Cognitive Determinants of Physical Activity and Their Inter-relationships with Mental Distress and Diabetes Self-care in Patients with Type 2 Diabetes Mellitus

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Abstract of thesis entitled:

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Background: Diabetes is an increasing problem in Hong Kong. Physical activity is an integral part of diabetes care but received surprisingly few attention locally. This study is the first study with focus on physical activity in Type 2 diabetes in Hong Kong.

Methods: For this cross-sectional study, 576 patients were recruited from two specialized diabetes clinics in Hong Kong for telephone interview. The interview included measures of physical activity (by IPAQ), mental distress (by DASS21), diabetes self-care (by SDSCA), self-care self-efficacy (by DES), exercise efficacy, attitude and subjective norm towards exercise, time-spent on exercise, instrumental social support, and various indicators of diabetes control (HbA1c, blood pressure, LDL-cholesterol). Regression models were fitted to identify determinants of physical activity, mental distress, and diabetes self-care. Structural equation modeling was used to model the inter-relationships between the variables.

Results: About half of the patients did not meet international guidelines of physical activity for diabetes patients. Exercise efficacy and attitudes towards exercise are the two dominant factors that predict physical activity level and exhibit significant difference between key stages of change. Level of mental distress was very low and did not correlate with physical activity or diabetes self-care.

Conclusion: There is a need to implement physical activity programs for the diabetes patients in Hong Kong. Stage-matched intervention for increasing physical activity level should be introduced into the current diabetes management routine.

糖尿病於香港爲禍日深。運動雖爲控制糖尿病之一大法門，惟目前本地對糖尿病患者運動之研究有限。有見及此，本研究針對此課題作較深入的探討。本橫切性研究從於香港參加糖尿病併發症檢測計劃之乙形糖尿病患者中抽樣五百七十六名並進行電話訪問。訪問以結構性問卷爲基，對參加者收集包括運動習慣及效驗「efficacy」、精神健康、自我照料之情況及效驗、對運動之態度及客觀軌範、社會支援、糖尿病各項臨床指標、等。以回歸分析及結構方程模形找出影響運動量之因子。結果指出，近半受訪者運動量低於國際準則。另運動效驗及對運動之態度對糖尿病患者之運動量影響深遠。如以其爲運動促進項目骨幹並針對參加者之改變階段「stages of change」進行調整，更可事半功倍。

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Chapter 1

Introduction and literature review

1.1 Introduction

Two hundred and forty six million people are diagnosed with diabetes around the world.[1] The International Diabetes Federation (IDF) estimated that the numbers is going to raise to 380 million by the Year 2025.[1] Close to four million people between 20–79 years of age may die from diabetes and other related diseases in 2010 alone, which accounts for 6.8% of all-cause mortality around the world.[2]

Contrary to popular belief, diabetes is not a "disease of the rich". In 2007, the countries with the highest number of people with diabetes are India (40.9 million), China (39.8 million), United States of America (19.2 million), Russia (9.6 million) and Germany (7.4 million).[1] India and China made the top of the list by having a large population size. The actual prevalence of diabetes in India and China might not be very high, but the actual number of people that are affect, and the costs associated with the treatment of those people are significant problems for those countries. If one were to look at prevalence data alone, the data will surprise them even more. The countries with highest diabetes prevalence in 2007 are Nauru (30.7 percent), United Arab Emirates (19.5 percent), Saudi Arabia (16.7 percent), Bahrain (15.2 percent), and Kuwait (14.4 percent). The IDF estimated that the developing countries will have the largest increase in diabetes prevalence by 2025.

In Hong Kong, studies to study the population prevalence of diabetes were conducted in the 1990s. A study in 1990 found the age-adjusted prevalence of diabetes to be 7.7% in a workforce sample.[3] A population-based study conducted in 1995 found a 8.5% age-adjusted prevalence.[4] A recent population survey by the Hong Kong Government found diabetes prevalence to be about 3.8%.[5] However, those data only counted patients who were already diagnosed with diabetes. Studies have found that only about 30% of diabetes subjects were previously diagnosed.[3,4] Another study by Ko et al.[6] found 2.8% (age-standardized) of asymptomatic subjects recruited from the community had undiagnosed diabetes. Therefore, the prevalence needs to take those into account and the true prevalence can potentially be anywhere from 6.6–12.7%. The International Diabetes Federation estimated that by 2030, 13.7% of the population in Hong Kong will be living with diabetes.[2]

Currently, there is no known cure for diabetes. Patients must take care of their own conditions on a daily basis. Therefore, the quality of self-care directly impacts the prognosis of diabetes. However, proper self-care often involves drastic change in lifestyle that include switching to a healthy diet, as well as increasing physical activity level.

The American Diabetes Association (ADA) recommends that diabetes patients should at least engage in 150 minutes per week of moderate-, or above, intensity aerobic physical activity.[7] However, the activities should be carried out over a few days because the glucose-lowering effect of physical activity was found to last for less than 72 hours.[8] Therefore, the American College of Sports Medicine (ACSM) recommends that exercise should be carried out on at least three to five days per week, with at least 30 minutes per day.[8] It has been shown that exercising regularly can lower HbA1c level of type 2 diabetes patients, and the magnitude of the effect increases with the intensity of the exercise.[9,10] Aside from lowering blood glucose level, physical activity also results in other benefits such as reducing the risk of having cardiovascular diseases, weight loss, and enhancing physiological functions.[8,11]

International studies found that diabetes patients were twice as likely than others to suffer from depression.[12] Minor and major depression respectively increases mortality rate of diabetes patients by 1.67 times and 2.3 times, as compared with that of non-depressed diabetes patients.[13] Depression is associated with suboptimal control of clinical indicators[14] and a higher prevalence of diabetes complications.[15] In Hong Kong, the prevalence of depression among people who were above 60 years was found to be 11.0% for male and 14.5% for female.[16] The same researchers reported that 26% of diabetes patients of age 60 years old or above have elevated symptoms of depression.[17] However, no mental health study includes local diabetes patients younger than 60 years old. Elevated symptoms of anxiety and stress were also found in the diabetes patient population in Hong Kong.

Lack of physical activity is related to depressive symptoms.[18] Meta-analysis studies found that participating in exercise can decrease the level of depression.[19,20] There are also evidence for using exercise to relieve anxiety,[21] and stress.[22]

Meta-analysis showed that dietary control can cause modest weight-loss[23] and losing weight can decrease insulin resistance among overweight and obese individuals.[24] Foot care is another important aspect of diabetes self-care. Self-monitoring of blood glucose (SMBG) is recommended for patients who need insulin therapy.[7] It is also an useful indicator for glycemic control.

Social support plays an important role in diabetes management.[25,26] Support from friends and family members were important facilitators of physical activity.[27–29] There are four types of social support—emotional, informational, appraisal, and instrumental.[30] Instrumental social support, the provision of tangible aids and services, was found to be most important in preventing depression in the elderly population of Hong Kong.[31]

Under the Theory of Reasoned Action, attitudes towards exercise and subjective norm are important predictors of exercise.[32] Attitudes refers to patients' perceived effects of exercise and how those effects were evaluated. Subjective norm refers to patients' perception on what other people thought about exercise and how they value those opinions.[30] Exercise efficacy was found to correlate with physical activity level.[33]

Self-care self-efficacy, or the perceived ability to engage in various self-care activities under different situations, was associated with diabetes self-care compliance in various populations.[34–38] Enhancement of psychosocial self-efficacy through a patient empowerment programme improved the control of blood glucose level among diabetes patients.[39]

Despite physical activity being a major component of diabetes self-care, there is no local study focusing on physical activity among diabetes patients in Hong Kong. This study has the following objectives:

1. To measure the physical activity level, preference on different types of exercise, symptoms of depression and various self-care activities in a clinical sample of type 2 diabetes patients.

2. The associations between various factors and level of physical activity were investigated.

3. Factors in association with level of mental health (depression, anxiety, and stress) and self-care were identified.

4. The inter-relationships among physical activity level, exercise efficacy, level of

self-care, self-care self-efficacy, level of depression and social support were examined by fitting a structural equation model (SEM).

5. Application of behavioral change theories to describe patients' pattern of physical activity participation to generate recommendations for planning of future interventions.

1.2 Literature Review

1.2.1 Treatment strategies for diabetes mellitus

There are three primary indicators for good diabetes control: glycated hemoglobin (HbA1c) of $< 7\%$, blood pressure below 130/80 mmHg, and low-density lipoprotein (LDL) cholesterol at $< 2.6\ \mathrm{mmol\,l^{-1}}$.[7] It has been established that managing HbA1c level can reduce microvascular and neuropathic complications.[40–42] Holman et. al[43] demonstrated that intensive therapy to lower blood glucose level for newly diagnosed diabetes patients were beneficial event after 10 years. About 20–60% of people with diabetes also suffer from hypertension, which is a major risk factor for cardiovasvular diseases such as myocardial infarction, stroke, retinopathy, and nephropathy.[44] A review by Arauz-Pacheco and others showed that treatment of hypertension in diabetes patients can reduce the risk of those diseases.[44]

Pharmacological treatment

There are many classes of antidiabetic drugs for treatment of diabetes with different mechanisms of action. The main classes include those that stimulate insulin secretion by the pancreatic β-cells (sulphonylureas and rapid-acting secretagogues), or those that reduce glucose production by the liver (biguanides). α-glucosidase inhibitors delay digestion of food and reduce absorption of carbohydrate in the intestine. Thiazolidinediones increase insulin action at the adipose tissue, muscle, and liver.[45]

Among the many antidiabetic drugs, metformin (a biguanide) is recommended by the American Diabetes Association and the European Association for the Study of Diabetes as the first-line drug at initial analysis.[46] Metformin was developed in the 1950s, and it is the only biguanide available in the UK and the US.[47] Metformin can reduce HbA1c level by about 1–2% when prescribed alone, which is among the best among the main classes of antidiabetic drugs. Other advantages of metformin include a relatively cheap price and less side-effects compared with other antidiabetic drugs.[46]

Despite the benefit for lowering blood glucose in diabetes patients, pharmacological treatments are not without their risks. There is a lack of evidence on long-term safety of many of the antidiabetic drugs.[46] Recent evidence emerged from The Action to Control Cardiovascular Risk in Diabetes (ACCORD) study. The ACCORD study studied 10,251 patients with high CVD risks and compared the effect of intensive glycemic control (HbA1c target $< 6.0\%$) to standard glycemic control (HbA1c target 7.0–7.9%).[48] The lower HbA1c target of the intensive control group was achieved by using antidiabetic drugs from more classes of drugs. That study was terminated after 3.5 years because of increased mortality in the intensive control group.

Because of the potential problem with using pharmacological agents alone to control blood glucose level, the current consensus is to include lifestyle modification as part of diabetes management.[46] Patient with minor level of hypertension (systolic blood pressure of 130–139 mmHg or diastolic blood pressure of 80–89 mmHg are recommended to use lifestyle modification alone without the need of pharmacological therapy. Lifestyle therapy was also recommended for patients with dyslipidemia of all cases.[7]

Lifestyle modification

Fujinuma et al. showed that 16.1% of patients who required insulin injection and 25.9% of patients who were taking oral hypoglycemic agents could switch to diet therapy alone.[49] None of the patients who did not exercise were able to switch to diet therapy alone. Moreover, for patients who still needed medication, the dosage were reduced. Apart from the benefit of getting off a painful treatment (insulin injection). The reduction in medication can translate into substantial saving to the patients, as well as for the public health-care system.

It has long been recognized that body composition, as measured by BMI, is associated with diabetes.[50] Body weight is the result of the balance between energy intake and energy expenditure. When energy intake is greater than energy expenditure, the excess energy is stored inside the body as glucagon or fat. The effect of body fat on insulin resistance is more profound in people with central obesity.[51] Although the exact mechanism of how central obesity causes insulin resistance remains unknown.[52] It is logical to deduce that weight control would be an effective method for diabetes management.

In order to control weight within the "normal" range, one can approach the problem from two different angles. First approach is to reduce energy intake. Reduction in caloric intake is very effective in controlling blood glucose level. A drastic approach to reduce caloric intake is to undergo gastric surgery.[53–55] But dietary control is also an effective strategy to control weight (Reviewed by American Diabetes Association[7]).

The second approach, which works in tandem with reducing energy intake, is to increase energy expenditure. That can be achieved by increasing physical activity level. Since physical activity is beneficial not only for managing diabetes itself, but it can also reduce a wide-range of diabetes-related comorbidities, as well as improve general quality of life. Therefore, it is very cost-effective to adopt this treatment. Since diabetes is incurable, the cost of life-long medication could become prohibitive for patients, especially those with low income. Therefore, increasing physical activity can be an alternative to maintain stable glycemic control for diabetes patients.

1.2.2 Physical activity for diabetes management

Definition of Physical Activity

The World Health Organization defines physical activity as "any bodily movement produced by skeletal muscles that requires energy expenditure".[56] The Surgeon General of the United States wrote that physical activity is "bodily movement produced by the contraction of skeletal muscle that increases energy expenditure above the basal level".[57] According to those definitions, any movement produced by the body is classified as physical activity. Although often used interchangeably, exercise is a specific subset of physical activity that is "planned, structured, repetitive, and purposive in the sense that improvement or maintenance of one or more components of physical fitness is the objective".[58]

Physical activity recommendations for diabetes patient

Different organizations offer slightly different recommendations about how much exercise is needed for diabetics.

The American Diabetes Association (ADA) recommended that diabetics should do at least 150 minutes per week of moderate-intensity aerobic physical activity.[59] Their recommendation is based on a meta-analysis by Boulé et al.[9], which found the average number of physical activity sessions per week to be 3.3, at 53 minutes per session, in the reviewed studies.

Studies have found that physical activities should be carried out over a few days because the glucose-lowering effect of physical activity was found to last for less than 72 hours.[8] The Canadian Diabetes Association also recommends 150 minutes per week of moderate- to vigorous-intensity aerobic exercise.[60] But they went a step further by recommending that diabetics should not have two consecutive days without exercise. The International Diabetes Federation offered a similar recommendation: "30–45 minutes of physical activity on 3–5 days per week, or an accumulation of 150 minutes of physical activity per week".[61] The American College of Sports Medicine (ACSM) recommends that exercise should be carried out on at least three to five days per week, with at least 30 minutes per day.[8]

All of the aforementioned organizations recommended physical activity of at least moderate-intensity. However, there are other organizations such as Diabetes UK recommended 30 minutes of any physical activity, which includes walking, on at least five days per week.[62] Diabetes Australia also recommends diabetes patients to engage in any physical activity for about 30 minutes every day".[63] However, walking might not be enough to achieve improvement in glycemic control.[64] Those organizations probably just put walking in their recommendation so that people who are not used to more vigorous forms of exercise can start walking more to kick-start their lifestyle change. Therefore, for the most part, this thesis concentrated on physical activities of moderate or vigorous intensities.

Benefits of physical activity for diabetes patients

Physical activity is gaining increasing attention in recent years because of the increasingly sedentary lifestyle of people around the world.[65]

Physical activity showed protective effect against all-cause mortality.[11] It is also protective against diseases such as cardiovascular diseases[11], pulmonary diseases, neuromuscular diseases, immunological and hematological diseases, orthopedic diseases, and psychological conditions.[66] Numerous studies[67–76] showed that physical activity contributes to the prevention of type 2 diabetes.

Aside from contributing to a sedentary lifestyle, technology also brought another host of problems to the modern world. The technologies that brought the world closer together also brought with them an increase in mental health problems. The stress caused by the fast pace of living in the modern day world often increase depression and anxiety levels. The World Health Organization estimated that by 2030, depression will become the second leading cause of loss of disability adjusted life years (DALYs).[77]

The increased prevalence of depression in diabetes patients was noticed for years[78,79] Anderson et al. performed a meta-analysis in 2001 and found that diabetes patients are twice as likely to have depression when compared to those who were non-diabetic.[12]. They found that prevalence of depression in diabetes patients was dependent on the type of study (controlled versus un-controlled) and method of diagnosis (self-report versus interview). Depression was found to be present in at least 20% of diabetes patients in controlled studies, and up to 32% in uncontrolled studies.[12] In a more recent study, Egede et al.[80] also found that diabetes patients were more likely to be depressed. Another study in Australia[81] found depression in 24% of diabetes patients and 17% of non-diabetes.

In Hong Kong, the prevalence of depression among people who are above 60 years was found to be 11.0% for male and 14.5% for female.[16] The same researchers found 26% of diabetes patients, age 60 or above, to have elevated symptoms of depression.[17] However, there is no study that look at diabetes patients of all ages. A recent study of the diabetes population in Hong Kong also found that the diabetes patients exhibited multiple symptoms of depression and anxiety.[82] They were also found to have elevated level of treatment-related stress. Exercise as a treatment for depression, anxiety, and other mood disorders had long been recognized in the literature.[83] However, the integration of exercise into treatment of mental health problems was not a wide-spread practice, both in Hong Kong[82] and other countries.[84]

One of the possible reasons for the higher prevalence of complications might be because of poor adherence to exercise, diet and medication found in a number of studies of depressed diabetes patients.[85–89] Health care use and expenditures were reported to be higher for diabetes patients who are depressed.[80,90] Depression was also found to adversely affect quality of life for diabetes patients.[81,91] But one must keep in mind that what is true for one population may not be true for another. Kaholokula et al.[92] observed a ethnic difference in the relationship between depression and quality of life.

Sociodemogrpahic characteristics can affect prevalence of depression in diabetes. Females were more likely than male diabetes patients to be depressed.[12,93] Those with lower education were also more likely to be depressed.[93]

Diabetes complication can restrict movement ability of patients because of failing vision. A study by Benyamini and Lomranz[94] found that having to give up activity due to failing health is associated with higher depression symptoms.

Treating depression by itself might not be sufficient to control diabetes. Katon et al.[95] compared intervention group with depression treatment (medication or problem-solving treatment) to usual care group. At baseline, both groups had similar level of depression. By six months into the study, the intervention group were significantly less depressed than the usual care group. The difference persist until the end of the study at 12 months. However, HbA1c level of both study groups did not differ during the whole study. Similar results were observed by Georgiades et al.[96] They used cognitive behavioral therapy to treat depression in a group of diabetes patients and found reduction of depression was not association with HbA1c level. One possible reason for this finding is that treating depression might not translate into improvement of diabetes self-care. Lin et al.[97] found that depressed diabetes patients who underwent intensive depression treatment (medication, problem-solving treatment, or both) did no better than the control group on healthy diet, physical activity and smoking cessation.

Lack of physical activity was suggested as a risk factor for depressive symptoms.[18] North et al.[19] conducted a meta-analysis on 80 published studies and found that exercise was negatively correlated with level of depression. In another meta-analysis of effect of exercise on depression, Craft and Landers[20] once again established that those who exercised were less depressed than the those who did not exercise. There has been numerous reviews on the use of exercise to treat depression.[98,99] There are considerable evidence on the effectiveness of using exercise to reduce depressive symptoms. Aerobic exercise was found to reduce depression in elderly (age 60–75).[100] Exercise was found to be at least as good as, or even better than, medication for treatment of major depressive disorder.[101] Bäckman et al. studied they effect of physical activity on middle–old age former elite athletes and found a protective effect against depression.[102]

The association of physical activity/exercise with depression led researchers to study the use of exercise as an intervention in depression management. A review by Lawlor and Hopker[103] found that previous research into effectiveness of exercise to treat depression were plagued with quality issues. They concluded that there was not enough evidence to judge whether that was a valid approach. A more recent longitudinal study by Delahanty et al. found that depression at baseline is inversely associated with both baseline physical activity level as well as physical activity level at the end of their study (2–3 years).[33] Another 10-year cohort study by Harris et al.[104] also found higher level of physical activity to associate with reduced depression.

Existence of a dose-response relationship between physical activity and depression would be the best evidence. However, Dunn et al. failed to find very good evidence for such relationship in their review.[105] They found that higher level of physical activity did associate with lower symptoms of depression. But there was no randomized controlled trials to provide solid evidence for that relationship.

Leisure time physical activity were found to be inversely associated with depression.[33,86,102,106] Therefore, physical activity is potentially an inexpensive way to control diabetes. However, those studies failed to account for energy expenditure during travel and work. For many people, especially those who engage in manual labor, occupational energy expenditure is their major source of physical activity. The failure to take those other sources of energy expenditures into account when trying to establish an association between physical activity (not just exercise) and depression will fail to do it accurately.

