of the tests (e.g., 148[31] vs. 279[36]). In addition, the questionnaires used to evaluate self-efficacy were different. In the first study, the authors used a specific questionnaire on self-efficacy related to weight loss.[38] In the second, the questionnaire used assessed self-efficacy related to diet and exercise behavior.[64]

4.2 | Limitations

The first limitation—and an important aspect of the results in this review—is the small number of studies selected. Indeed, despite scientific evidence of a strong link between motivational levers (i.e., motivation and self-efficacy), health, and PA, only seven studies met the inclusion criteria of our review (i.e., T2D subjects and interventions that combined PA and motivational levers).

The number of subjects included varied widely (from 108[32] to 1156 subjects[34]). The profile of the subjects also varied from one study to another. In all the studies, diabetes was not the only selection criterion; it was always associated with either coronary heart disease, dyslipidemia, hypertension, overweight and/or obesity, metabolic syndrome, or menopause. We can assume that each pathology associated with diabetes could, in its own way, influence the outcome of interventions.

In addition, the various measures and questionnaires used and the diversity of intervention modalities made it difficult to synthesize the results. Measures aiming at quantifying PA were predominantly subjective (i.e., self-reported questionnaires). Only one study proposed the use of an accelerometer to measure the objective quantity of PA practiced.[38] The literature demonstrates the relevance of using the number of daily steps as an evaluator of sedentary behavior.[69] The different studies proposed various measures for self-efficacy (e.g., walking, exercise, obstacles, weight, and diet). With regard to motivation, the reference theories in the included studies were not homogeneous. Motivation could be assessed through autonomy support, satisfaction of BPN, perceived competence, or types of motivation.

The modalities of interventions also varied; for instance, the number of sessions per week (from 1 to 3 sessions), the number of ancillary interventions (from 0 to 21), and the duration of the intervention (from 8 weeks to 12 months).

Furthermore, the studies did not propose any evaluation at a temporal distance from the program, that is, with regard to the sustainability of the effects of the interventions. It should be noted that most of the included studies focus on motivation and few on self-efficacy. A theoretical approach combining motivation and self-efficacy was never proposed.

4.3 | Perspectives

A systemic approach across the different concepts (motivation, the theory of hope, and self-efficacy) would give a clearer idea of how people affected by T2D feel about engaging in PA. Such an approach would make it possible to combine different levers to propose improved modalities better adapted to patients.

In particular, the hierarchical model of intrinsic and extrinsic* motivation might be appropriate because an individual's motivation is not only general (i.e., a personality trait) but also relative to a given situation or context.[70] The theory of hope, on the other hand, is a positive state based on an interaction between goal-oriented energy and motivation (i.e., a motivational component), as well as the different ways of achieving them (i.e., an operant component).[71]

This theory is part of the indirect conception of optimism[72] and is defined as a positive projection toward the future. Its main interest, apart from the prism of analysis it offers, lies in the intervention methods it can suggest, both in terms of defining a PA program, in other words, the goals and the meaning they have for the person (e.g., pleasure vs. health), and the means it will be possible to implement (e.g., number of sequences in the week, type of activity, intensity, duration). Hope offers an interesting prism for analyzing behaviors, especially when the person is no longer able to project themselves positively into the future. It is therefore possible to act in a general way by supporting the hope of individuals, by setting clear goals in the tasks, by offering them diversified solutions, and by supporting autonomous motivation (favoring pleasure goals, linked to intrinsic motivation, rather than only linked to health). Another option is the personalization of the intervention on hope through determination of personal goals, as well as individualized paths to reach them, while taking into account the intrinsic motivation of each individual.

5 | CONCLUSION

This review highlights the scarcity of interventions offering innovative PA support combining both variables of interest and interventions dedicated to people with T2D. However, in view of the results of the included studies, it would seem that interventions combining group adapted PA practice with an intervention based on the quality of motivation, the satisfaction of BPNs, or on self-efficacy could induce an increase in the amount of PA practice and perseverance. This review therefore highlights a crucial element in the management of people with T2D. The combination of intervention on the strong levers of persistence and PA management reinforces the already-known benefits of PA for people with T2D.

Moreover, none of the proposed interventions are based on the theory of hope, despite its pertinence to different fields[†] (i.e., health, education, or sport).[71]

Indeed, the theory of hope provides a means to study both the role of goals and the impact of an intervention on an individual (e.g., pleasure vs. health) while also suggesting possible modalities (e.g., number of sequences in the week, type of activity, intensity or duration). Links are established between levels of hope, motivation, and self-efficacy.[75] A high level of hope promotes motivation to overcome an obstacle while simultaneously aiding in the search for appropriate means.[71,76] Moreover, hope predicts, in its entirety but also through the unique motivational component, a unique independent variance in self-efficacy. Finally, it also seems relevant to link operant and motivational components to the goals of hope theory.

Complementing this review with other contributions,[71] to the theory of hope in health, seems a promising path to follow to develop future research and study systemic interventions that combine PA with considerations such as motivation, self-efficacy, and the theory of hope.

AUTHOR CONTRIBUTIONS

Élise Maudet-Coulomb: Conceptualization; data curation; formal analysis; investigation; methodology; project administration; resources; visualization; writing—original draft; writing—review and editing. **Charles Martin-Krumm**: Conceptualization; methodology; project administration; supervision; validation; writing—original draft; writing—review and editing. **Cyril Tarquinio**: Writing—review and editing. **Jean-Christophe Mino**: Conceptualization; funding acquisition; methodology; project administration; supervision; validation; writing—original draft; writing—review and editing.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

TRANSPARENCY STATEMENT

The lead author Élise Maudet-Coulomb affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

ORCID

Élise Maudet-Coulomb http://orcid.org/0000-0001-9232-2055

ENDNOTES

* Motivation varies from person to person. There are three types of motivation: intrinsic motivation (e.g., doing PA for pleasure), extrinsic motivation (e.g., doing PA because the doctor said it was better for your health), and amotivation (e.g., not wanting to do PA).

† A review of the literature on interventions using the theory of hope in the fields of health, school, and sport was carried out.[73] Very few studies have been identified in the field of sport[74] (and these mainly deal with improving performance) and no intervention has been carried out in the field of PA for health.

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