Diabetes patients are more likely to have anxiety disorder.[107,108] The anxiety-reducing effect of exercise has been recognized for some time.[21] Altchiler and Motta compared the effects of aerobic and anaerobic exercise for anxiety reduction.[109] The aerobic group was asked to perform low-impact, large body movements continuously to induce increase in heart rate to about 70–85% of one's maximum heart rate. The anaerobic group was asked to perform calisthenics and stretching exercises for the same amount of time. They found that only aerobic exercise was able to reduce both state and trait anxiety.[109]

General anxiety disorder was found, by meta-analysis of clinical studies, to be presented in about 14% of diabetes patients from clinical samples.[110] The same review found elevated level of anxiety in up to 40% of the clinical diabetes population. Results from the Diabetes Prevention Program found that perceived anxiety is negatively correlated with physical activity participation.[33] Current physical activity recommendations for diabetes patients often state that it is necessary to engage in at least 30 minutes of physical activities per day, but the activities can be broken down into 10 minutes sessions to receive the same physiological benefits. However, a study by Osei-Tutu and Campagna found that walking continuously for $30\,\mathrm{min\,d^{-1}}$ was effective in reducing anxiety but walking 10 minutes for three times per day did not result in any significant reduction.[111]

When people are under stress, they released hormones such as adrenaline and cortisol as part of their "fight or flight" response. This causes stored energy to be released from storage into the blood stream in the form of glucose. However, when stress level decreases, diabetes patient are unable to efficiently store the excess glucose becaues of insulin deficiency or insulin resistance. This leads to prolonged elevation of glycemic level.[112] Participants who reported higher level of stress in the Diabetes Prevention Program were found to engage in less physical activity.[33] Norris et al. reported that habitual exercises had less stressful lives.[113] Another study found that the participating in physical activity alone is enough to moderate the effect of minor stress[22] Salmon suggested that exercising was able to increase people's resistance to stress through counterconditioning.[114] Under the counterconditioning theory, people who are exposed to stressful event during exercise also acquired some degree of resistance to other stressors. As a result, people who exercise are also less stressful.

Cognitive factors that affect physical activity participation

Despite the benefits of physical activity and exercise for diabetes patients. Uptake of this behavioral change is often quite low.[115,116] The traditional practice of providing information to the patients appears to be not an effective mean to motivate sedentary patients to be more physically active.[117] Psychological theories provide useful insights into factors that can be useful for intervention planners. This study drew on three popular theories for behavioral change—the Theory of Reasoned Action, the Social Cognitive Theory, and the Transtheoretical Model.

The Theory of Reasoned Action[118] (TRA) was employed to describe the determinants of physical activity among diabetes patients. Under the TRA, the likelihood of performing a specific action is determined by individual motivational factors. Attitude and subjective norm are the underlying factors that influence behavioral intention, which in turns determine actual behavior. Attitude towards a specific behavior was found to be a better predictor of that behavior than the target of said behavior.[119]. However, different behavior or different people can be motivated by different constructs. For example, subjective norm was found to be significant for breast cancer patients only and not for other types of cancer.[120,121] For exercise, it was found that attitude is a better predictor of intention to exercise than subjective norm.[122] Studies included in the review by Godin only included studies that were carried out in Western countries. The Western countries primarily value individualism over collectivism. Triandis suggested that behaviors of people in individualistic countries are primarily determined by attitudes, whereas those in collectivistic countries are dominated by norm.[123] The Chinese culture values family and social ties, and can be considered as a collectivistic culture. Therefore, the balance between the two TRA constructs could be different in a Chinese society. However, social culture in Hong Kong is more complicated because the traditional Chinese cultural values are mixed with Westernized culture because of the British colonization period.

The Social Cognitive Theory (SCT) formulated by Bandura emphasized the interaction between environment, person, and behavior.[124,125] Self-efficacy, the confidence to perform a particular activity, was one of the major constructs of the SCT. Self-efficacy has been found to be an important factor for a wide variety of behaviors, which include metabolic control, health related quality of life, problem solving, self-care compliance, dietary habits, insulin injection, monitoring of glycemic level, as well as exercise (see review by Allen[126]).

The Transtheoretical Model (TTM) introduced the concept of stages of change.[127] The TTM is the first major theory that incorporate the element of time into the process of behavioral change. While other theories of behavioral change usually consider change as either success or failure, the TTM treats change as a process that involves different stages of increasing readiness for change. There are five stages of change: those who did not intend to make change within the next six months belong to the precontemplation stage; when the intention to change within the next six months are formed, then such person belongs in the contemplation stage; preparation stage consists of people who are ready for immediate change within the next thirty days and has taken steps to facilitate the change; after the target behavioral change is achieved, it is considered to have reached the action stage; and finally if the change is maintained for more than six months, then they have reached the maintenance stage. There is also a sixth stage, the termination stage, with complete behavioral change and no chance of relapsing into the old habits. However, for exercise, reaching the termination stage is probably unrealistic. It was found that progressing forward through the stages of change to exercise is correlated with good diabetes management.[128]

Stage-matched intervention programs for exercise has met with some success on general populations.[129,130] A study of diabetes patients has shown that exercise counseling based on the TTM plus exercise information was more effective than exercise information alone for increasing physical activity level at both 6,[131] and 12 months.[132] Another study that compared stage-matched intervention with educational advice on exercise for Type 2 diabetes patients also found that intervention based on stage of change is more effective.[133] They employed different processes of change that matches specific stage of change to maximize the effect of intervention. It is theorized that mismatch of process of change and stage of change would result in reduced or even ineffective program.[127]

The processes of change can be broadly categorized into either the cognitive-affective processes and the behavioral processes.[134] The cognitive-affective processes include consciousness raising, self re-evaluation, dramatic relief, environmental re-evaluation, and social liberation. Consciousness raising is about increasing awareness of the cause and effect of a behavior; self re-evaluation deals with how a behavior affects oneself; dramatic relief utilises the motivational power of other people's experience; environmental re-evaluation is about the effect on a person's social environment for changing their behavior.

Behavioral processes include counterconditioning (either by using similar behaviors to reduce negative feeling towards the target behavior or by associating negative stimuli with the problematic behavior), stimulus control (reducing exposure to environmental temptations), reinforcement management (getting rewarded for making change), helping relationships (increase social support), and self-liberation (personal committment to change).

A meta-analysis by Rozen found that the importance of different processes of change differs for different behavior.[134] According to the TTM, the cognitive-affective processes should increae from precontemplation stage and peak around contemplation and preparation stage, while the behavioral processes should peak at the action or maintenance stage. However, Rosen found that use of the cognitive-affective processes continued to increase well into the action and maintenance stage for exercise adoption.[134]

In Hong Kong, the application of TTM in exercise research is limited to the undergraduate student population.[135] The current study is the first local study to investigate the level of readiness of diabetes patients to engage in exercise.

1.2.3 Diabetes self-care and associated factors

Management of diabetes is a life-long commitment. It can be daunting for people with newly diagnosed diabetes, as well as posing problems for long-time sufferers. Proper diabetes care require patients to maintain multiple self-care activities for the rest of their lives. Aside from increasing physical activity that was just covered in the previous section, other aspects of diabetes self-care that are also important include a healthy diet, proper foot care, and frequent self-monitoring of blood glucose.

Management of diabetes relies on cooperation of the patient. Traditional medical treatment involves doctors telling the patient what to do, and then the patient is expected to perform what is required of them. However, often time the patient lack the skill or mindset to adhere to the treatment. The concept of patient empowerment is gaining recognition as an important part of the puzzle for successful diabetes management. Patient empowerment is "helping patients discover and develop their inherent capacity to be responsible for their own lives and gain mastery over their diabetes".[136]

Diabetes patients themselves are responsible for managing their health. They decided what to eat for lunch, whether to go jogging in the evening, or to be vigilant about doing their blood glucose monitoring every day, etc.. Nobody, not their doctor, not their friends, and not even their family members or significant others, can force them to do the "right" things. The patients themselves are ultimately responsible for their own doings because they are the only one who are in complete control.

Doctors and nurses can tell the patients when to take their medicine; nutritionist can instruct the patients on a balanced diet, or to read the food labels; physical trainer may teach them exercises that are appropriate to them. These consist the knowledge part of diabetes care. Knowledge is important, but equally important is what diabetes patients do with all the knowledge that they just acquired. The patients themselves weight the pros and cons of each strategies for diabetes management, and decide which are worthwhile to them to do, and to what extent they are willing to comply with the recommended strategies.

The root of the empowerment approach is based on community psychology, adult education, and counseling psychology.[137] In contrast to the traditional paternalistic approach of medicine, the empowerment approach aims at enabling patients to gain more power over their treatment. Instead of telling the patients that they have to do this and avoid doing that, empowering the patients allow them to participate in their treatment process. The patients can be part of the decision process to decide what kind of medical treatment and self-management strategies that are easier for them to follow. This is in line with the recent move towards a more patient-centered care model.[138]

A number studies have tried to test the effect of social support on diabetes self-care. However, in the review by van Dam et al., the authors found that the number of controlled intervention studies in this area was surprisingly small.[26] And different groups tested different modes of social support, such as group visits to physician, peer group, internet peer group, spouse-oriented diabetes education, etc., without any concensus on a preferred method. Social support did show positive influence on a number of behaviors (including physical activity), psychosocial factors and quality of life, knowledge of diabetes, and to some extend, biomedical risk factors.[25,26] Aalto et al. found that when social support was not adequate, patients would experience a higher level of diabetes-related distress.[139]

For diabetes patients, level of depression was found to be associated with mortality. Katon et al.[13] found that diabetes patients who had minor depression was associated with 1.67 times mortality rate, and major depression was associated with a even higher mortality rate (2.30 times when compared with non-depressed patients). Depression was found to be associated with suboptimal control of clinical indicators[14] and a higher prevalence of diabetes complications.[15]. A higher prevalence of complications would then cause the patient to be even more depressed. Peyrot and Rubin[140] found that having more than two diabetes complications was associated with persistent depression. The rigorous requirements of diabetes self-care might also cause anxiety disorder.[141] A study by Peyrot et al. found that an anxious coping style was associated with poorer glycemic control.[142] In a local study, 43.8% of diabetes patients reported that the need to inject insulin made them more stressful.[82] The same study also found other stress-inducing factors included fear of diabetes-related complications such as retinopathy and stroke. Stress from non-diabetes related source can also affect diabetes self-care. It was reported that 55.7% of diabetes patients reported work-related stress negatively affected their diabetes control.[82]

1.3 Research goals

The study of using physical activity or exercise for diabetes management is not as well studied as using them for diabetes prevention. Drivers or inhibitors of physical activity or exercise participation needed to be identified for the local diabetes population. To that end, we wanted to test the following hypotheses in this study:

1. Exercise efficacy is positively correlated with physical activity

2. Subjective norm, instead of attitudes towards exercise, is the dominant Theory of Reasoned Action construct

3. Patients who are depressed, anxious, or stressful have lower level of physical activity

4. Patients who are depressed, anxious, or stressful do worse on diabetes self-care

5. Patients who performed better diabetes self-care (other than exercise) also have higher level of physical activity

6. Patients who had higher level of physical activity performed other tasks of diabetes self-care better

Chapter 2

Methodologies

2.1 Participant Recruitment

2.1.1 Setting

This study employed a cross-sectional design. Patients with Type 2 diabetes mellitus were recruited from two locations: The Prince of Wales Hospital and the Yao Chung Kit Diabetes Assessment Centre from March, 2008 to May, 2009. The Prince of Wales Hospital is a public hospital managed by the Hospital Authority of Hong Kong. The cost of care for Eligible Persons—those who have a valid Hong Kong Identity Card—are very affordable. General out-patient services only cost HK$30 per attendance.[143] The Prince of Wales Hospital is part of the New Territory East Cluster of the Hospital Authority. It provides health-care services to residents living in the districts of Shatin, Tai Po and North District. The diabetes team there provides comprehensive diabetes complication screening to patients with diabetes to help the patients and doctors to choose a best course of action to manage the diabetes. The assessment cost HK$150, which is fairly affordable.

The Yao Chung Kit Diabetes Assessment Centre[144] is a private specialized diabetes clinic. It also provides diabetes complication screening that is based on the same protocol that is used by the team at the Prince of Wales Hospital. The main difference between the Yao Chung Kit centre and the Prince of Wales Hospital is the catchment area. While the service at the Prince of Wales Hospital is only for those who live within the New Territory East Cluster. The Yao Chung Kit centre accepts referral from anywhere in Hong Kong. The other difference between the two services is the cost of service. Since the Yao Chung Kit centre is a private service, it charges HK$480 per assessment, which is three times the cost compared to service at the Prince of Wales.

2.1.2 Sample size planning

For sample size planning purpose, we assumed that 70% of the participants are physically inactive and 30% of those participants who were physically active have depressive symptoms. The smallest detectable odds ratio equals to 1.696 (power = 0.8, $\alpha = 0.05$). A sample size of 550 should be adequate for the purpose. nQuery Advisor version 4.0 was used for the sample size calculation.

As a rule of thumb, for structural equation models, 15 subjects are needed for each indicator variable. The proposed sample size of 550 is enough to support SEM models with 36 indicators.

2.1.3 Recruitment procedure

Patients who attended the complication screening sessions were individually briefed about the project and were invited to join the study. Patients who required the support of walking aids, such as crutches and wheelchair, were not invited to join the study because they were not fit for physical activity (n = 117). Trained interviewers called the consented participants to administer the questionnaires at a scheduled time. Appointments were made again if necessary. 59.8% (636 / 1063) of the eligible patients gave written consent and joined the study. 576 patients (54.2%) were successfully telephone-interviewed.

2.2 Instruments of Measurement

2.2.1 Physical activity level

The Chinese version of the International Physical Activity Questionnaire, short interview format (IPAQ-C),[145,146] was used to measure the level of physical activity in the last seven days. The IPAQ-C uses a relative measure of physical activity intensities.[147] Relative measures of physical activity intensities are determined by individuals' relative changes in heart rate and breathing rate during physical activity. Vigorous-intensity physical activities are defined as those that can cause the participant to breathe heavily and result in a substantial increase in heart rate. Moderate-intensity physical activities are those that can cause the breathing to be somewhat harder than normal and result in a noticeable quickening of heart beat. Walking at a leisurely pace, with no increase in breathing or heart rate, is considered below the moderate-intensity level.

It is a 7-item self-report questionnaire that measures the frequency (days per week) and duration (hours per day) of physical activities at different intensities (vigorous, moderate, or walking). The original English version has been validated in a dozen of countries.[148] The IPAQ-C has very good test-retest reliability for physical activity level at different intensities, as well as overall physical activity level, in a Chinese population (ICC = 0.81–0.89, $p < 0.001$).[145]

In addition, patients were also asked about the amount of time they spent on exercise of at least moderate-intensity level for each day during the past week (see Appendix A).

2.2.2 Energy expenditure from physical activity

The different quantity (frequency and duration) and quality (intensity) of physical activities make it difficult to compare one activity to another. A quantifiable measure that incorporates all those factors can be used for comparison. By using the intensity, frequency, and duration information gathered from the IPAQ, MET min $week^{-1}$ for each patient was calculated.

By definition, the metabolic rate during quiet sitting is 1 MET, which by convention is set to $3.5\,ml\,O^2\,kg^{-1}\,min^{-1}$ or $1.0\,kcal\,kg^{-1}\,hr^{-1}$.[149] This rate is called the Resting Metabolic Rate. MET is defined as the ratio of metabolic rate during an activity to the Resting Metabolic Rate. For example, sleeping is 0.9 MET and running at $16\,km\,h^{-1}$ costs 18 MET. By using MET, activities of different intensities can be quantified into a single unit of measurement. Combining MET with frequency (day per week) and duration (minute per day) data then we can obtain a single unit of measure for physical activity level—MET minutes per week (MET min $week^{-1}$).

MET min $week^{-1}$ is calculated according to the IPAQ Scoring Protocol.[150] The IPAQ-Short Form that was used in this study is able to differentiate different intensities (vigorous, moderate, walking) with the corresponding frequency and duration of performance, but it does not differentiate between individual physical activities. To get around this limitation, a single MET value was assigned to a particular physical activity intensity (8.0 MET for vigorous, 4.0 MET for moderate, 3.3 MET for walking). MET min $week^{-1}$ for activities at each intensity was then calculated using those values and the frequency and duration information. And then total physical activity level is calculated by adding up MET min $week^{-1}$ from different intensities.

2.2.3 Cut-off for determination of physical inactivity

The ADA and ACSM guidelines of physical activity for diabetes patients were used to determine the physical activity status of the patients. The ADA guideline calls for a minimum of 150 min week^{-1} of physical activity at moderate or above intensity. The ACSM guideline is more stringent by requiring that the 150 min week^{-1} should be carried out over five days, which means 30 min d^{-1} for five days per week. In addition, those who exercised very infrequently < 1 d week^{-1} were also identified for comparison.

Using the concept of energy expenditure mentioned previously, physical activity recommendation can be expressed in terms of MET min week^{-1}. For example, moderate-intensity activity (4.0 MET) for 150 minutes per week translates into 600 MET min week^{-1}. This cut-off can be used to determine whether someone meet the recommended level of physical activity.

From the standpoint of energy expenditure, energy that are used during any form of physical activity do not differ qualitatively. 100 MET min week^{-1} from walking should be equivalent to 100 MET min week^{-1} from running or swimming. So another cut-off using the 600 MET min week^{-1} cut-off, but included all sources of physical activities instead of just moderate-intensity or above, were also described.

2.2.4 Physical activity self-efficacy

Patients were asked to rate their confidence, on a 0–10 scale, to engage in moderate- or vigorous-intensity exercise for at least 30 minutes per day for either 3 days or 5 days per week (Appendix A).

2.2.5 Attitude towards exercise and subjective norm

Items to measure attitude towards exercise and subjective norm were constructed based on published methods.[32] A high attitude score means that a patient's perception towards exercise is more positive; and a high subjective norm score means that a patient thinks that other people approve of them doing exercise. The items are shown in Appendix A and the scoring algorithm are shown in Appendix B. Cronbach's α was 0.83 for attitude towards exercise, and 0.69 for subjective norm.

2.2.6 Perceived barriers to physical activity

The questions asked the patients to rate their confidence on a 5-point Likert-type scale ranging from "strongly Disagree" to "strongly Agree" to engage in physical activity under various situations that might affect them. However, since that only deals with hypothetical situations, a question about the actual occurrence of the described situations was also included into the study.

2.2.7 Level of self-care

The Summary of Diabetes Self-Care Activity (SDSCA) scale was used to measure diabetes self-care.[151] Each patient was presented with a list of self-care activities and was asked to indicate the frequency (days per week) that they engaged in each of these activities. The Chinese version of the SDSCA used in this study is based on the version that was developed by Tang et al.[152] but only those items that were related to general diet, specific diet, foot care, and self-monitoring of blood glucose (SMBG) were used in this study. We did not use the items related to exercise because that was assessed separately using the IPAQ. In addition, the Tang et al. version added one extra item for foot care to the original English version. In this study, we only used items that are present in the English version. Each domain of self-care was assessed by using two questions, with the exception of SMBG. During our study, it was found that 26% of the patients were not asked to perform SMBG by their health-care provider. Therefore, they were unable to answer the question "On how many of the last seven days did you test your blood sugar the number of times recommended by your health-care provider?". As a result, SMBG was only assessed by the question "On how many of the last seven days did you test your blood sugar?". For this study, Cronbach's α was 0.98 for the general diet domain, 0.60 for foot care, and was not calculated for SMBG because that was only measured with one question. Cronbach's α for specific diet was -0.01 for this study, which is drastically different from previous finding of 0.81 in the Tang et al. study.[152] Therefore, items for specific diet were analysed separately as "vegetable intake" and "fat intake".

Confirmatory factor analysis was performed to test the five-factor model for level of self-care. We assumed that measurement reliability of the single indicator domains (vegetable intake, meat intake, and SMBG) to be 0.80. Results showed that our data fit with the proposed model ($\chi^2 = 6.872$, df = 7, RMSEA = 0.0155, NNFI = 0.996, CFI = 0.999).

Overall level of self-care was represented by summation of all individual items' scores. It is a general representation of the level of self-care without delving into the performance of any specific activity and had a Cronbach's α of 0.58.

2.2.8 Self-care self-efficacy

Self-care self-efficacy was measured using the Diabetes Empowerment Scale (DES). It is a 20-item scale that measures the degree of patient empowerment in carrying out diabetes self-care.[153–155] Patients were asked to rate their agreement with a statement about their ability to handle diabetes-related psychosocial problems on a 5-point

Likert-type scale, with answers ranging from "strongly disagree" to "strongly agree". Using confirmatory factor analysis, the original study showed that the items were found to make up of five domains—Achieving Goals, Overcoming Barriers, Coping, Suitable Methods, and Obtaining Support. The DES showed acceptable levels of internal consistency with Cronbach's α ranging from 0.69 to 0.90 for the five domains and 0.85 overall.[155] In this study, we found from confirmatory factor analysis that our data fit with the five-domain model ($\chi^2 = 457.529$, df = 160, RMSEA = 0.0509, NNFI = 0.975, CFI = 0.979). Cronbach's α for the DES were 0.79 for Achieving Goals, 0.82 for Overcoming Barriers, 0.69 for Coping, 0.77 for Obtaining Support, 0.86 for Suitable Methods.

2.2.9 Level of mental distress

Depression was measured by the depression sub-scale of the Depression, Anxiety, and Stress Scales (DASS21), Chinese version.[156] The 21-item DASS21 is a self-report scale that measures the negative emotional states that are commonly referred to as depression, anxiety and stress. The depression sub-scale comprised of 7 items and measures dysphoria, hopelessness, devaluation of life, self-deprecation, lack of interest and involvement, anhedonia, and inertia. A high score on the anxiety sub-scale means that the person is panicky and apprehensive. They may experience uncontrollable trembles, dryness of mouth, or pounding of the heart. However, a note must be made that dryness of mouth is a typical symptom of diabetes as well. Those who scored a higher stress score are typically more tense, easily upset and irritable, and are intolerant of interruption or delay. Respondents were asked to rate on a 4-point Likert-type scale, how often they had those feelings during the last seven days.

The Chinese version of the DASS-21 was found to fit best with a three-factor model (df = 186, χ^2 = 942.34, Adjusted Goodness of Fit Index (AGFI) = 0.86) when compared with either a single-factor model (df = 189, χ^2 = 1231.91, AGFI = 0.83) or a two-factor model (df = 188, χ^2 = 1007.19, AGFI = 0.86) by using confirmatory factor analysis on a sample of people in Hong Kong.[157] This finding is consistent with the structure of the English version . The English version of DASS21 depression sub-scale had high internal consistency (Cronbach's α = 0.97) and were strongly correlated with the Beck Depression Inventory, a more specialized instrument for measurement of depression (r = 0.79).[158] Confirmatory factor analysis showed that the existing three-factor model fitted our data (χ^2 = 781.534, df = 186, RMSEA = 0.0435, NNFI = 0.988, CFI = 0.989). Our data also showed that the DASS21 sub-scales maintained good levels of reliability (Cronbach's α for depression = 0.84, anxiety = 0.74, stress = 0.83). The three scored can be combined to give a measure of general emotional disturbance.

2.2.10 Instrumental social support

We developed a 5-item scale to measure perceived instrumental social support received by the diabetes patients (see Appendix A). Confirmatory factor analysis showed that a one-factor model fitred very well with our data (χ^2 = 8.326, df = 5, RMSEA = 0.0261, NNFI = 0.993, CFI = 0.997). Overall level of instrumental social support was derived by the mean of the item scores. Cronbach's α for this scale was 0.67.

2.3 Statistical Analysis

Descriptive statistics on patients' characteristics, which included socio-demographics, severity of diabetes, diabetes self-care, diabetes self-care self-efficacy, frequency and duration of physical activity, were presented. Prevalence of patients who were physically inactive according to either the ADA or ACSM recommendations was derived. Gender-specific preferences on different types of exercise were presented. The proportion of physical activity which was planned exercise was calculated. Cognitive factors such as control of barriers to exercise, attitudes towards exercise, subjective norm towards exercise, exercise efficacy were also described. The level of instrumental social support experienced by the patients were presented. Level of mental distress experienced by the patients, in terms of depression, anxiety, and stress were derived.

Logistic regression was used to investigate the associations between level of physical activity and various independent variables (several socio-demographic and psychosocial variables). Dependent variables indicating a low level of physical activity or physical inactivity were created by different methods. First, those who exercised very infrequently were defined as those having moderate- or vigorous-intensity exercise for ≤ 1 day per week (infrequent exerciser). Second, those who did not meet the ADA guideline of having > 150 minutes of physical activity at moderate or vigorous level per week (physical inactivity according to ADA), and this was calculated for both physical activity or exercise. Third, those who did not meet the ACSM recommended physical activity guideline of having moderate or vigorous physical activity for at least 30 minutes per day for 5 days per week (physical inactivity according to ACSM). Data from exercise was used for this calculation. Forth, those who spent less than 600 MET min week^{-1} on physical activity of at least moderate-intensity were designated as inactive. Lastly, patients who expended less than 600 MET min week^{-1} of energy from all physical activites, including walking, were considered as being physically inactive.

Linear regression was used to identify factors in correlation with time-spent on physical activities in various sub-group of patients who potentially need more help with becoming more active. Patients were stratified according to their obesity status (those whose BMI $\geq$ 25 kg m^{-2}were considered obese[159]), stages of change, and HbA1c level.

Distribution of patients' readiness to engage in regular exercise (at least 30 minutes per day for 5 days per week of moderately intense exercise) was described in terms of the stages of change. Exercise preference for patients in different stages of change was identified. Change in levels of various cognitive factors with the stages were also compared. Logistic regression was used to identify factors that were associated with being in the precontemplation stage (those who did not think about regular exercise) or in the action/maintenance stage (those who already particpated in regular exercies).

Factors in correlation with different aspects of diabetes self-care were identified using linear regression analyses. Linear regression was also used to assess factors correlated with levels of mental distress (depression, anxiety, and stress).

Factors in correlation with two important cognitive factors—exercise efficacy and attitudes towards exercise were identified through linear regression models.

All statistical analyses, other than structural equation modeling, were performed using R.[160]

Structural equation modelling (SEM) was performed to simultaneously test the inter-relationships among physical activity and other variables. This study is the first attempt to examine the inter-relationships among these variables among diabetes patients using SEM. The SEM was conducted using LISREL for Windows 8.80.[161] Maximum Likelihood method was used to compare the observed covariance structure against that of the hypothesized model.

We proposed that physical activity level has a positive influence on other domains of self-care. Since self-care self-efficacy is the underlying psychosocial driver of self-care, we expect it to positively affect both physical activity and other diabetes self-care domains.[37] Level of depression, anxiety, and stress can potentially affect physical activity level and other diabetes self-care activities.[87,88] Physical activity level was further influenced by exercise efficacy[162,163] and instrumental social support. Social support was expected to mitigate depressive symptoms, reduce anxiety, as well as relieving stress level.[31,164,165]

Exercise efficacy was estimated by using a single indicator. Therefore, it is impossible to simultaneously estimate both the factor loadings and error variance. Error variance was fixed at [(1 - reliability) $\times$ variance of indicator] as suggested by some researchers.[166] Since there is no published data on the reliability of the exercise self-efficacy measure, we assumed that the reliability is 0.8. The model was re-fit under the assumptions that reliability of the exercise self-efficacy measure was 0.7 and 0.9 to cross-check how those assumptions would affect the model.

Chapter 3

Patient characteristics

3.1 Socio-demographic characteristics

There were slightly more male patients (54%) than female patients (46%) in our sample. Males patients were significantly better educated than females (77.2% of males had attained a secondary education versus 47.3% of females; Table 3.1), more likely to have a full-time job (58.1% versus 26.8%), and more likely to be a smoker (16.5% versus 2.3%). The mean age of the participants was 57.74 years and there was no significant difference in age between the two genders ($p > 0.05$). About 55% of the patients were obese (BMI $\geq 25 \text{ kg m}^{-2}$; WHO criteria for Asia-Pacific[159]).

3.2 Diabetes profile

3.2.1 Severity of diabetes

The mean duration of diabetes since diagnosis was 8.94 years and showed no gender difference ($p > 0.05$; Table 3.2). Older patients were diagnosed with diabetes for significantly longer period of time (10.50 years versus 7.68 years, $p < 0.001$). Female patients were 1.83 times more likely than male patients to require insulin injection

Table 3.1: Socio-demographic characteristics

	% or (Mean ± SD)*		
	Male (N = 311)	Female (N = 265)	p†
Age (years)	57 97 ± 10 44	57 46 ± 11 60	NS
Education level			
No formal education	4 2	14 7	< 0 001
Primary	18 6	38 0	
Secondary	62 5	40 7	
University or above	14 7	6 6	
Full-time employment	58 1	26 8	< 0 001
Smoking status			
Non-smoker	57 1	94 7	< 0 001
Ex-smoker	26 5	3 1	
Current smoker	16 5	2 3	
Body Mass Index			
Normal (< 23 $\mathrm{kg\,m^{-2}}$)	24 6	24 4	NS
Overweight (23–24 9 $\mathrm{kg\,m^{-2}}$)	21 3	18 7	
Obese I (25–29 9 $\mathrm{kg\,m^{-2}}$)	42 6	42 7	
Obese II (≥ 30 $\mathrm{kg\,m^{-2}}$)	11 5	14 1	

* % for categorical variables, (Mean ± SD) for continuous variables
† χ^2 test for categorical variables, Student's T-test for continuous variables, NS $p > 0\ 05$

for treatment of diabetes (28.7% versus 18.0%, $p < 0.01$), but age did not affect the insulin usage requirement. About 48% of the patients had high HbA1c level (≥ 7%); 58% of the patients had high blood pressure (≥ 130/80 mmHg) and LDL-cholesterol level of 47% of the patients were high (≥ 2.6 mmol/l). There was no significant gender difference in meeting any of the clinical targets ($p > 0.05$). Older patients were 1.46 times more likely to have high blood pressure ($p < 0.05$), but there was no significant age difference with regard to HbA1c or LDL-cholesterol levels ($p > 0.05$). Only $sim14\%$ of the patients were able to meet all three clinical treatment targets and there was no significant difference between genders or age groups ($p > 0.05$).

Table 3.2: Dıabetes profıle

	Gender*			Age*		
	Male	Female	p†	< 60 years	≥ 60 years	p†
Duratıon of dıabetes (years)	8 87±7 25	9 03±7 19	NS	7 68±6 36	10 50±7 88	< 0 001
Requıre ınsulın ınjectıon	18 0	28 7	< 0 01	22 0	24 4	NS
HbA1c (%)						
Normal (< 7)	53 6	49 6	NS	52 1	51 8	NS
Hıgh (≥ 7)	46 4	50 4		47 9	48 2	
Blood pressure (mmHg)						
Normal (< 130/80)	41 6	42 4	NS	46 3	37 1	< 0 05
Hıgh (≥ 130/80)	58 4	57 6		53 7	62 9	
LDL-cholesterol ($\text{mmol}\,\text{l}^{-1}$)						
Normal (< 2 6)	50 7	55 2	NS	49 0	57 2	NS
Hıgh (≥ 2 6)	49 3	44 8		51 0	42 8	
Met all 3 treatment targets‡	14 1	13 5	NS	14 6	12 9	NS

* % for categorıcal varıables, (Mean ± SD) for contınuous varıables
† χ^2 test for categorıcal varıables, Student's T-test for contınuous varıables, NS $p > 0\ 05$
‡ Normal HbA1c, blood pressure, and LDL-cholesterol

3.2.2 Level of diabetes self-care and self-care self-efficacy

The patients had what they considered a "healthy diet" about half of the time (3.39 out of 7 days, Table 3.2). Older patients maintained a healthy diet on more days than the younger patients ($3.80\,\text{d}\,\text{week}^{-1}$ versus $3.08\,\text{d}\,\text{week}^{-1}$, $p < 0.01$). They had at least five servings of vegetables on 3.27 days of a week on average. And on average, they did not eat any red meat or other high fat food items on 3.51 days of a week. They only had proper foot care (inspection of feet and inside of shoes) on 2.10 days per week. Patients only performed SMBG on 1.23 days per week. There was no significant gender difference in all domains of diabetes self-care ($p > 0.05$).

Male patients had significantly higher scores on all of the DES sub-scales (Archiving goals: 3.92 versus 3.74, $p < 0.001$; Overcoming barriers: 3.61 versus 3.44, $p < 0.01$; Coping: 3.83 versus 3.70, $p < 0.001$; Obtaining support: 3.83 versus 3.72, $p < 0.05$; Suitable methods: 3.75 versus 3.58, $p < 0.01$).

Although there was no significant difference in their believes in their ability to

Table 3.3: Diabetes self-care

	Gender			Age		
	Male	Female	$p^{\dagger}$	< 60 years	≥ 60 years	$p^{\dagger}$
Domains of diabetes self-care (SDSCA sub-scale scores*)						
General diet	3 17±3 01	3 66±2 96	NS	3 08±2 89	3 80±3 09	< 0 01
Vegetable intake	3 09±3 10	3 47±3 19	NS	3 31±3 11	3 21±3 20	NS
Fat intake	3 48±2 64	3 54±2 80	NS	3 33±2 66	3 69±2 77	NS
Foot care	2 11±2 53	2 07±2 51	NS	1 98±2 48	2 25±2 57	NS
SMBG	1 34±1 85	1 09±1 53	NS	1 24±1 67	1 19±1 74	NS
Self-care self-efficacy (DES sub-scale scores*)						
Archiving Goals	3 92±0 54	3 74±0 61	< 0 001	3 80±0 59	3 87±0 56	NS
Overcoming Barriers	3 61±0 64	3 44±0 70	< 0 01	3 53±0 64	3 53±0 71	NS
Coping	3 83±0 46	3 70±0 54	< 0 001	3 75±0 50	3 79±0 51	NS
Obtaining Support	3 83±0 54	3 72±0 63	< 0 05	3 81±0 56	3 76±0 61	NS
Suitable Methods	3 75±0 62	3 58±0 65	< 0 01	3 70±0 59	3 63±0 68	NS

* Mean±SD
† χ^2 test for categorical variables, Student's T-test for continuous variables, NS $p > 0\ 05$

set targets for diabetes control ($p < 0.05$, Table 3.4), male patients scored higher on self-care target selection ($p < 0.01$), planning ($p < 0.01$), and determination ($p < 0.05$).

There was no gender difference in the patients' belief of the existance of barriers to self-care ($p > 0.05$, Table 3.5), the ability to think about possible solutions to the barriers ($p > 0.05$), and the willingness to try different methods to overcome the barriers ($p > 0.05$). On the other hand, the male patients scored significantly higher on their ability to choose the most effective method to overcome the barriers ($p < 0.01$).

Male patients scored significantly higher on their ability to handle bad mood that was caused by diabetes ($p < 0.01$, Table 3 6). The male patients also scored higher on their believes about their ability to handle diabetes-related stress ($p < 0\ 01$) and whether they were active about handling the stress ($p < 0\ 05$). The area where male and female patients showed no significant difference was their belief about how diabetes can bring stress to daily living ($p > 0\ 05$).

Table 3.4: DES—Achieving diabetes goals

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	p^*
In general, I believe that I can set realistic targets for diabetes control						
Overall	0 5	9 3	8 5	71 8	9 9	
Male	0 0	7 7	6 8	74 6	10 9	NS
Female	1 1	11 3	10 6	68 3	8 7	
In general, I believe that I know which targets for diabetes control is the most important for me						
Overall	0 2	3 6	5 9	75 6	14 7	
Male	0 0	2 6	3 2	77 5	16 7	< 0 01
Female	0 4	4 9	9 1	73 2	12 5	
In general, I believe that I am able to turn my diabetes control targets into workable plan						
Overall	0 3	10 4	14 7	65 2	9 3	
Male	0 0	9 0	11 3	68 2	11 6	< 0 01
Female	0 8	12 1	18 9	61 5	6 8	
In general, I believe that I can achieve my target for diabets control once I determined to do it						
Overall	0 7	8 0	15 6	63 0	12 8	
Male	0 3	7 4	11 6	65 9	14 8	< 0 05
Female	1 1	8 7	20 4	59 2	10 6	

* Pearson's χ^2 test

Male patients scored higher on their perceived ability to obtain support for diabetes self-care ($p < 0.05$, Table 3.7) There was no significant gender difference on the scores for patients' belief in things that support their self-care efforts ($p > 0.05$) and where to obtain support ($p > 0.05$).

In choosing suitable methods for diabetes control, the male patients scored higher on perceived knowledge of where to obtain information ($p < 0.01$, Table 3.8). The males also had significant higher score than the females on their perceived ability to increase knowledge of themselves in order to select a suitable self-care plan ($p < 0.05$).

3.3 Physical activity and exercise profile

3.3.1 Frequency and duration of physical activity

Table 3.9 presents the participants' level of physical activity at different intensities.

Around 40% (42%) of the patients had had at least 10 minutes per day of moderate

Table 3.5: DES—Overcoming barriers

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	p^*
In general, I believe that there are barriers that make it difficult for me to reach my targets of diabetes control						
Overall	0 3	9 2	13 7	68 7	8 1	
Male	0 0	8 7	13 2	68 5	9 6	NS
Female	0 8	9 8	14 3	68 7	6 4	
In general, I believe that I can think of ways to overcome the barriers						
Overall	0 3	18 0	19 7	56 6	5 4	
Male	0 0	15 8	18 3	59 8	6 1	NS
Female	0 8	20 8	21 5	52 5	4 5	
In general, I believe that I can try different methods to overcome the barriers						
Overall	0 7	17 5	23 0	53 1	5 7	
Male	0 3	14 8	21 5	57 2	6 1	NS
Female	1 1	20 8	24 9	47 9	5 3	
In general, I believe that I can decide on the most effective method to overcome the barriers						
Overall	0 7	16 1	28 0	49 0	6 2	
Male	0 0	14 5	24 1	54 3	7 1	$< 0\ 01$
Female	1 5	18 1	32 8	42 3	5 3	

* Pearson's χ^2 test

physical activity on at least 6 days during the past week. However, there were still 32% of the patients who had 1 day or less of moderate physical activity. 54% of the patients typically spent more than 30 minutes on moderate physical activity on their active days.

The majority of the patients (69%) did not engage in at least 10 minutes per day of vigorous physical activity in the last seven days About 26% of the patients spent at least 30 minutes per day on vigorous activities on the days which they participated in vigorous physical activities.

77% of the patients did manage to walk for at least 10 minutes per day on at least 6 days per week. And most of them (67%) walked for at least 30 minutes.

Overall, 15% of the patients had at least 150 minutes per week of vigorous physical activity, 43% of them had at least 150 minutes per week of moderate physical activity, and 61% walked for at least 150 minutes in the past week.

Table 3.6: DES—Coping

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	p^*
In general, I believe I can handle diabetes-related bad mood						
Overall	0 2	7 4	21 1	64 2	7 1	
Male	0 3	3 9	20 3	67 5	8 0	< 0 01
Female	0 0	11 7	22 3	60 0	6 0	
In general, I believe that living with diabetes can be stressful in daily lives						
Overall	0 5	7 4	15 4	68 0	8 7	
Male	0 3	8 4	14 5	67 8	9 0	NS
Female	0 8	6 4	16 6	67 9	8 3	
In general, I believe that I can handle diabetes-related stress						
Overall	0 5	5 2	14 5	72 5	7 3	
Male	0 6	2 3	11 9	76 5	8 7	< 0 01
Female	0 4	8 7	17 7	67 5	5 7	
In general, I believe that I am active about dealing with diabetes-related stress						
Overall	0 2	5 9	15 1	69 2	8 7	
Male	0 3	3 5	14 8	71 1	10 3	< 0 05
Female	0 0	8 7	17 7	66 8	6 8	

* Pearson's χ^2 test

3.3.2 Meeting various international physical activity recommendations for diabetes patient

In this study, 40% of the diabetes patients had moderate- or vigorous-intensity exercise on one day or less during the last seven days According to the ACSM, ADA and Diabetes UK definitions, respectively, 54%, 43% and 13%of the participants were classified as "physically inactive" (Table 3.10)

40% of the patients failed to participate in at least 600 MET min week^{-1} worth of activities if energy expenditure from walking was not taken into account. If contributions from walking was included, then only 13% of the patients failed the 600 MET min week^{-1} cut-off (Table 3 10)

Table 3.7: DES—Obtaining support

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	p^*
In general, I know the things that support me in dealing with diabetes						
Overall	0 2	6 2	11 1	74 0	8 5	
Male	0 0	5 1	11 3	74 9	8 7	NS
Female	0 4	7 5	10 9	72 8	8 3	
In general, I know where I can obtain support to help me dealing with diabetes						
Overall	0 2	8 5	12 1	71 3	8 0	
Male	0 0	6 1	11 3	74 6	8 0	NS
Female	0 4	11 3	13 2	67 2	7 9	
In general, if needed, I can ask for support from others to help me dealing with diabetes						
Overall	0 2	9 3	15 9	67 3	7 3	
Male	0 3	6 1	17 0	68 5	8 0	< 0 05
Female	0 0	13 2	14 7	65 7	6 4	

* Pearson's χ^2 test

3.3.3 Proportion of planned physical activity (exercise)

About 83% of physical activities performed by the patients were considered as exercise by the patients (Table 3 11). There was no significant difference between the patients with EP< 0 8 and those with EP$\geq$ 0.8 on gender, age, eduation level, and employment type ($p > 0.05$)

3.3.4 Types of exercise performed by diabetes patients

All patients were asked about the type of exercise they usually performed (Table 3 12). The majority (44 5%) of them reported strolling as their preferred type of exercise. Stretching exercises, including all sorts of "morning exercises", Tai-Chi, "health exercise", were preferred by 25.9% of the patients, and was more popular among the females (32.6%) when compared to the male patients (20.2%). More males engaged in jogging (19.9% versus 8 4%), swimming (10.1% versus 7.6%), and hiking (13 0% versus 4 2%).

Stretching, jogging, and hiking were performed by more physically active patients than the physically inactive ones (by both the ACSM and ADA definitions). The

Table 3.8: DES—Suitable methods

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	p^*
In general, I believe I know where to obtain information to help me select a self-care plan that is suitable for me						
Overall	0 2	10 4	12 1	69 4	8 0	
Male	0 0	8 0	9 0	74 0	9 0	< 0 01
Female	0 4	13 2	15 8	63 8	6 8	
In general, I believe I know enough about diabetes for me to select a self-care plan that is suitable for me						
Overall	0 3	16 8	15 7	60 4	6 7	
Male	0 3	15 1	14 8	61 1	8 7	NS
Female	0 4	18 9	17 0	59 2	4 5	
In general, I believe that I know about myself enough so that I can select a self-care plan that is suitable for me						
Overall	0 2	12 3	17 0	63 1	7 4	
Male	0 0	10 9	14 1	65 6	9 3	NS
Female	0 4	14 0	20 4	60 0	5 3	
In general, I believe I know how to improve understanding of myself in order to select a self-care plan that is suitable for me						
Overall	0 0	12 3	15 9	64 5	7 3	
Male	0 0	9 3	15 1	66 2	9 3	< 0 05
Female	0 0	15 8	17 0	62 3	4 9	
In general, I believe that I am capable of deciding whether it is worthwhile to change the way I perform diabetes self-care						
Overall	0 3	8 3	18 9	63 8	8 7	
Male	0 3	6 4	18 3	64 0	10 8	NS
Female	0 4	10 6	19 6	63 4	6 0	

* Pearson's χ^2 test

overall gender differences aforementioned were mostly maintained when patients were stratified by their physical activity status.

3.4 Cognitive factors for physical activity participation

3.4.1 Barriers to exercise participation

Male patients had to work more than eight hours per day on 2 64 $\mathrm{d\,week^{-1}}$ on average, which was significantly more than the 1.26 $\mathrm{d\,week^{-1}}$ for the females ($p < 0\ 001$; Table 3.13). On the other hand, females had significantly more days when they

Table 3.9: Physical activity participation by level of intensity

	Physical activity intensity (n = 564)		
	Vigorous/%	Moderate/%	Walking/%
Number of days in the last seven days with at least 10 minutes of physical activity			
0	69	27	7
1	5	5	1
2–3	12	16	7
4–5	4	9	8
6–7	10	42	77
Typical time-spent on physical activity on days with at least some physical activities ($\text{min}\,\text{d}^{-1}$)			
< 10*	69	27	7
10–29	5	18	25
30–59	8	22	32
≥ 60	18	32	35
Time-spent on physical activity ($\text{min}\,\text{week}^{-1}$)			
0	69	27	7
1–50	3	9	4
51–100	6	12	8
101–150	7	9	20
> 150	15	43	61

* Patients who did not participate in any physical activity

needed to take care of family ($p < 0.001$), felt tired ($p < 0.001$), felt sick ($p < 0.01$), had no interest in exercise ($p < 0.05$), and exercised without a companion ($p < 0.001$; Table 3.13). There was no significant gender difference on the number of days that the patients had to participate in leisure activities other than exercise ($p > 0.05$).

There were significant gender differences for the need to take care of family ($p < 0.001$) and feeling tired ($p < 0.05$; Table 3.14). There was no significant gender difference for other barriers to exercise that we examined.

3.4.2 Attitudes towards exercise

In general, about 86% of the patients thought that exercise is an effective mean of diabetes control (data not shown).

About 72% of the patients thought that exercise would not cause weight gain

Table 3.10: Percentage of diabetes patients who were physically active

Based on time-spent	%	Based on energy expenditure	%
Number of days in the last 7 days with at least 30 minutes per day of exercise of at least moderate-intensity (day)			
0	36		
1	4		
2–4	13		
5–7*	46		
Time spent on physical activity of at least moderate intensity (min week^{-1})		Energy expenditure from physical activity of at least moderate-intensity (MET min week^{-1})	
< 75	31	0–299	31
75–149	12	300–599	9
150–224†	15	600–899†	13
225–300†	4	900–1199†	6
≥ 300†	38	≥ 1200†	42
Time spent on physical activity of any intensity (min week^{-1})		Energy expenditure from all sources of physical activity (MET min week^{-1})	
< 75	4	0–299	4
75–149	9	300–599	9
150–224‡	10	600–899‡	10
225–300‡	7	900–1199‡	9
≥ 300‡	69	≥ 1200‡	68

* Physically active according to ACSM recommendation
† Physically active according to ADA recommendation
‡ Physically active according to Diabetes UK recommendation

(Table 3.15) 84% disagreed that exercise would increase the risk of diabetes complications The patients also thought that exercise can help lower their blood glucose level (73%) and made them more energetic (88%). There was no significant difference between the male and female.

There was a significant difference between male and female patients on how they thought about the energy-enhancing effect of exercise (Table 3 16). Male tended to value this effect of exercise more than the females. For the effect of exercise on weight, risk of diabetes complications, and blood glucose, there was no significant difference between the genders.

Table 3.11: Exercise proportion by socio-demographics

	N	Patients / %		p
		Low EP* (< 0.8)	High EP* (≥ 0.8)	
Overall	549	17.3	82.7	
Gender				
Male	300	16.0	84.0	NS
Female	249	18.9	81.1	
Age				
< 60	298	19.8	80.2	NS
≥ 60	248	13.7	86.3	
Education level				
Primary or below	196	18.4	81.6	NS
Secondary or above	346	16.8	83.2	
Employment type				
Others	302	14.6	85.4	NS
Full-time	240	20.0	80.0	

* $EP = \frac{\text{Time-spent on exercise}+1}{\text{Time-spent on physical activity}+1}$

3.4.3 Subjective norm towards exercise

The majority (96%) of patients believed that, in general, people they know thought that exercise is good for them (data not shown).

91% of the patients agreed that their family member thought that exercise is good for them. 88% and 97% of them thought that their friends and doctors, respectively, thought of exercise as beneficial (Table 3.17). Althought 66% of the patients agreed that other diabetes patients thought of exercise as good for themselves, one-third of the patients held a neutral stance about other patients' beliefs. There was no significant gender difference about patients' thought about others opinions.

Most of the patients (93%) were motivated to comply with doctors' opinions, followed by family members (87%) and friends (82%; Table 3.18). Only 60% of the patients would value the opinion of other diabetes patients. Again, there was no significant difference on patients' motivation to comply with each of the referent groups.

Table 3.12: Type of exercise by level of physical activity

	Exercise participation (%)*								
	Male	Female	All	Male	Female	All	Male	Female	All
	Physical activity level (minutes per week)								
	< 150			≥ 150			All		
Strolling	46 3	51 1	48 1	40 1	44 9	42 6	42 7	46 6	44 5
Stretching	11 6	21 3	15 4	29 6	38 6	34 2	20 2	32 6	25 9
Jogging	14 3	2 2	9 6	25 0	12 0	18 4	19 9	8 4	14 6
Swimming	7 5	6 4	7 1	12 5	8 2	10 3	10 1	7 6	8 9
Hiking	5 4	1 1	3 7	17 8	5 7	11 6	13 0	4 2	8 9
Cycling	2 0	4 3	2 9	5 8	3 8	4 8	3 9	3 8	3 8
Others	15 6	12 8	14 5	23 7	17 7	20 6	19 5	15 2	17 5
	Days with at least 30 minutes of at least moderate-intensity exercise								
	< 5			≥ 5			All		
Strolling	42 8	43 7	43 1	42 6	50 0	46 5	42 7	46 6	44 5
Stretching	11 7	22 7	16 1	33 6	41 2	37 6	20 2	32 6	25 9
Jogging	17 2	2 5	11 4	23 8	13 2	18 2	19 9	8 4	14 6
Swimming	10 6	5 9	8 7	9 0	9 6	9 3	10 1	7 6	8 9
Hiking	7 2	2 5	5 4	21 3	5 9	13 2	13 0	4 2	8 9
Cycling	2 7	3 4	3 0	5 6	4 4	5 0	3 9	3 8	3 8
Others	20 0	15 1	18 1	18 0	15 4	16 7	19 5	15 2	17 5

* Percentages may add up to more than 100% because patients can choose more than one type of exercise

3.4.4 Exercise efficacy

Patients' exercise efficacy was measured by their confidence to engage in at least 30 minutes of exercise at moderate or above intensity for five days per week The mean exercise efficacy score was 5.62 (out of 10) and showed no significant gender difference ($p > 0.05$; Table 3.20)

3.4.5 Instrumental social support

Results for some of the instrumental social support the patients received from others are listed in Table 3.19 Most of the patients agreed that others were generally supportive of their diabetes self-care (87%) About 84% of the patients were encour-

Table 3.13: Occurance of barriers to exercise

Barriers to exercise	Mean ± SD / day		
	Male	Female	p^*
Worked more than 8 hr per week	2 64 ± 2 96	1 26 ± 2 43	< 0 001
Needed to take care of family	2 49 ± 3 09	5 24 ± 2 90	< 0 001
Felt tired	1 31 ± 2 24	2 36 ± 2 74	< 0 001
Not interested in exercise	0 97 ± 2 11	1 39 ± 2 44	< 0 05
Felt sick	1 07 ± 2 05	1 59 ± 2 45	< 0 01
No exercise companion	0 85 ± 1 91	1 58 ± 2 53	< 0 001
Participated in leisure activities other than exercise	0 96 ± 1 89	1 23 ± 2 18	*NS*

^{NS} Not significant at $\alpha = 0\ 05$
* Wilcoxon rank sum test

aged to be more physically active, and 69% agreed that other people would eat more healthy food when dining with the them. 64% of the patients agreed that family members or friends would remind them to take their diabetes medications Male patients were more likely to get reminded to take their diabetes medications than the females ($p < 0\ 05$). The differences between genders on level of instrumental social support their received were non-significant ($p > 0.05$) for other aspects of support

Althought 44% of the patients agreed that family members or friends would exercise with them. There were 35% who indicated that they did not exercise with others (Table 3 19).

3.4.6 Summary scores for barriers, attitudes, subjective norm, and instrumental social support

Summary scores were computed for barriers to exercise, attitudes towards exercise, subjective norm and instrumental social support (Table 3.20). There was no gender difference for patients' attitudes towards exercise, subjective norm towards exercise, and barriers to exercise ($p > 0\ 05$) Overall, male patients had slightly higher social support score than females (Mean: 3.72 versus 3 62, $p < 0.05$; Table 3.20).

Table 3.14: Perceived effect of barriers to exercise

	N	% of patients who answered					p^*
		Strongly increased	Increased	No effect	Decreased	Strongly decreased	
Worked more than 8 hr per week							
Male	301	0 3	2 7	54 8	27 6	14 6	NS
Female	248	0 4	1 2	66 9	21 0	10 5	
Needed to take care of family							
Male	304	0 0	1 0	83 2	13 8	2 0	< 0 001
Female	259	0 0	2 7	66 4	25 1	5 8	
Felt tired							
Male	298	0 7	1 3	47 3	42 3	8 4	< 0 05
Female	253	0 0	3 2	39 5	43 1	14 2	
Not interested in exercise							
Male	294	0 3	3 4	67 3	21 8	7 1	NS
Female	249	0 0	2 4	59 4	28 1	10 0	
Felt sick							
Male	297	1 0	8 1	50 2	33 3	7 4	NS
Female	247	0 0	10 5	47 8	30 8	10 9	
No exercise companion							
Male	302	0 7	0 7	63 6	31 8	3 3	NS
Female	255	0 0	2 4	56 5	34 9	6 3	
Participated in leisure activities other than exercise							
Male	299	0 0	3 0	85 3	10 4	1 3	NS
Female	251	0 0	2 8	85 3	10 8	1 2	

^{NS} Not significant at $\alpha = 0\ 05$
* Pearson χ^2 test for gender difference

3.5 Mental distress in diabetes patients

Table 3.21 shows the patients' mental distress scores. This sample of patients showed very few symptoms of depression, anxiety, and stress. The mean sub-scale scores was low for both genders (depression: 2.32 for males and 3.92 for females; anxiety: 2.80 for males and 4 07 for females; stress 3.91 for males and 5 38 for females; all sub-scales were scored on a range of 0–42). Female patients were significantly more likely than males to have higher scores related to depression ($p < 0\ 001$), anxiety ($p < 0.01$), stress ($p < 0.01$), as well as the overall mental health score ($p < 0\ 001$).

Table 3.15: Perceived outcomes of exercise

Perceived outcome of exercise	N	% of patients who answered					p^*
		Strongly agreed	Agreed	Neutral	Disagreed	Strongly disagreed	
Weight *gain*							
Overall	541	0	5 5	12 2	68 9	13 3	
Male	288	0 0	5 2	13 2	68 8	12 8	NS
Female	253	0 0	5 9	11 1	69 2	13 8	
Increase risk of diabetes complications							
Overall	541	0 4	3 9	11 6	72 3	11 8	
Male	289	0 3	2 8	11 8	73 0	12 1	NS
Female	252	0 4	5 2	11 5	71 4	11 5	
Lower blood glucose level							
Overall	541	13 7	68 8	13 5	3 9	0 2	
Male	288	14 9	71 2	10 4	3 1	0 3	NS
Female	253	12 3	66 0	17 0	4 7	0 0	
Feel more energetic							
Overall	543	22 8	65 2	7 9	3 7	0 4	
Male	289	24 2	64 7	8 0	3 1	0 0	NS
Female	254	21 3	65 7	7 9	4 3	0 8	

^{NS} Not significant at $\alpha = 0\ 05$
* Pearson χ^2 test for gender difference

There was no significance difference for depression, anxiety, and stress scores when patients with low exercise proportion (< 0.8) were compared to those with high exercise proportion (≥ 0.8; Table 3.22).

3.6 Summary

Both genders were similarly represented in this sample (54% male versus 46% female) The male patients were better educated, more likely to have a full-time job, and more likely to smoke. 55% of the patients were obese (BMI $\geq$ 25 kg m^{-2}) and 20% were overweight (BMI $\geq$ 23 kg m^{-2}; WHO obesity guidelines for Asian[159]) On average, this group of patients has been diagnosed with diabetes for around nine years. Around half of the patients were able to meet either the treatment

Table 3.16: Values attached to exercise outcomes

		% of patients who answered					
Exercise outcome	N	Very good	Good	Neutral	Bad	Very bad	p^*
Weight *gain*							
Overall	543	0.7	7.4	14.0	58.6	19.3	
Male	290	1.0	8.3	16.2	57.2	17.2	NS
Female	253	0.4	6.3	11.5	60.1	21.7	
Increase risk of diabetes complications							
Overall	542	0.0	2.4	4.2	65.1	28.2	
Male	289	0.0	3.1	2.8	66.1	28.0	NS
Female	253	0.0	1.6	5.9	64.0	28.5	
Lower blood glucose level							
Overall	540	20.5	67.0	6.1	5.0	1.5	
Male	288	21.4	67.6	4.8	4.8	1.4	NS
Female	252	19.4	66.3	7.5	5.2	1.6	
Feel more energetic							
Overall	541	33.3	63.2	3.5	0.0	0.0	
Male	289	38.1	59.9	2.1	0.0	0.0	< 0.05
Female	252	27.8	67.1	5.2	0.0	0.0	

^{NS} Not significant at $\alpha = 0.05$
* Pearson χ^2 test for gender difference

target for HbA1c (< 7%), blood pressure (< 130/80 mmHg), and LDL-cholesterol (< 2.6 mmol l^{-1}) Only about 14% of them were able to meet all treatment targets. Females were more likely to require insuline injection than the males (28.7% for females versus 18.0% for males).

Patients who were older than 60 years of age had what they considered as a healthy diet on more days of the week than the younger ones. Other than this difference, different genders and age groups showed no difference in their levels of diabetes self-care for various domains. Patients appeared to be managing their diet (~3–4 days per week) better than performing proper foot care (~ 2 days per week) and self-monitoring of blood glucose level (about once per week). Male patients had higher level of self-care self-efficacy. However, age did not have any significant effect on self-care self-efficacy.

Table 3.17: Normative beliefs about benefits of exercise

Referent group	N	% of patients who answered					p^*
		Strongly agreed	Agreed	Neutral	Disagreed	Strongly disagreed	
Family members							
Overall	544	24 1	67 5	7 7	0 7	0 0	
Male	290	25 9	67 9	5 5	0 7	0 0	NS
Female	254	22 0	66 9	10 2	0 8	0 0	
Friends							
Overall	544	21 0	67 1	11 0	0 9	0 0	
Male	290	21 4	66 6	10 7	1 4	0 0	NS
Female	254	20 5	67 7	11 4	0 4	0 0	
Doctor							
Overall	544	36 9	59 9	3 1	0 0	0 0	
Male	290	40 7	57 2	2 1	0 0	0 0	NS
Female	254	32 7	63 0	4 3	0 0	0 0	
Other diabetes patients							
Overall	541	11 6	53 8	33 3	1 3	0 0	
Male	289	11 4	53 6	33 6	1 4	0 0	NS
Female	252	11 9	54 0	32 9	1 2	0 0	

^{NS} Not significant at $\alpha = 0\ 05$
* Pearson χ^2 test for gender difference

Exercise efficacy was similar for both genders. Around 40% of the participants had at least 30 minutes of moderate or vigorous exercise on one day or less per week, and about half of the patients in the study were considered physically inactive according to international guidelines (ADA: 43%; ACSM· 54%). Most of the physical activities performed by this group of patients were of moderate intensity, and as a result, using energy expenditure as an outcome resulted in similar findings. Contrary to the recommendations that only based on moderate-intensity, or higher, physical activity, if time-spent on walking is included into the calculation as per the Diabetes UK guidelines, up to 86% of the patients were considered physically active.

Around 80% of the patients' physical activities were planned exercise, and there was no significant difference for gender, age, education level, or employment type. Overall, the five most-popular exercise for the diabetes patients were walking (44.5%),

Table 3.18: Motivation to comply with different people

Referent group	N	% of patients who answered					p^*
		Strongly agreed	Agreed	Neutral	Disagreed	Strongly disagreed	
Family members							
Overall	544	19 7	66 7	10 7	2 9	0 0	
Male	290	20 0	66 6	9 7	3 8	0 0	NS
Female	254	19 3	66 9	11 8	2 0	0 0	
Friends							
Overall	544	14 0	67 6	14 9	3 5	0 0	
Male	290	14 8	68 6	14 1	2 4	0 0	NS
Female	254	13 0	66 5	15 7	4 7	0 0	
Doctor							
Overall	544	34 4	58 8	5 9	0 9	0 0	
Male	290	36 6	59 3	3 4	0 7	0 0	NS
Female	254	31 9	58 3	8 7	1 2	0 0	
Other diabetes patients							
Overall	542	7 7	51 8	36 2	4 2	0 0	
Male	289	6 9	52 9	36 0	4 2	0 0	NS
Female	253	8 7	50 6	36 4	4 3	0 0	

^{NS} Not significant at $\alpha = 0\ 05$
* Pearson χ^2 test for gender difference

stretching (25.9%), followed by jogging (14.6%), swimming (8.9%), and hiking (8 9%). In general, female patients preferred the more mild types of exercise (walking and stretching) while the males preferred more vigorous ones (jogging, swimming, and hiking). Preference for jogging and hiking were exceptionally low for those who were physically inactive (around 1–2%).

The effect of barriers to exercise on both genders were similar in general. However, having to work for more than eight hours per week appeared to be the most frequent barriers to exercise encountered by the male patients; the males spent significantly more days per week doing that than the females (2.64 versus 1.26 days per week). Having to work long hours negatively affected exercise participation, and the effect was similar across genders On the other hand, the biggest barrier for the females was the need to take care of their families Compared to the males, the female patients

Table 3.19: Instrumental social support

	N	% of patients who answered					p^*
		Strongly agree	Agree	Neutral	Disagree	Strongly disagree	
Family members and friends were supportive of your diabetes self-care							
Overall	576	20 1	66 4	10 6	2 8	0 2	
Male	311	20 6	69 1	8 7	1 3	0 3	NS
Female	265	19 6	63 0	12 8	4 5	0 0	
Family members and friends would remind you to take diabetes medications							
Overall	577	11 6	52 1	22 8	13 1	0 3	
Male	311	12 5	56 3	20 9	9 6	0 6	$< 0\ 05$
Female	265	10 6	46 8	25 3	17 4	0 0	
Family members and friends would encourage you to exercise							
Overall	577	16 8	66 8	10 2	6 1	0 2	
Male	311	17 4	69 5	8 7	4 2	0 3	NS
Female	265	16 2	63 4	12 1	8 3	0 0	
Family members and friends would exercise with you							
Overall	577	8 5	35 1	21 8	32 2	2 4	
Male	311	8 4	36 7	24 4	28 0	2 6	NS
Female	265	8 7	33 6	18 1	37 4	2 3	
Other people would have a more healthy diet when dining with you							
Overall	577	14 4	54 5	13 1	17 1	0 9	
Male	311	13 8	55 0	13 5	16 7	1 0	NS
Female	265	15 1	53 6	12 8	17 7	0 8	

^{NS} Not significant at $\alpha = 0\ 05$
* Pearson χ^2 test for gender difference

reported significantly more days which they had to take care of family (5.24 versus 2.49 days per week), felt sick (1 59 versus 1 07 days per week) or tired (2.36 versus 1 31 days per week), lost interest in exercise (1 39 versus 0 97 days per week), or had no exercise companion (1.58 versus 0.85 days per week). Feeling sick or tired had negative effect on exercise participation, and tiredness had stronger effect on females than the males. The need to take care of family had higher negative impart on exercise participation on the females when compared to the male patients. Lack of exercise companionship negatively affected both genders in similar proportions On the other hand, the patients did not have many other leisure activities (about 1 day

Table 3.20: Summary scores for various constructs

	Gender / Mean ± SD		
	Male	Female	$p^{\dagger}$
Attitudes towards exercise	1 23 ± 0 90	1 15 ± 0 93	NS
Subjective norm towards exercise	4 66 ± 2 22	4 43 ± 2 33	NS
Barriers to exercise	−5 42 ± 9 54	−6 51 ± 11 75	NS
Exercise efficacy	5 59 ± 4 28	5 64 ± 4 39	NS
Instrumental social support	3 72 ± 0 53	3 62 ± 0 61	< 0 05

NS Not significant at $\alpha = 0\ 05$
* Student's T-test

Table 3.21: Mental distress profile

	Gender / Mean ± SD		
DASS21 scores	Male	Female	p*
Depression sub-scale	2.32 ± 4.61	3 92 ± 6 07	< 0 001
Anxiety sub-scale	2.80 ± 3 94	4.07 ± 5 09	< 0.01
Stress sub-scale	3.91 ± 5.79	5 38 ± 6.93	< 0.01
Overall	8 97 ± 13.02	13.29 ± 16.10	< 0 001

* Student's T-test

per week), and participating in other leisure activities appeared to have a smaller impact than the other barriers.

Overall, both genders scored similarly on their attitudes towards exercise. The patients showed good understanding of the effects of exercise. 80–90% were able to correctly answer the effect of exercise on weight, blood glucose level, risk of diabetes complications, and mood. Using exercise for weight control were valued less than the other uses (risk of complications, glycemic control, mood improvement). Males

Table 3.22: Mental distress by exercise proportion

	Exercise proportion (EP)* / Mean ± SD		
DASS21 sub-scale score	Low EP (< 0.8)	High EP (≥ 0 8)	$p^{\dagger}$
Depression	3 53 ± 5 69	2 87 ± 5 25	NS
Anxiety	3 89 ± 4 85	3 21 ± 4.37	NS
Stress	5 24 ± 7.23	4.32 ± 6.07	NS

* $EP = \frac{\text{Time spent on exercise}+1}{\text{Time spent on physical activity}+1}$
† Wilcoxon rank sum test

valued the mood-improving effect of exercise more than the females. But other than that difference, gender did not affect patients' perceived outcomes of exercise or their values attached to those outcomes.

Subjective norm towards exercise were similar for both genders. More than 90% of the patients agreed that their family members, friends, as well as their doctors thought that exercise is good for the patients. Among that group, patients were most likely to listen to their doctors, followed by family members, and friends. On the other hand, the patients were not so sure about what other diabetes patients thought about exercise. Only $\sim$ 65% of the patients agreed that other diabetes patients believed in the beneficial effects of exercise. And only 60% of the patients were likely to listen to the opinion of other diabetes patients. Both genders showed similar pattern for their normative beliefs and motivation to comply with others.

86.5% of the patients agreed that their family members and friends were supportive of their diabetes self-care; 83.6% agreed that they were encouraged to exercise. However, only 43.6% of the patients agreed that family or friends would exercise with them. Family member and friends would have a more healthy diet when dining with 68.9% of the patients. Male patients were more likely to be reminded to take their diabetes medications than the females.

Although the levels of depression, anxiety, and stress were quite low in general (2–5 points on a scale with potential range from 0–42). Nonetheless, females patients had significantly higher levels of all three types of mental distress. As a result, overall level of mental distress was also higher in female patients. Those who had higher proportion of physical activity in the form of exercise had lower, but non-significant, levels of mental distress.

3.7 Discussion

This chapter provides a first look at some of the characteristics of the sample of Type 2 diabetes patients.

Although the proportion (14%) of patients who had good control on all three primary indicators (HbA1c, blood pressure, LDL-cholesterol) was quite good when compared with diabetes patients who were not going through complication screening (Prof. Juliana Chan, personal communication). Still, when combined with the high prevalence of obesity (55%) meant that there is a need for improvement for lifestyle modification, including promotion of physical activity. About 40–50% of the patients were able to meet the physical activity guidelines from international organizations. However, that means more than 50% of the patients still need to be more physically active because diabetes patients need to be active in order to keep their glycemic levels under control.

Moreover, previous survey has found that about 38.1% of the general population in Hong Kong were physically inactive.[5] If we standardized the prevalence of physical inactivity in our sample to the population surveyed in that report, 50.0% of the patients would have been considered as physically inactive. The diabetes patients, who should be more active because of their condition actually were less active than the general population. That is a cause of alarm.

The five most popular types of exercise were strolling, stretching, jogging, swimming, and hiking. These exercises do not require specialized equipment and venue, and are safe to perform. Physically inactive female patients were about twice more likely than males to have participated in stretching; inactive male patients were about 6.7 times more likely than females to jog. Such patterns may be taken into account for exercise promotion programs.

The majority of patients had a very high proportion physical activities that in the form of planned exercise. There are a few possible scenarios which could have led this to happen. First, some patients might not need to work or perform domestic tasks and used their free time to exercise. Other patients had indicated that they were using everyday chores as a form of exercise. For example, they would walk to the market instead of taking motorized transportation. This second type of patients might not actually had enough physical activities as the recommendations were mostly based on physical activities during leisure time. It might be necessary to revise the physical activity recommendations so that they are based on all physical activities instead of just leisure physical activity/exercise alone.

Female patients needed to take care of their family on significantly more days per week than the male patients. In addition, more female reported that domestic duties decreased their exercise participation. For females to take care of domestic matters is a cultural tradition. However, the need to take care of domestic duties left little time for the female patients to participate in leisure activities. Although it was found that by standing or walking around at home for two hours per day significant reduced the risk of developing type 2 diabetes.[167] Using domestic activities to substitute exercise for diabetes management has not been adequately studied. In addition, performing domestic duties in the solitude of their own home prevented them from realizing some of the other social and psychological benefits of exercise, especially exercising with other people.

The prevalences of depression, anxeity, and stress are not obtained from this study, as DASS21 is based on a dimensional conception and has no explicit cut-off points.[156] The level of depression however, seemed very low for this group of diabetes patients, with only a few cases exhibited high number of depressive symptoms. Previous study that 26% of local diabetes patients had elevated level of depression.[17] This might be a reflection of the support the patients received as part of the integrated diabetes care service. In addition, the more days of tiredness and sickness expressed by the females might be a result of somatization of depressive symptoms in the Chinese population.[168]

In general, males reported getting higher level of instrumental social support than the females. The gender-differential was most profound in term of giving reminders to take medications. Taking medication is often necessary to keep the diabetes in control. Reminders from care-takers can help the patients to take the medications in a timely manner. Females patients reported getting less support from the males on this matter. It might be beneficial to provide training to care-takers of diabetes patients, especially the male care-takers of female patients, to highlight the advantage of giving medication reminders to the patients.

Patients were knowledgable about the effects of exercise in general, but there were still 10–20% of them who thought exercise is useless or downright harmful. For patients with poor diabetes control, assessing their knowledge about exercise to clear possible mis-conceptions might be useful to help the patients to become more physically active.

The effect of peer-support on diabetes care have gained increasing attention in recent years.[169] However, our results indicated that this approach might have limited effect on as much as 40% of the diabetes population in Hong Kong.

The patients' performance on other aspects of diabetes self-care varied. Their diet conformed to general dietary guidelines (perceived "healthy diet", vegetable intake, or fat intake) about half of the time. Proper foot care was however, only carried out about one third of the time. And they only performed self-monitoring of blood glucose about one day per week. More self-management education is therefore needed to emphasize the importance of those self-care activities. Information on foot care is scarce on the market because for the most part, foot care cannot be commercialized as a product.

Chapter 4

Determinants of physical activity and exercise

4.1 Introduction

Physical activity is an essential part of lifestyle changes that diabetes patients must adopt in order to manage their disease. Patients need to engage in sufficient physical activity to keep their glycemic level in check. From a public health point of view, the goal is to find factors that caused diabetes patients to not have "enough" exercise, i.e. be physically inactive.

Physical activity recommendations that were discussed in the first half of this chapter represent the minimum required amount of physical activity for diabetes patients. The second part of this chapter presented a finer-grain view of the relationships between independent variables and time-spent on physical activity. Rather than simply looking at whether the patients were active enough, factors that were correlated with the amount of time being spent on physical activity were identified. And finally, factors that correlated with time-spent on physical activity in a few high-risk sub-groups of patients were also explored. Groups that were looked at included those who had poor weight control (BMI $\geq$ 25 $\mathrm{kg\,m^{-2}}$), those who did not think about regular exercise (in precontemplation stage of change, the concept of stages of change will be further explained in Chapter 5), and patients who had poor glycemic control (HbA1c $\geq 7\%$).

4.2 Methods

Independent variables that were tested in this chapter include socio-demographic factors (gender, age, education level, employment type), exercise efficacy, behavioral constructs from the Theory of Reasoned Action (attitudes towards exercise, subjective norm, perceived control), instrumental social support, mental distress (depression, anxiety, and stress), various domains of diabetes self-care (general diet, vegetable intake, fat intake, foot care, and self-monitoring of blood glucose), and clinical parameters (body mass index, years since diagnosed with diabetes, meeting clinical targets for HbA1c, blood pressure, and LDL-cholesterol, meeting at least 2 clinical targets).

In the first part of this chapter, multivariate logistic regressions were used to identify factors that affect physical activity status in diabetes patients. Physical activity status was determined by one of the following criteria.

Infrequent exerciser was defined as those who had one day or less of moderate intensity physical activity per week. This definition distinguished those who had very infrequent exercise from others. This is a crude measure of high degree of physical inactivity. Proportion of patients who fell into this criteria was the sample regardless of whether physical activity or exercise was used for the calculation.

ADA-inactive The American Diabetes Association recommends a minimum of $150\,\mathrm{min\,week}^{-1}$ of moderate-intensity physical activity. Patients who did not reach this level of activity was defined as "ADA-inactive". The ADA recommendation only make use of the amount of time spent on physical activity as the criterion to determine whether someone is physically active. Meeting the ADA recommendation through exercise only or from all sources of physical activities were modeled.

ACSM-inactive The American College of Sports Medicine calls for participation in physical activity of at least moderate intensity for $30\,\mathrm{min\,d^{-1}}$ on at least 5 days per week. Those who did not meet all of the criteria were defined as "ACSM-inactive". This definition takes frequency of physical activity into account in addition to time-spent. Since data from the IPAQ that was used to measure physical activity cannot be used to determine how much physical activities were performed on a given day. Therefore, only exercise data was used.

EN-inactive In addition to time-spent, level of physical activity can be expressed in terms of energy expenditure. Energy expenditure was expressed in terms of metabolic equivalent (MET), which is the relative energy expenditure of an activity compared to the resting rate. Moderate-intensity activity was defined as having a MET of 4.0 and vigorous activities have a MET of 8.0. Since both recommendations from the ACSM and ADA add up to $150\,\mathrm{min\,week^{-1}}$, which, when expressed in terms of energy expenditure, translated into $600\,\mathrm{MET\,min\,week^{-1}}$. Diabetes patients who spent $< 600\,\mathrm{MET\,min\,week^{-1}}$ were defined as "EN-inactive". The use of energy expenditure allowed for the inclusion of physical activity intensity information into the analysis. Since we did not distinguish moderate-intensity exercise from vigorous-intensity exercise, this was only computed from physical activity data.

EN-all-inactive The previous definitions for physical activity only take into account physical activities of moderate intensity or higher. However, qualitatively, energy that are used during moderate or vigorous activities are equivalent to energy that used for walking. In fact, walking is defined as having a MET value of 3.3. "EN-all-inactive" patients were those who spent $< 600\,\text{MET}\,\text{min}\,\text{week}^{-1}$ of energy on all physical activities, including walking. Since exercise data only measured activities of at least moderate-intensity, physical activity data was used in the computation of this variable.

The above-mentioned definitions are but some of the methods by which physical activity status can be determined. They represent a group of recommendations with increasingly demanding prerequisites. Logistic regression modeling was used to find variables that were important for physical activity participation, regardless of how physical inactivity is defined. All independent variables were first modeled in univariate logistic regression models, then the ones that were significant univariately were then modeled under a multivariate logistic regression model.

Factors that were correlated with time-spent on physical activities of at least moderate-intensity were identified using multiple linear regressions. Independent variables that were modeled in the previous part were also included in the initial model. Variables were then removed one at a time using a backward stepwise elimination procedure based on the Akaike's Information Criterion (AIC) until the final model was obtained. In addition, we hypothesized that different sub-group of patients could be under the influence of different set of variables. Patients were stratified into different sub-groups according to their obesity status, physical activity status (based on the ADA guidelines), and according to their stage of changes to regular exercise (at least $30\,\text{min}\,\text{d}^{-1}$ on at least 5 days per week (ACSM guidelines)). The AIC-based modeling strategy used on the complete sample was employed again for the sub-group analysis.

4.3 Results

4.3.1 Factors in association with physical inactivity

Infrequent exerciser as the dependent variable

The results of the multiple logistic regression analysis identified two significant predictors for infrequent exerciser: exercise efficacy ($OR_m = 0.82$, $p < 0.001$) and positive attitudes towards exercise ($OR_m = 0.64$, $p < 0.05$; Table 4.1). The other two behavioral constructs, subjective norm and perceived control, were not significant in multivariate analysis ($p > 0.05$). Instrumental social support was significantly associated with being an infrequent exerciser in univariate analysis ($OR_u = 0.51$, $p < 0.001$), but was not significant in the multivariate model ($p > 0.05$). For diabetes self-care scores, the general diet and vegetable intake domains of diabetes self-care were associated with infrequent exercise in univariate analysis (general diet: $OR_u = 0.90$, $p < 0.01$; vegetable intake: $OR_u = 0.93$, $p < 0.05$), but not during multivariate analysis.

None of the socio-demographic variables, mental health sub-scale scores, as well as clinical parameters was associated with being an infrequent exerciser (Table 4.1).

Failure to meet the physical activity recommendation for diabetes patients from the American College of Sports Medicine (ACSM-inactive) as dependent variable

Females were significantly less likely to be classified as inactive according to the ACSM guidelines ($OR_m = 0.39$, $p < 0.001$; Table 4.1). Exercise efficacy was identified as a significant predictor for physical inactivity ($OR_m = 0.76$, $p < 0.001$).

Patients with a full-time job were significantly more likely to be inactive in univariate analysis only ($OR_u = 2.66$, $p < 0.001$). Attitudes toward exercise, subjective norm, and perceived control were significant predictors in univariate analyses ($p < 0.001$ for all), and became non-significant in multivariate analysis ($p > 0.05$ for all). Instrumental social support was also only found to be significant in univariate analysis ($OR_u = 0.53$, $p < 0.001$). General diet was the only diabetes self-care domain that showed significant association with physical inactivity ($OR_u = 0.88$, $p < 0.001$). But that associated also became non-significant in the multivariate model.

Again, the DASS21 depression, anxiety, and stress sub-scale scores were all non-significant predictors ($p > 0.05$). And none of the clinical parameters tested was associated with physical inactivity (based on ACSM guidelines; $p > 0.05$; Table 4.1). Age and education level showed no significant association with ACSM-inactivity.

Failure to meet the physical activity recommendation for diabetes patients from the American Diabetes Association (ADA-inactive) as dependent variable

Female gender was the only significant socio-demographics predictor of ADA-inactive regardless of whether exercise or physical activity was used as the outcome (exercise: $OR_m = 0.55$, $p < 0.05$; physical activity: $OR_m = 0.44$, $p < 0.001$; Table 4.2). Exercise efficacy was the other variable that consistently predicted ADA-inactivity as defined by either physical activity ($OR_m = 0.83$, $p < 0.001$) or exercise ($OR_m = 0.79$, $p < 0.001$). Positive attitudes towards exercise ($OR_m = 0.67$, $p < 0.01$) and instrumental social support ($OR_m = 0.57$, $p < 0.05$) were significantly associated with ADA-inactivity that was computed from physical activity, but not significant if computed from exercise.

Subjective norm was only significant in univariate analyses (exercise: $OR_u = 0.80$, $p < 0.001$; physical activity: $OR_u = 0.85$, $p < 0.001$). Similarly, perceived control was significant in univariate analyses (exercise: $\text{OR}_u = 0.96$, $p < 0.001$; physical activity: $\text{OR}_u = 0.97$, $p < 0.01$) but not in multivariate analyses.

Results for diabetes self-care showed that the general diet self-care score was significantly associated with ADA-inactivity by either method of computation in univariate analyses (exercise: $\text{OR}_u = 0.88$, $p < 0.001$; physical activity: $\text{OR}_u = 0.92$, $p < 0.01$). But none of the other diabetes self-care domains was significantly associated with physical inactivity in univariate logistic regression ($p > 0.05$). Neither scores from the depression, anxiety, nor stress sub-scale was significantly associated with physical inactivity. None of the clinical parameters tested was associated with physical inactivity ($p > 0.05$; Table 4.2).

Failure to meet recommended level of energy expenditure from physical activity of at least moderate intensity (EN-inactive) as dependent variable

Female gender ($\text{OR}_m = 0.44$, $p < 0.001$; Table 4.3) was the only significant sociodemographics variables in the multivariate logistic model. Exercise efficacy ($\text{OR}_m = 0.81$, $p < 0.001$), and attitudes towards exercise ($\text{OR}_m = 0.68$, $p < 0.05$) were significantly associated with physical inactivity status.

Full-time employment was only significant in univariate analysis ($\text{OR}_u = 1.48$, $p < 0.05$). Instrumental social support was not a significant predictor of physical inactivity in multivariate logistic analysis, but was significant in univariate analysis ($\text{OR}_u = 0.54$, $p < 0.001$). Both subjective norm ($\text{OR}_u = 0.84$, $p < 0.001$) and perceived control ($\text{OR}_u = 0.97$, $p < 0.001$) were only found to be significant in univariate analysis . Although general diet ($\text{OR}_u = 0.93$, $p < 0.05$) and foot care ($\text{OR}_u = 0.92$, $p < 0.05$) domain scores were associated with physical inactivity in univariate analyses, the associated became non-significant in multivariate analysis.

The DASS21 sub-scale scores were not significantly associated with physical inactivity even during univariate analyses ($p > 0.05$). None of the clinical parameters tested was associated with physical inactivity (based on energy expenditure from moderate-intensity, or higher, physical activity; $p > 0.05$; Table 4.1).

Failure to meet recommended level of energy expenditure from physical activity of all intensities (EN-all-inactive) as dependent variable

Exercise efficacy was the only significant predictor of physical activity ($OR_m = 0.83$, $p < 0.001$; Table 4.3) when energy expenditure from all sources of physical activity were considered.

While perceived control was significant univariately ($OR_u = 0.95$, $p < 0.001$), it was not associated with EN-all-inactive in the multivariate analysis. Subjective norm was also found to be only significant in univariate analysis ($OR_u = 0.87$, $p < 0.05$). General diet domain score was significant in univariate analysis ($OR_u = 0.89$, $p < 0.05$). However, when it was put into a multivariate model with other variables, it became non-significant ($p > 0.05$). Full-time employment was significantly associated with a higher likelihood of being inactive (based on energy expenditure from all physical activities) in univariate analysis ($OR_u = 1.82$, $p < 0.05$; Table 4.3). None of the other socio-demographic variables tested was significant in univariate analyses ($p > 0.05$).

Attitudes towards exercise, a significant predictor in many of the previous models for physical inactivity, was not even significant in univariate analysis to predict EN-all-inactive. Instrumental social support, the depression, anxiety, and stress DASS21 sub-scale scores, as well as the clinical parameters had no significant association with physical inactivity ($p < 0.05$; Table 4.3).

Summary

Exercise efficacy appeared to be the most important factor since it predicted physical inactivity in all of the definitions of physical inactivity that we tested. It was significant regardless of whether physical activity or exercise was used for calculation, or whether time-spent or energy expenditure was used as the unit, or even when an unconventional and extreme cut-off was used.

Females appeared to be more likely to be physically active, contrary to stereotypical beliefs. However, there was no gender difference for very infrequent participation in exercise. And if energy expenditure from walking was included, male and female were not significantly difference in their ability to meet the cut-off. A full-time employment was significantly associated with physical inactivity in univariate analyses for most of the definitions of physical inactivity. But that associated disappeared in every multivariate model that we tested.

A positive attitude towards exercise and high subjective norm were associated with physical inactivity in univariate analyses. For definitions of physical inactivity that were based on physical activity of moderate or high intensity (Infrequent exerciser, ADA-inactive (physical activity), EN-inactive), attitude remained significant in multivariate analyses. But for other definitions, attitude was not significant in multivariate models. On the other hand, regardless of which definition was used, subjective norm became non-significant in multivariate logistic regression analyses.

Instrumental social support predicted physical inactivity significantly in univariate models, with the exception of the one that included walking (EN-inactive-all). But all multivariate models that had instrumental social support included showed non-significant association between social support and physical inactivity.

Having a healthy diet in general were associated with lower likelihood of physical inactivity in univariate analyses. However, the associations became non-significant in multivariate analyses. Other forms of diabetes self-care did not show any consistent pattern of association with physical inactivity.

Non of the mental health scores was associated with physical inactivity status. Obesity status and the primary indicators for diabetes control (HbA1c, blood pressure, LDL-cholesterol) appeared to have no effect on physical inactivity.

4.3.2 Factors in correlation with time-spent on physical activity

Full sample

When all patients were analyzed together, old age was significantly correlated with a decreased time spent on physical activity ($\beta_m = -0.58$, $p < 0.01$; Table 4.4). On the other hand, exercise efficacy ($\beta_m = 0.20$, $p < 0.001$) and attitudes towards exercise ($\beta_m = 0.44$, $p < 0.001$) were positive predictors of time-spent on physical activity.

In the next sections, factors in correlation with time-spent on physical activity in various high-risk subgroups were identified.

4.3.3 Sub-group analysis of Obese and non-obese patients

First, regression analyses were performed on two separate groups of patients according to their obesity status.

Non-obese patients

For non-obese patients (BMI < 25 kg m^{-2}), exercise efficacy ($\beta_m = 0.26$, $p < 0.001$) and attitudes towards exercise ($\beta_m = 0.36$, $p < 0.05$; Table 4.4) were positively correlated with time-spent on physical activity in the multivariate linear regression analysis. Body mass index was marginally correlated with time-spent on physical activity ($\beta_m = -0.13$, $p < 0.10$).

Obese patients

For patients whose BMI were at least 25 $kg\,m^{-2}$, exercise efficacy ($\beta_m = 0.19$, $p < 0.001$) and attitudes towards exercise ($\beta_m = 0.56$, $p < 0.001$) were significant positive predictors of time-spent on physical activity (Table 4.4). Vegetable intake also showed significant correlation with time-spent on physical activity ($\beta_m = 0.12$, $p < 0.05$). Age was negatively correlated with time-spent on physical activity ($\beta_m = -0.79$, $p < 0.05$). Instrumental social support was correlated with time-spent on physical activity ($\beta_m = 0.68$, $p < 0.05$).

4.3.4 Sub-group analysis of patients at different stages of change to regular exercise

Patients were classified into sub-groups according to their readiness to exercise regularly, that is, to participate in at least five days of exercise at moderate or higher intensities, for at least 30 minutes per day.

Patients who were in precontemplation stage

For those who were in the precontemplation stage (never think about exercise regularly), old age ($\beta_m = -1.01$, $p < 0.01$) and high blood pressure ($\beta_m = -0.71$, $p < 0.05$) were negatively correlated with physical activity level (Table 4.5). Exercise efficacy ($\beta_m = 0.10$, $p < 0.05$) and instrumental social support ($\beta_m = 0.78$, $p < 0.05$) were positively correlated with level of physical activity. Interestingly, level of depression was positively correlated with physical activity ($\beta_m = 0.07$, $p < 0.05$). Diabetes self-care scores for the general diet domain and foot care domain were marginally correlated with physical activity ($\beta_m = 0.11$, $p < 0.10$ and $\beta_m = -0.15$, $p < 0.10$; respectively).

Patients who were in either contemplation or preparation stage

Exercise efficacy was a significant predictor ($\beta_m = 0.30$, $p < 0.01$) for patients who had thought about engaging in regular exercise (those in contemplation or preparation stage; Table 4.5). Perceived control was positively correlated with physical activity ($\beta_m = 0.18$, $p < 0.01$). Patients with better foot care appeared to spend more time on physical activities ($\beta_m = 0.53$, $p > 0.01$). Body mass index ($\beta_m = 0.27$, $p < 0.05$) and a high level of LDL-cholesterol ($\beta_m = 2.19$, $p < 0.01$) were both positively correlated with physical activity.

Having a secondary education ($\beta_m = -2.01$, $p < 0.05$) and longer duration since diagnosed with diabetes ($\beta_m = -0.16$, $p < 0.05$) were correlated with spending less time on physical activities in this group of patients.

Patients who were in either action or maintenance

Physical activity level of patients who were already exercising regularly (action or maintenance stage) was positively correlated with exercise efficacy ($\beta_m = 0.21$, $p < 0.001$), and their attitudes towards exercise ($\beta_m = 0.48$, $p < 0.001$). On the other hand, those who were older had a lower level of physical activity ($\beta_m = -0.64$, $p < 0.05$; Table 4.5).

Neither any of the mental distress scores, self-care domain scores, nor clinical indicators was correlated with time-spent on physical activity for this group of patients.

4.3.5 Sub-group analysis of patients based on HbA1c level

Patients were classified into sub-groups based on their HbA1c level. The treatment target for HbA1c of $< 7\%$ was used as the cut-off to stratify patients into those who had normal level of HbA1c ($< 7\%$) and those who had high level of HbA1c($\geq 7\%$).

Patients with normal level of HbA1c

For patients whose level of HbA1c was below the treatment target ($< 7\%$), higher exercise efficacy ($\beta_m = 0.17$, $p < 0.001$), more positive attitudes towards exercise ($\beta_m = 0.40$, $p < 0.05$), and better instrumental social support ($\beta_m = 0.87$, $p < 0.01$) were correlated with spending more time on physical activity. On the other hand, higher body mass index ($\beta_m = -0.10$, $p < 0.01$) were correlated with less time-spent on physical activity.

Patients with high level of HbA1c

The amount of time spent on physical activity for patients with higher level of HbA1c ($\geq 7\%$) were in correlation with female gender ($\beta_m = 0.86$, $p < 0.001$), exercise efficacy ($\beta_m = 0.23$, $p < 0.001$), and attitudes towards exercise ($\beta_m = 0.37$, $p < 0.05$).

4.3.6 Summary

Although different sub-groups appeared to have their own set of significant predictors. Exercise efficacy was consistently found to be a significant predictor for time-spent on physical activity in all sub-groups.

In two of the high-risk sub-groups (obese and high HbA1c), attitudes towards exercise was another significant factor that predicted time-spent on physical activities. However, attitudes was not significant for those who who were not ready to become more active (precontemplation stage, contemplation/preparation stage).

For those who did not think about regular exercise (precontemplation stage), increasing their level of instrumental support correlated with more time-spent on physical activities. The correlation became only marginal for those who had already thought about regular exercise (contemplation/preparation stages). However, for those who had high HbA1c, this kind of social support was not significantly correlated with time-spent on physical activities.

Depression was found to have a very weak but significant correlation with time-spent on physical activity for patients in the precontemplation stage to regular exercise. It was not a significant predictor in other sub-groups. Other mental distress variables were also not correlated with the amount of time the patients spent on physical activities.

4.4 Discussion

With different organizations championing different sets of physical activity guidelines for diabetes patients, each different from the others by a little. It is useful to identify common predictors for physical activity that have an effect regardless of how inactivity was defined.

Males were more likely than females to be physically inactive. But when walking was counted, the gender difference disappeared. A possible explanation is that since many of the female patients were housewives, many of their household duties were considered as moderate-intensity physical activities. Female gender was also found to be correlated with time-spent on physical activity only those whose HbA1c level was above the treatment target ($\geq 7\%$). The females are taking better care of themselves when the needs arise. Patient education need to highlight the importance of the HbA1c level so that both genders can grasp the necessity of lifestyle changes to keep HbA1c level under control.

Exercise efficacy was positively associated with physical activity status regardless of how physical activity was defined and it was positively correlated with time-spent on physical activity. Sub-group analyses revealed that it was also a significant factor for time-spent on physical activity in all of the groups that we modeled. Therefore, it should be the focal point of all intervention programs for physical activity. Exercise efficacy can be acquired through participating in exercise. So for patients who are not used to being physically active, health-care providers should customize an exercise plan for each patient so that the patients can build up their confidence to exercise regularly. However, preparedness to engage in regular exercise will be different for each patient. Our model for patient in different stages of change can be used as a guide to determine which patient should receive which treatment. For example, increasing instrumental social support appeared to be a potential strategy to increase physical activity participation for those who did not think about regular exercise. And once they started thinking about regular exercise, then instrumental social support became less important and give way to patients' ability to overcome barriers. By overcoming the barriers to regular exercise, the patients would have formed their own opinion about the effect of exercise. The positive opinion would then serve as a driver for the patients to maintain regular exercise.

Attitudes toward exercise were associated with infrequent exercise and physical inactivity according to the ADA guideline based on both time-spent and energy expenditure. It was also a significant predictor of time-spent on physical activity in most of the sub-groups. A more positive attitudes towards exercise is expected to correlate with longer participation in physical activity according to the Theory of Reasoned Action.[119] Programs promoting physical activity level should changes cognitions about efficacy and attitudes about physical activities. Introduction of simple and doable types of exercise, such as jogging (which is preferred by physically inactive males) may be useful.

Clinical indicators of diabetes control were used by doctors for prognosis. Failure to meet target levels of those indicators were also routinely used to encourage patients to perform better self-care. The lack of association between those indicators with physical activity in all of our analyses was a surprise. It is possible that patients might have used alternative management strategy other than physical activity to control their diabetes. This possibility will be explored in Chapter 6.

It is interesting to note that non of the mental distress variables (depression, anxiety, and stress) was associated with physical inactivity. And other than those who were not thinking about regular exercise, these variables were not correlated with time-spent on physical activity. For patients who had not think about regular exercise (i.e. in the precontemplation stage), depression was negative correlated with time-spent on physical activity. There are evidence that suggest exercise can be used to reduce depression.[105] Those patients were probably using physical activity as a coping mechanism to reduce stress, which will be examined further in Chapter 7. It also suggested that although exercise can reduce depression, existence of depressive symptoms might exert a negative impact on physical activity participation for those who are already active. It must be noted that this sample of patients had very low level of mental distress. So the observed correlation can only be applied to the lower portion of the mental distress spectrum. Existing diabetes treatment programs in Hong Kong usually do not have screening for mental health problem. Incorporation of depression screening might proved to be helpful.

Table 4.1: Logistic regression for physical inactivity

	Definition of physical inactivity‖					
	Infrequent exerciser			ACSM-inactive		
	% inactive	OR_u (95% CI)	OR_m (95% CI)	% inactive	OR_u (95% CI)	OR_m (95% CI)
Gender						
Male	26.8	1.0		62.5	1.0	1.0
Female	21.3	0.74 (0.48, 1.13)	—	45.7	0.51 (0.35, 0.73)§	0.39 (0.24, 0.64)§
Age (yr)						
< 60	20.9	1.0		58.6	1.0	
≥ 60	28.1	1.48 (0.97, 2.26)*	—	50.0	0.71 (0.49, 1.01)*	—
Education level						
Primary or less	27.8	1.0		53.5	1.0	
Secondary or above	22.2	0.74 (0.48, 1.15)	—	55.3	1.08 (0.74, 1.57)	—
Employment type						
Others	23.3	1.0		44.2	1.0	
Full-time	25.4	1.12 (0.73, 1.70)	—	67.8	2.66 (1.83, 3.88)§	NS
Duration of diabetes (year)		1.03 (1.00, 1.06)*	—		1.02 (0.99, 1.04)	—
Exercise efficacy		0.82 (0.78, 0.87)§	0.83 (0.79, 0.88)§		0.76 (0.72, 0.80)§	0.76 (0.72, 0.81)§
Behavioral constructs						
Positive attitudes		0.52 (0.38, 0.70)§	0.64 (0.44, 0.91)†		0.67 (0.54, 0.82)§	NS
Subjective norm		0.80 (0.72, 0.90)§	NS		0.82 (0.75, 0.89)§	NS
Perceived control		0.97 (0.95, 0.99)‡	NS		0.95 (0.93, 0.97)§	NS
Social support		0.51 (0.35, 0.74)§	NS		0.53 (0.38, 0.73)§	NS
Mental distress						
Depression		0.99 (0.94, 1.03)	—		0.99 (0.96, 1.02)	—
Anxiety		1.00 (0.95, 1.04)	—		1.00 (0.96, 1.04)	—
Stress		1.00 (0.96, 1.03)	—		0.99 (0.97, 1.02)	—
Self-care scores						
General diet		0.90 (0.94, 0.97)‡	NS		0.88 (0.83, 0.93)§	NS
Vegetable intake		0.93 (0.87, 0.99)†	NS		0.96 (0.91, 1.02)	—
Fat intake		0.98 (0.91, 1.06)	—		1.00 (0.94, 1.07)	—
Foot care		0.97 (0.89, 1.05)	—		0.97 (0.90, 1.04)	—
SMBG		1.00 (0.88, 1.13)	—		1.00 (0.90, 1.11)	—
BMI ($kg\,m^{-2}$)		1.03 (0.98, 1.08)	—		1.04 (1.00, 1.09)*	—
HbA1c						
Normal	22.7	1.0		51.9	1.0	
High ($\geq$ 7%)	26.0	1.20 (0.79, 1.83)	—	57.9	1.27 (0.89, 1.83)	—
Blood pressure						
Normal	20.4	1.0		56.0	1.0	
High ($\geq$ 130/80 mmHg)	27.1	1.45 (0.95, 2.25)	—	53.7	0.91 (0.63, 1.31)	—
LDL cholesterol						
Normal	26.2	1.0		53.1	1.0	
High ($\geq$ 2.6 $mmol\,l^{-1}$)	22.0	0.79 (0.52, 1.21)	—	56.4	1.14 (0.80, 1.64)	—
Number of ABC targets met¶						
≤ 1	26.0	1.0		57.5	1.0	
≥ 2	22.3	0.82 (0.53, 1.24)	—	51.7	0.79 (0.55, 1.14)	—

OR_u Univariate odds ratio, OR_m Multivariate odds ratio, — Variable not included in multivariate model, NS Not significant at $\alpha = 0.05$

* $p < 0.10$, † $p < 0.05$, ‡ $p < 0.01$, § $p < 0.001$

‖ *Infrequent exerciser* $\leq 1\,d\,week^{-1}$ of physical activity at moderate or vigorous intensity, *ACSM-inactive* $\geq 30\,min\,d^{-1}$ of moderate or higher intensity physical activity on $< 5\,d\,week^{-1}$

¶ Meeting HbA1c, blood pressure, or LDL cholesterol targets

Table 4.2: Logistic models for physical inactivity (based on ADA guidelines)

	Physically inactive according to ADA guidelines‖					
	Based on exercise			Based on physical activity		
	% inactive	OR_u (95% CI)	OR_m (95% CI)	% inactive	OR_u (95% CI)	OR_m (95% CI)
Gender						
Male	49 6	1 0	1 0	51 4	1 0	1 0
Female	37 7	0 61 (0 42, 0 89)†	0 55 (0 34, 0 88)†	35 6	0 52 (0 36, 0 756)§	0 44 (0 27, 0 68)§
Age (yr)						
< 60	47 0	1 0		46 8	1 0	
≥ 60	40 8	0 78 (0 54, 1 12)	—	41 2	0 80 (0 55, 1 15)	—
Education level						
Primary or less	46 7	1 0		45 7	1 0	
Secondary or above	42 9	0 86 (0 59, 1 26)	—	43 5	0 91 (0 62, 1 34)	—
Employment type						
Others	35 2	1 0	1 0	36 8	1 0	1 0
Full-time	55 2	2 28 (1 57, 3 32)§	NS	53 4	1 97 (1 36, 2 87)§	NS
Duration of diabetes (year)		1 02 (0 99, 1 04)	—		1 02 (0 99, 1 04)	—
Exercise efficacy		0 78 (0 74, 0 82)§	0 79 (0 75, 0 84)§		0 83 (0 79, 0 87)§	0 83 (0 78, 0 87)§
Behavioral constructs						
Positive attitudes		0 63 (0 50, 0 79)§	NS		0 63 (0 49, 0 78)§	0 67 (0 49, 0 90)‡
Subjective norm		0 80 (0 72, 0 87)§	NS		0 85 (0 78, 0 93)§	NS
Perceived control		0 96 (0 94, 0 97)§	NS		0 97 (0 95, 0 99)‡	NS
Social support		0 49 (0 34, 0 68)§	NS		0 52 (0 37, 0 72)§	0 57 (0 36, 0 89)†
Mental distress						
Depression		0 98 (0 95, 1 02)	—		0 99 (0 95, 1 02)	—
Anxiety		1 01 (0 97, 1 05)	—		0 99 (0 95, 1 03)	—
Stress		1 00 (0 97, 1 03)	—		0 99 (0 97, 1 02)	—
Self-care scores						
General diet		0 88 (0 83, 0 94))§	NS		0 92 (0 87, 0 98)‡	NS
Vegetable intake		1 00 (0 94, 1 06)	—		0 95 (0 89, 1 01)*	—
Fat intake		1 01 (0 94, 1 08)	—		1 04 (0 97, 1 11)	—
Foot care		0 96 (0 89, 1 03)	—		0 93 (0 86, 1 00)*	—
SMBG		0 98 (0 88, 1 09)	—		1 04 (0 93, 1 15)	—
BMI ($kg\,m^{-2}$)		1 03 (0 99, 1 08)	—		1 02 (0 98, 1 07)	—
HbA1c						
Normal	40 1	1 0		42 0	1 0	
High ($\geq$ 7%)	49 1	1 44 (1 00, 2 08)*	—	46 9	1 22 (0 84, 1 77)	—
Blood pressure						
Normal	42 8	1 0		43 5	1 0	
High ($\geq$ 130/80 mmHg)	45 3	1 11 (0 77, 1 60)	—	44 8	1 06 (0 73, 1 53)	—
LDL cholesterol						
Normal	41 7	1 0		42 7	1 0	
High ($\geq$ 2 6 $mmol\,l^{-1}$)	47 0	1 24 (0 86, 1 79)	—	46 0	1 15 (0 79, 1 66)	—
Number of ABC targets met¶						
≤ 1	50 2	1 0	1 0	48 3	1 0	
≥ 2	37 9	0 60 (0 42, 0 87)‡	0 62 (0 40, 0 96)†	40 2	0 72 (0 50, 1 04)	—

OR_u Univariate odds ratio, OR_m Multivariate odds ratio, — Variable not included in multivariate model, NS Not significant at $\alpha = 0\,05$

* $p < 0\,10$, † $p < 0\,05$, ‡ $p < 0\,01$, § $p < 0\,001$

‖ <150 min $week^{-1}$ of at least moderate-intensity physical activity / exercise

¶ Meeting HbA1c, blood pressure, or LDL cholesterol targets

Table 4.3: Logistic regression for physical inactivity (based on energy expenditure)

	Definition of physical inactivity‖					
	EN-inactive			EN-all-inactive		
	% inactive	OR_u (95% CI)	OR_m (95% CI)	% inactive	OR_u (95% CI)	OR_m (95% CI)
Gender						
Male	45.6	1.0	1.0	15.4	1.0	
Female	32.8	0.58 (0.40, 0.86)‡	0.44 (0.27, 0.71)§	10.3	0.63 (0.35, 1.11)	—
Age (year)						
< 60	39.8	1.0		13.6	1.0	
≥ 60	39.9	1.01 (0.69, 1.47)	—	12.6	0.92 (0.53, 1.59)	—
Education level						
Primary or less	42.9	1.0		16.2	1.0	
Secondary or above	38.1	0.82 (0.56, 1.22)	—	11.4	0.66 (0.38, 1.16)	—
Employment type						
Others	35.6	1.0	1.0	10.1	1.0	1.0
Full-time	45.0	1.48 (1.02, 2.17)†	NS	16.9	1.82 (1.05, 3.19)†	NS
Duration of diabetes (year)		1.02 (1.00, 1.05)*	—		1.00 (0.96, 1.04)	—
Exercise efficacy		0.81 (0.77, 0.85)§	0.81 (0.76, 0.86)§		0.80 (0.74, 0.86)§	0.83 (0.76, 0.90)§
Behavioral constructs						
Positive attitudes		0.60 (0.47, 0.76)§	0.68 (0.49, 0.92)†		0.94 (0.68, 1.26)	—
Subjective norm		0.84 (0.76, 0.92)§	NS		0.87 (0.75, 0.99)†	NS
Perceived control		0.97 (0.95, 0.99)§	NS		0.95 (0.93, 0.98)§	NS
Social support		0.54 (0.38, 0.76)§	NS		0.89 (0.55, 1.44)	—
Mental distress						
Depression		1.00 (0.96, 1.03)	—		0.99 (0.93, 1.04)	—
Anxiety		1.00 (0.96, 1.04)	—		1.02 (0.95, 1.07)	—
Stress		1.00 (0.97, 1.03)	—		1.01 (0.96, 1.05)	—
Self-care scores						
General diet		0.93 (0.87, 0.99)†	NS		0.89 (0.81, 0.98)†	NS
Vegetable intake		0.97 (0.91, 1.03)	—		0.94 (0.86, 1.03)	—
Fat intake		1.04 (0.97, 1.11)	—		0.98 (0.90, 1.10)	—
Foot care		0.92 (0.85, 0.99)†	NS		0.89 (0.78, 1.00)*	—
SMBG		1.03 (0.92, 1.15)	—		1.07 (0.92, 1.23)	—
BMI ($kg\,m^{-2}$)		1.02 (0.97, 1.07)	—		1.04 (0.97, 1.11)	—
HbA1c						
Normal	38.2	1.0		11.5	1.0	
High (≥ 7%)	41.7	1.16 (0.79, 1.69)	—	15.1	1.37 (0.79, 2.39)	—
Blood pressure						
Normal	40.5	1.0		13.9	1.0	
High (≥ 130/80 mmHg)	39.3	0.95 (0.65, 1.39)	—	12.5	0.89 (0.51, 1.55)	—
LDL cholesterol						
Normal	39.1	1.0		13.3	1.0	
High (≥ 2.6 $mmol\,l^{-1}$)	40.7	1.07 (0.73, 1.56)	—	13.0	0.97 (0.56, 1.69)	—
Number of ABC targets met¶						
≤ 1	42.5	1.0		13.8	1.0	
≥ 2	37.2	0.80 (0.55, 1.17)	—	12.5	0.89 (0.51, 1.55)	—

OR_u Univariate odds ratio, OR_m Multivariate odds ratio, — Variable not included in multivariate model, NS Not significant at $\alpha = 0.05$

* $p < 0.10$, † $p < 0.05$, ‡ $p < 0.01$, § $p < 0.001$

‖ *EN-inactive* engaged in < 600 MET min week^{-1} of physical activity at moderate or vigorous intensity, *EN-all-inactive* used < 600 MET min week^{-1} of energy from all physical activities

¶ Meeting HbA1c, blood pressure, or LDL cholesterol targets

Table 4.4: Linear regression for time-spent on physical activity, stratified by obesity

	β_m (95% CI)		
	Overall	Normal (BMI $<$ 25 kg m^{-2})	Obese (BMI $\geq$ 25 kg m ^{2})
Gender			
Male	*ref*	*ref*	*ref*
Female	0 43(0 02, 0 83)†	*NS*	0 47(−0 11, 1 05)
Age (year)			
$<$ 60	*ref*	*ref*	*ref*
$\geq$ 60	−0 58(−0 99, −0 17)‡	*NS*	−0 79(−1 39, −0 20)‡
Education level			
Primary or less	*ref*	*ref*	*ref*
Secondary or above	*NS*	*NS*	*NS*
Employment type			
Others	*ref*	*ref*	*ref*
Full-time	*NS*	*NS*	*NS*
Duration of diabetes (year)	*NS*	*NS*	*NS*
Exercise efficacy	0 20(0 16, 0 25)§	0 26(0 18, 0 33)§	0 19(0 12, 0 26)§
Behavioral constructs			
Positive attitudes	0 44(0 20, 0 68)§	0 36(0 03, 0 68)†	0 56(0 23, 0 89)§
Subjective norm	*NS*	*NS*	*NS*
Perceived control	*NS*	−0 03(−0 06, 0 01)	*NS*
Social support	0 33(−0 06, 0 71)*	*NS*	0 68(0 12, 1 25)†
Mental distress			
Depression	*NS*	*NS*	0 04(−0 01, 0 10)
Anxiety	*NS*	*NS*	*NS*
Stress	*NS*	*NS*	*NS*
Self-care scores			
General diet	*NS*	*NS*	*NS*
Vegetable intake	0 05(−0 01, 0 12)	*NS*	0 12(0 03, 0 21)†
Fat intake	*NS*	*NS*	*NS*
Foot care	*NS*	*NS*	*NS*
SMBG	*NS*	*NS*	−0 15(−0 30, 0 01)*
BMI (kg m ^{2})	−0 04(−0 09, 0 01)	−0 13(−0 27, 0 02)*	*NS*
HbA1c			
Normal	*ref*	*ref*	*ref*
High ($\geq$ 7%)	*NS*	−0 40(−0 96, 0 16)	*NS*
Blood pressure			
Normal	*ref*	*ref*	*ref*
High ($\geq$ 130/80 mmHg)	*NS*	*NS*	*NS*
LDL cholesterol			
Normal	*ref*	*ref*	*ref*
High ($\geq$ 2 6 mmol l^{-1})	*NS*	*NS*	*NS*
Number of ABC targets met$^{\Vert}$			
$\leq$ 1	*ref*	*ref*	*ref*
$\geq$ 2	*NS*	*NS*	*NS*

Note Dependent variable = LN(time-spent on physical activity of at least moderate-intensity + 1), β_m regression coefficient from model selected by using backward stepwise multiple linear regression, *NS* Variable removed by backward stepwise elimination based on reduction of AIC

* $p < 0\ 10$, † $p < 0\ 05$ ‡ $p < 0\ 01$, § $p < 0\ 001$

$^{\Vert}$ Meeting HbA1c, blood pressure, or LDL cholesterol targets

Table 4.5: Linear regression for time-spent on physical activity at different stages of change

	β_m (95% CI)		
	Precontemplation	Contemplation / Preparation	Action / Maintenance
Gender			
Male	*ref*	*ref*	*ref*
Female	0 50(−0 19, 1 18)	*NS*	*NS*
Age (year)			
< 60	*ref*	*ref*	*ref*
≥ 60	−1 01(−1 71, −0 32)‡	*NS*	−0 64(−1 20, −0 08)†
Education level			
Primary or less	*ref*	*ref*	*ref*
Secondary or above	*NS*	−2 01(−3 64, −0 39)†	*NS*
Employment type			
Others	*ref*	*ref*	*ref*
Full-time	*NS*	*NS*	*NS*
Duration of diabetes (year)	*NS*	−0 16(−0 29, −0 04)†	*NS*
Exercise efficacy	0 10(0 01, 0 20)†	0 30(0 11, 0 49)‡	0 21(0 13, 0 29)§
Behavioral constructs			
Positive attitudes	0 35(−0 10, 0 79)	*NS*	0 48(0 20, 0 77)§
Subjective norm	*NS*	*NS*	*NS*
Perceived control	*NS*	0 18(0 07, 0 29)‡	*NS*
Social support	0 78(0 07, 1 49)†	−1 20(−2 55, 0 14)*	*NS*
Mental distress			
Depression	0 07(0 01, 0 13)†	0 09(−0 06, 0 24)	*NS*
Anxiety	*NS*	0 26(−0 06, 0 57)	*NS*
Stress	*NS*	*NS*	*NS*
Self-care scores			
General diet	0 11(−0 01, 0 23)*	*NS*	*NS*
Vegetable intake	*NS*	*NS*	*NS*
Fat intake	*NS*	*NS*	*NS*
Foot care	−0 15(−0 30, 0 00)*	0 53(0 21, 0 85)‡	*NS*
SMBG	*NS*	0 33(−0 04, 0 70)*	*NS*
BMI ($\mathrm{kg\,m^{-2}}$)	*NS*	0 27(0 07, 0 48)†	*NS*
HbA1c			
Normal	*ref*	*ref*	*ref*
High ($\geq$ 7%)	*NS*	−1 21(−2 63, 0 20)*	0 45(−0 10, 1 00)
Blood pressure			
Normal	*ref*	*ref*	*ref*
High ($\geq$ 130/80 mmHg)	−0 71(−1 40, −0 02)†	*NS*	*NS*
LDL cholesterol			
Normal	*ref*	*ref*	*ref*
High ($\geq$ 2 6 $\mathrm{mmol\,l^{-1}}$)	*NS*	2 19(0 69, 3 69)‡	*NS*
Number of ABC targets met$^{\|}$			
≤ 1	*ref*	*ref*	*ref*
≥ 2	*NS*	*NS*	*NS*

Note Dependent variable = LN(time spent on physical activity of at least moderate intensity), β_m regression coefficient from model selected by using backward stepwise multiple linear regression, *NS* Variable removed by backward stepwise elimination based on reduction of AIC

* $p < 0\ 10$, † $p < 0\ 05$, ‡ $p < 0\ 01$, § $p < 0\ 001$

$^{\|}$ Meeting HbA1c, blood pressure, or LDL cholesterol targets

Table 4.6: Linear regression for time-spent on physical activity, stratified by HbA1c level

	β_m (95% CI)	
	Normal HbA1c (< 7%)	High HbA1c (≥ 7%)
Gender		
Male	*ref*	*ref*
Female	*NS*	$0\ 86(0\ 26, 1\ 46)^{‡}$
Age (year)		
< 60	*ref*	*ref*
≥ 60	$-0\ 44(-1\ 01, 0\ 12)$	$-0\ 57(-1\ 17, 0\ 04)^{*}$
Education level		
Primary or less	*ref*	*ref*
Secondary or above	*NS*	*NS*
Employment type		
Others	*ref*	*ref*
Full-time	*NS*	*NS*
Duration of diabetes (year)	$-0\ 04(-0\ 09, 0\ 00)^{*}$	*NS*
Exercise efficacy	$0\ 17(0\ 11, 0\ 23)^{§}$	$0\ 23(0\ 16, 0\ 30)^{§}$
Behavioral constructs		
Positive attitudes	$0\ 40(0\ 08, 0\ 71)^{†}$	$0\ 37(0\ 02, 0\ 71)^{†}$
Subjective norm	*NS*	*NS*
Perceived control	*NS*	*NS*
Social support	$0\ 87(0\ 31, 1\ 43)^{‡}$	*NS*
Mental distress		
Depression	$0\ 04(-0\ 01, 0\ 09)$	*NS*
Anxiety	*NS*	*NS*
Stress	*NS*	*NS*
Self-care scores		
General diet	*NS*	*NS*
Vegetable intake	*NS*	$0\ 08(-0\ 01, 0\ 18)^{*}$
Fat intake	*NS*	*NS*
Foot care	*NS*	*NS*
SMBG	$-0\ 12(-0\ 28, 0\ 04)$	*NS*
BMI ($kg\ m^{-2}$)	$-0\ 10(-0\ 17, -0\ 04)^{‡}$	
Blood pressure		
Normal	*ref*	*ref*
High (≥ 130/80 mmHg)	*NS*	*NS*
LDL cholesterol		
Normal	*ref*	*ref*
High (≥ 2 6 $mmol\ l^{-1}$)	*NS*	*NS*
Number of ABC targets met[‖]		
≤ 1	*ref*	*ref*
≥ 2	*NS*	*NS*

Note Dependent variable = LN(time-spent on physical activity of at least moderate-intensity), β_m regression coefficient from model selected by using backward stepwise multiple linear regression, *NS* Variable removed by backward stepwise elimination based on reduction of AIC

$^{*}\ p < 0\ 10$, $^{†}\ p < 0\ 05$, $^{‡}\ p < 0\ 01$, $^{§}\ p < 0\ 001$

[‖] Meeting HbA1c, blood pressure, or LDL cholesterol targets

Chapter 5

The importance of considering stages of change for future exercise interventions

5.1 Introduction

Stages of change is one of the core constructs of the Transtheoretical Model (TTM).[127] Under the stage model, instead of classifying a behavior simply by its presence or absence, behavioral change is expressed as a continuous process that goes through different stages. Each stage represents different level of readiness to engage in the target behavior. Stage-matched interventions have been shown to be more effective at increasing physical activity level in general populations,[129,130] as well as in diabetes patients.[131–133] The key to stage-matched intervention is to apply different processes of change in accordance with the stages of change. Processes of change can be categorized into two types—cognitive-affective processes and behavioral processes. Cognitive-affective processes deal with how someone *think* about a particular behavior; and behavioral processes deal with how *participation* changes personal behavior.[134]

Previous local study of application of TTM in exercise is limited to the undergraduate student population.[135] Since being physically active is an important part of diabetes management, studying stages of change to exercise in the diabetes population may bring new ideas to future programming planning.

5.2 Objective and methods

The goal of this chapter is to describe the readiness of Hong Kong's diabetes patients to engage in exercise and to identify factors that might help patients to be more ready for regular exercise.

Patients' self-reported readiness to engage in regular exercise were used to determine their stages of change (regular exercise was defined as engaging in at least 30 minutes of moderate-intensity exercise for five days per week (ACSM recommendation)). Patients who indicated that they never think about regular exercise in the past six months were in the Precontemplation stage. Contemplation is the stage when patients started thinking about regular exercise but was still struggling. For the Preparation stage, patients were actively trying to engage in regular exercise. For the patients who already engaged in regular exercise, they belonged to the Action stage if they only started for less than six months. For those who had already been exercising regularly for more than six months, they belonged to the Maintenance group.

The distribution of stages of change to regular exercise was first described to give us a picture of the current situation. Then, stage-specific exercise preferences of the diabetes patients were explored to identify any shift in preference with stage progression.

A meta-analysis by Rosen showed that unlike as predicted under the TTM, use of both cognitive-affective and behavioral processes increased continuously from precontemplaton stage all the way to maintenance stage.[134] Differences between the stages for some cognitive factors (exercise efficacy, attitudes towards exercise, subjective norm, control of barriers to exercise) were examined. Diabetes patients receive plenty of patient education on the importance of exercise because of the necessity for them to exercise for diabetes control. We expected that this population should follow a more orthodox TTM trajectory with cognitive processes peaking at the contemplation and preparation stages, followed by a peak of behavioral processes at the action and maintenance stages.

Then, factors in association with being in the precontemplation stage (reference = all other stages) were identified using multivariate logistic regression. In addition, since the public health goal is for patients to be active instead of just thinking about being active, we used multivariate logistic regression to identify factors in association with the action or maintenance stages (reference = patients who were at precontemplation, contemplation, or preparation stage).

For the multivariate logistic regression analyses, independent variables were first fitted independently under a univariate logistic model. Then variables that were significant in univariate analyses were then modeled together in a multivariate model. Independent variables that were tested include socio-demographic characteristics such as gender, age, education level, employment type. Cognitive constructs, including exercise efficacy, attitudes towards exercise, subjective norm, and control of barriers were also used as independent variables. Furthermore, the effect of instrumental social support were assessed. The influence of obesity was tested in both regression models. Glycosylated hemoglobin (HbA1c) level, blood pressure, and LDL-cholesterol level, the primary indicators of diabetes control, were also tested for association with the stages of change.

5.3 Results

5.3.1 Stage distribution

Out of the 517 patients who responded to the questions on stage of change, the majority of patients were classified into either the Precontemplation (46%), or the Maintenance (40%) stage. 4% was in the Contemplation stage, 7% was in the Preparation stage, and only 2% was in the Action stage. There was no significant gender difference ($p > 0.05$; Table 5.1).

Table 5.1: Exercise stages of change

Stages of change	All / % (N = 576)	Male / % (N = 311)	Female / % (N = 265)	p^*
Precontemplation	46.4	45.1	47.9	NS
Contemplation	4.3	4.7	3.8	
Preparation	7.2	8.3	5.8	
Action	1.9	2.5	1.2	
Maintenance	40.2	39.4	41.2	

NS Not significant at $\alpha = 0.05$
* Pearson χ^2 test comparing males against females

5.3.2 Stage-specific exercise participation

Participation in milder forms of exercise such as strolling and stretching were similar across different stages of change (Table 5.2). A higher percentage of patients participated in more vigorous forms of exercise such as jogging, swimming, and hiking as they progressed through the stages.

5.3.3 Stage-specific change in cognitive factors

Exercise efficay was found to be significantly associated with stages of change (One-way ANOVA: $F_4 = 74.16$, $p < 0.001$). Exercise efficacy increased with each progression in the stages of change (Table 5.3). Mean score for exercise efficacy increased

Table 5.2: Exercise preference by stages of change

	Participated in each type of exercise / %			
	Precontemplation	Cont/Prep/Action	Maintenance	p^*
Strolling	44	46	46	*NS*
Stretching	13	12	19	*NS*
Jogging	9	16	20	< 0 01
Swimming	5	12	11	< 0 05
Hiking	5	12	14	< 0 01

NS Not significant at $\alpha = 0\ 05$
* Pearson χ^2 test

from 2.73 for those in the precontemplation stage, to 3.43 for patients who were in the contemplation stage, 6.97 for those in preparation stage, 8 10 for those in action stage, and 8.22 for those in the maintenance stage. Results from linear regression analyses showed that the only significant increase of exercise efficacy was from the contemplation stage to the preparation stage ($p < 0.001$). The increase of exercise efficacy for other stage progressions (precontemplation to contemplation, preparation to action, action to maintenance) were not significant ($p > 0.05$).

Table 5.3: Exercise efficacy by stages of change

	Exercise efficacy	Destination stage *p*-value for stage progression*			
Starting stage†	Mean±Std dev	Contemplation	Preparation	Action	Maintenance
Precontemplation	2 73±3 55	NS	—	—	—
Contemplation	3 43±4 13	—	< 0 001	—	—
Preparation	6 97±3 77	—	—	NS	—
Action	8 10±3 28	—	—	—	NS
Maintenance	8 22±3 27	—	—	—	—

NS Not significant at $\alpha = 0\ 05$
* *p*-value for comparing the mean of exercise efficacy of the "Starting" stage to the "Destination" stage
† Stages of change for at least 5 days per week of exercise at moderate or higher intensity for at least 30 minutes per day

Attitudes towards exercise was also found to be significantly associated with stages of change (One-way ANOVA: $F_4 = 6.08$, $p < 0.001$). The mean attitudes score increased from 1.01 (precontemplation) to 1.26 (contemplation), but then decreased again to 1.09 (preparation), and further decreased to 0.78 (action), but finally increased once again for those in the maintenance stage (Table 5.4). However, those fluctuations in attitudes scores were not statistically significant, with the exception of going from action to maintenance stage ($p < 0.05$). Overall, the increase in attitudes from precontemplation stage to maintenance stage was significant (pairwise t-test with Bonferroni's adjustment for multiple comparisons: $p < 0.001$).

Table 5.4: Attitudes towards exercise by stages of change

	Attitudes score	Destination stage p-value for stage progression*			
Starting stage†	Mean±Std dev	Contemplation	Preparation	Action	Maintenance
Precontemplation	1 01±0 76	NS	—	—	—
Contemplation	1 26±1 05	—	NS	—	—
Preparation	1 09±0 83	—	—	NS	—
Action	0 78±0 49	—	—	—	< 0 05
Maintenance	1 41±0 99	—	—	—	—

NS Not significant at $\alpha = 0\ 05$
* p-value for comparing the mean of attitudes score of the "Starting" stage to the "Destination" stage
† Stages of change for at least 5 days per week of exercise at moderate or higher intensity for at least 30 minutes per day

Subjective norm was another factor that showed significant associated with stages of change (One-way ANOVA: $F_4 = 6.49$, $p < 0.001$). The mean subjective norm scored was 4.09 for precontemplation, 4.35 for contemplation, 4.39 for preparation, 4.10 for action, and 5.16 for maintenance stage. There was a significant difference between subjective norm scores of the precontemplation stage and the maintenance stage (pairewise t-test with Bonferroni's adjustment for multiple comparisons: $p < 0.001$). However, there was no significant difference for subjective norm scores of adjacent stages (Table 5.5).

Control of barriers to exercise was another cognitive factors that was found to be significantly associated with stages of change (One-way ANOVA: $F_4 = 9.502$, $p < 0.001$). Although a decrease in mean scores for control of barriers to exercise with stage progression was observed (precontemplation: -8.94; contemplation: -9.35; preparation: -4.83; action: -4.70; maintenance: -3.05). None of the de-

Table 5.5: Subjective norm by stages of change

	Subj norm score	Destination stage p-value for stage progression*			
Starting stage†	Mean±Std dev	Contemplation	Preparation	Action	Maintenance
Precontemplation	4 09±1 95	NS	—	—	—
Contemplation	4 35±1 88	—	NS	—	—
Preparation	4 39±1 82	—	—	NS	—
Action	4 10±1 31	—	—	—	NS
Maintenance	5 16±2 55	—	—	—	—

NS Not significant at $\alpha = 0\ 05$
* p-value for comparing the mean of subjective norm score of the "Starting" stage to the "Destination" stage
† Stages of change for at least 5 days per week of exercise at moderate or higher intensity for at least 30 minutes per day

crease in control of barrier score for adjacent stages was found to be statistically significant ($p > 0.05$, Table 5.6). The only significant decrease was observed between precontemplate and maintenance stage (pairwise t-test with Bonferroni's adjustment for multiple comparisons. $p < 0.001$).

Table 5.6: Barriers to exercise by stages of change

	Barriers score	Destination stage p-value for stage progression*			
Starting stage†	Mean±Std dev	Contemplation	Preparation	Action	Maintenance
Precontemplation	−8 94±10 71	NS	—	—	—
Contemplation	−9 35±12 51	—	NS	—	—
Preparation	−4 83±7 70	—	—	NS	—
Action	−4 70±11 54	—	—	—	NS
Maintenance	−3 05±9 85	—	—	—	—

NS Not significant at $\alpha = 0\ 05$
* p-value for comparing the mean of barriers score of the "Starting" stage to the "Destination" stage
† Stages of change for at least 5 days per week of exercise at moderate or higher intensity for at least 30 minutes per day

5.3.4 Factors in association with stages of change

Exercise efficacy was negatively associated with being in the precontemplation stage ($OR_m = 0.73$, $p < 0\ 001$; Table 5.7), but was positively associated with being in the action/maintenance stage ($OR_m = 1.32$, $p < 0\ 001$). A positive attitude towards exercise was negatively associated with precontemplation ($OR_m = 0.66$,

$p < 0.05$) but had a significant positive association with the action/maintenance stages ($\text{OR}_m = 1.50$, $p < 0.01$). For every unit point of increase in HbA1c level, the patients were 24% less likely to be in the precontemplation stage ($\text{OR}_m = 0.76$, $p < 0.001$).

Although subjective norm, control of barriers and instrumental social support were significant predictors during univariate analyses, all of them became non-significant in multivariate analyses (Table 5.7). Full-time employment were significant in univariate analyses for both outcomes, and yet, it was not significant when modeled in a multivariate logistic model.

Obesity did not show any association with stages of change. None of the indicators of diabetes control (HbA1c, blood pressure, LDL-cholesterol) was associated with being in precontemplation stage or in action/maintenance stage.

5.4 Discussion

The stage distribution showed that for this group of diabetes patients, who have had the disease for quite a number of years (mean is 8.94 years), a relatively stable equlibrium on exercise has been reached. There were many who have already become physically active for quite some time, and there were those who did not even think about trying to reach the recommended level of physical activity, with few patients between the two extremes. In order to make more efficient use of limited resources, it will be better to concentrate the efforts into moving patients away from the precontemplation stage first, and then eventually proceed into the action or even maintenance stage. Important clues to designing a stage-matched exercise intervention program can be found in our results for the variables exercise efficacy and attitudes towards exercise.

Patients with higher exercise efficacy and attitudes towards exercise were less likely to be in the precontemplation stage (compared to all other stages); they were also more likely to be in the action / maintenance stages (compared to the precontemplation / contemplation / preparation stage). Therefore, those two constructs should be the core components of any intervention program that aims at increasing exercise participation in diabetes patients. According to the Transtheoretical Model, advancing through the stages involves a decisional balance between the pros and cons of exercise.[127] The attitudes towards exercise measured in this study can be seen as the outcome from balancing the various pros and cons of exercise for diabetes control. The overall positive attitudes towards exercise for patients in the precontemplation stage suggested that patient education were able to instill positive attitudes about exercise into this group of patients.

The Transtheoretical Model paradigm also suggests that it is most efficient for intervention programs to match different processes of change to the stages of change in order to maximize the effect. Processes of change are activities that people use to progress thought the different stages of change.[127] With approximately 46% of the diabetes patients in the precontemplation stage, and only 2-7% in the contemplation, preparation, or action stage, it will be more efficient to first introduce intervention programs that focus on moving patients out of the precontemplation stage. The processes of change that should be employed for this stage is proposed to be the "consciousness raising", "environmental re-evaluation", and "dramatic relief" processes.[127]

Consciousness raising involves raising the awareness of the cause and effect of physical inactivity, as well as how to become more active. Therefore, more emphasis should be placed on increasing the perceived benefits of becoming physically active through patient education or even media campaigns. Environmental re-evaluation uses assessments of the difference between being physically active and inactive on one's social environment. Since physical inactivity does not directly affect others, interventions need to focus on indirect effects such as the possible impact on social life if insulin injection is required, or how family will be affected if patient suffers from multiple diabetes-related complications. Programs can also tap into the self-esteem of the patients by emphasizing how being active can be a role model for other diabetes patients. Some of the suggestions also tap into the dramatic relief process. Dramatic relief was achieved by using various techniques to emotionally move people by showing the consequences of being physically inactive, and how becoming active can reduce those effects. Interventions can use role-playing or personal testimonies to bring out the consequences of physical inactivity. These processes of change are closely related to how patients evaluate exercise. Our results showed that patients' attitudes towards exercise did not show any significant increase across stages until the maintenance stage. This shows that there is a need for identification of patients who did not think about regular exercise and offer them some of the suggested interventions. The goal is to improve their attitudes further until they start thinking about regular exercise.

The low exercise efficacy score for the earlier stages points at a potential target for intervention. We observed that there was a dramatic increase in exercise efficacy from the contemplation to the preparation stage. By definition, preparation stage is when patients were actively preparing to exercise regularly. During this period, they might have switched from using the cognitive-affective processes of change, to the behavioral processes instead. Evidence of this switch came from the observation that during the contemplation to action stages, participation in the more vigorous types of exercise such as jogging, swimming, and hiking was significantly higher than the earlier (precontemplation) stage. At the same time, participation in strolling and stretching remained constant. Processes such as self-liberation, reinforcement management, and counterconditioning are seen to have an effect even in a non-interventional situation. Therefore, to accelerate stage progression, interventions can include elements that highlight those processes of change to make the patients more "tuned" to the effects. Instructor-led exercise programs that utilise those elements can be prescribed to patients at the contemplation stage to help patients to build up their efficacy to exercise regularly and stimulate stage progression.

Between the contemplation and preparation stage, there was also an increase in control of barriers, which, while not statistically significant, is suggestive of another shift in the decisional balance. The increase in exercise efficacy probably caused the simutaneous increase in control to barriers. However, since control of barriers is dependent on the types of barriers being measured, it had a much higher variability than exercise efficacy. A better understanding of the types of barriers encountered by the patients in Hong Kong will give us a better estimation of the control of barriers construct.

Doctors usually use indices such as BMI, HbA1c level, blood pressure, and LDL-cholesterol level as indicators for diabetes control. Those are also used for explaining the severity of diabetes to the patients. The thought is that patients would adjust their lifestyle according to the severity of their disease, a school of thought that can be best-represented by the Health Belief Model.[170] However, in our sample of diabetes patients, none of those indicators was associated with stages of change to exercise. As discussed previously, this group of patients has reached some kind of equalibrium on exercise behavior because it has been many years since they started living with diabetes. They lack a trigger to spur them into action, this cue to action is a major component in the Health Belief Model. And apparantly, those clinical indicators can no longer be used as effective triggers to change exercise behavior.

The strategies outlined in the previous paragraphs can provide the external forces for diabetes patients to become more active.

Traditional intervention for improving physical activity level for diabetes patients, such as patient education classes as well as instructor-led exercise classes, usually employ same tactics for everyone, regardless of patients' readiness to become more active. Our results suggested that for those who were physically inactive and did not think about changing their ways, patient education need to be enhanced further to make patients more concious about the benefits of physical activity, and to decrease the influence of the negative effects. And once the patients start thinking about regular exercise, that would be the ideal time to offer them exercise class to help them raise their efficacy for exercise.

Table 5.7: Logistic regression for predicting stages of change to regular exercise

	Precontemplation (ref other stages)		Action/Maintenance (ref other stages)	
	OR_u (95% CI)	OR_m (95% CI)	OR_u (95% CI)	OR_m (95% CI)
Gender				
Male	*ref*	–	*ref*	–
Female	*NS*	–	*NS*	–
Age				
< 60 years	*ref*	–	*ref*	*ref*
≥ 60 years	*NS*	–	$1\ 58(1\ 11, 2\ 26)^*$	*NS*
Education level				
Primary or less	*ref*	–	*ref*	–
Secondary or above	*NS*	–	*NS*	–
Employment type				
Others	*ref*	*ref*	*ref*	*ref*
Full-time	$1\ 50(1\ 06, 2\ 13)^*$	*NS*	$0\ 53(0\ 37, 0\ 76)^‡$	*NS*
Cognitive constructs				
Exercise efficacy	$0\ 74(0\ 70, 0\ 77)^‡$	$0\ 74(0\ 70, 0\ 79)^‡$	$1\ 37(1\ 30, 1\ 45)^‡$	$1\ 30(1\ 23, 1\ 39)^‡$
Attitudes towards exercise	$0\ 64(0\ 51, 0\ 80))^‡$	$0\ 66(0\ 47, 0\ 90)^*$	$1\ 56(1\ 26, 1\ 94)^‡$	$1\ 50(1\ 11, 2\ 06)^†$
Subjective norm	$0\ 83(0\ 76, 0\ 91)^‡$	*NS*	$1\ 22(1\ 12, 1\ 33)^‡$	*NS*
Control of barriers	$0\ 95(0\ 93, 0\ 97)^‡$	*NS*	$1\ 06(1\ 04, 1\ 08)^‡$	*NS*
Social support	$0\ 57(0\ 41, 0\ 78)^‡$	*NS*	$1\ 72(1\ 25, 2\ 38)^‡$	*NS*
Obesity				
Normal (< 25 $kg\,m^{-2}$)	*ref*	–	*ref*	–
Obese (≥ 25 $kg\,m^{-2}$)	*NS*	–	*NS*	–
HbA1c				
Normal (< 7%)	*ref*	–	*ref*	–
High (≥ 7%)	*NS*	–	*NS*	–
Blood pressure				
Normal (< 130/80 mmHg)	*ref*	–	*ref*	–
High (≥ 130/80 mmHg)	*NS*	–	*NS*	–
LDL-cholesterol				
Normal (< 2 6 $mmol\,l^{-1}$)	*ref*	–	*ref*	–
High (≥ 2 6 $mmol\,l^{-1}$)	*NS*	–	*NS*	–

Note OR_u odds ratio from univariation logistic regression, OR_m odds ratio from multivariate logistic regression, – variable not included in multivariate model, *NS* not significant at $\alpha = 0\ 05$

$^*\ p < 0\ 05$, $^†\ p < 0\ 01$, $^‡\ p < 0\ 001$

Chapter 6

Determinants of diabetes self-care

6.1 Introduction

Diabetes management requires patients to actively engage in many different kinds of self-care tasks. Aside from physical activity, which was already discussed in Chapter 4, healthy diet, self-monitoring of blood glucose and foot care are also important aspects of diabetes self-care.

In this chapter, we tried to identify factors in association with level of self-care of separate self-care domains as well as overall level of self-care. The overall self-care score was constructed by summing up individual item from the diet, self-monitoring of blood glucose and foot care domains of the SDSCA. Simple linear regression was first used to identify factors that were in association with levels of self-care. Then variables that were significant in the simple linear regression analyses were modeled together in a multiple linear regression model. Independent variables that were tested for correlation with overall level of self-care included gender, age, education level, employment type, duration of diabetes, and physical activity level. Mental distress in terms of depression, anxiety, and stress scores were also tested for correlation. Instrumental social support is expected to be an extrinsic factor and self-care self-efficacy is an intrinsic factor for level of self-care. Physical measurement and clinical treatment indices including obesity status, HbA1c level, blood pressure, LDL-cholesterol level were also tested for their correlation with level of self-care.

Patients with higher self-care self-efficacy were expected to have better self-care. Patients who have had diabetes for longer period were also expected to show higher level of self-care because they are used to performing those activities. A higher level of instrumental social support was expected to correlate with higher level of self-care. Patients who exercised more were expected to do better in other aspects of diabetes self-care. Obese patients were expected to have better diet compared to the patients who were not obese. High levels of clinical indicator were hypothesized to motivate patients into doing better diabetes self-care.

6.2 Results

6.2.1 Factors in correlation with overall level of self-care

Linear regression analysis found that having a full time job ($\beta_m = -3.92$, $p < 0.001$; Table 6.1) was negatively correlated with the overall self-care score. In contrast, factors that were positively correlated with self-care score included instrumental social support ($\beta_m = 2.26$, $p < 0.05$) and self-care self-efficacy ($\beta_m = 5.41$, $p < 0.001$).

Duration of diabetes did not show any significant correlation with overall self-care ($p > 0.05$). Level of physical activity (log-transformed time-spent on physical activity of at least moderate-intensity) was not significantly correlated with overall self-care score ($p > 0.05$). The mental distress scores and whether or not clinical treatment targets were met appeared to have no significant correlation with overall level of self-care in simple linear regression analyses. Obesity also showed no significant association with overall level of self-care ($p > 0.05$; Table 6.1).

Factors in correlation with different domains of self-care were explored in Section 6.2.2 to 6.2.6.

6.2.2 Factors in correlation with a healthy diet

Patients who had a full-time job ($\beta_m = -0.86$, $p < 0.01$; Table 6.1) or were obese ($\beta_m = -0.70$, $p < 0.01$) were negatively correlated with the SDSCA general diet score. Self-care self-efficacy was positively correlated with general diet ($\beta_m = 1.52$, $p < 0.001$).

Time-spent on physical activity was significantly correlated with general diet score during univariate analysis ($\beta_u = 0.17$, $p < 0.01$), but the correlation became non-significant in the multivariate analysis ($p > 0.05$). Age and instrumental social support were correlated with general diet score in univariate analyses ($\beta_u = 0.75$, $p < 0.01$ and $\beta_u = 0.97$, $p < 0.001$, respectively). However, they were not significantly correlated with general diet in multivariate linear regression analysis ($p > 0.05$).

Duration since diagnosed with diabetes appeared to have no significant correlation with the general diet score ($p > 0.05$). The depression, anxiety, or stress scores were not correlated at all with general diet. Non of the clinical indicators was correlated with general diet (Table 6.2).

6.2.3 Factors in correlation with increase vegetable intake

Time-spent on physical activity was the only significant predictor of increase vegetable intake ($\beta_u = 0.12$, $p < 0.05$; Table 6.2). Non of the other variables that were tested was significant even in simple linear regression analysis ($p > 0.05$ for all).

6.2.4 Factors in correlation with decrease fat intake

Self-care self-efficacy was significantly correlated with decrease fat intake in the diabetes patients ($\beta_u = 0.72$, $p < 0.05$; Table 6.2). Instrumental social support was also significant in the univariate model ($\beta_u = 0.52$, $p < 0.05$). However, when instrumental social support was included in the multivariate linear model with self-care self-efficacy, instrumental social support was found to be non-significant while self-care self-efficacy was only marginally significant (data not shown). Therefore, instrumental social support was dropped from the multivariate model.

Neither the mental distress scores nor the levels of the clinical indicators were correlated with fat intake ($p > 0.05$). The amount of time since the patients were diagnosed with diabetes showed no significant correlation with fat intake. And the amount of time patients spent on physical activity also did not correlate with their fat intake ($p > 0.05$).

6.2.5 Factors in correlation with good foot care

Patients who had a full-time job had worse foot care score than the other patients ($\beta_m = -0.51$, $p < 0.05$; Table 6.3). Instrumental social support was significantly correlated with foot care ($\beta_m = 0.75$, $p < 0.001$). Self-care self-efficacy score was not correlated with foot care in the multivariate linear model despite a significant correlation during univariate analysis ($\beta_u = 0.66$, $p < 0.01$).

The mental distress scores for depression, anxiety, and stress were not correlated with foot care ($p > 0.05$). Severity of diabetes in term of the levels on the three primary clinical indicators (HbA1c, blood pressure, LDL-cholesterol) were also not correlated with foot care ($p > 0.05$). Duration of diabetes and time-spent on physical activity showed no significant correlation with level of foot care ($p > 0.05$).

6.2.6 Factors in correlation with increase frequency of self-monitoring of blood glucose

Self-monitoring of blood glucose was performed more frequently by patients who had at least a secondary education when compared to the less-educated ones ($\beta_m = 0.33$, $p < 0.05$; Table 6.3). Frequency of SMBG was also positively correlated with duration of diabetes ($\beta_m = 0.03$, $p < 0.01$), and self-care self-efficacy ($\beta_m = 0.56$, $p < 0.01$). Instrumental social support was a significant predictor of SMBG frequency in simple linear regression analysis ($\beta_u = 0.39$, $p < 0.01$), but it was not significant in multiple linear regression analysis.

Physical activity level did not correlate significantly with SMBG ($p > 0.05$). Scores for depression, anxiety, and stress were not correlated with SMBG ($p > 0.05$). And there was no correlation between SMBG and levels of HbA1c, blood pressure, or LDL-cholesterol ($p > 0.05$; Table 6.3).

6.3 Discussion

Self-care self-efficacy was found to be correlated with many aspects of diabetes self-care (a healthy diet in general, decrease fat intake, and more frequent SMBG). Despite those correlations, self-care self-efficacy was not correlated with vegetable intake or foot care in our sample.

The dietary changes that patients performed in order to achieve a healthy diet might have involved reducing overall dietary intake and a low-fat diet. They might not have considered a higher vegetable intake to be important for diabetes management or even unimportant in general. It is interesting to find that time-spent on physical activity was the only factor found to be significantly correlated with vegetable intake, and that it was not with any other aspects of diabetes self-care. It is possible that patients who took part in more physical activities were more health-conscious and ate more vegetables. Therefore, vegetable intake might be seen as a good dietary practice in general, but not something that is crucial for diabetes management. Health-care providers need to emphasize the importance of vegetable intake during patient education.

Foot care is an often-neglected part of diabetes self-care. Our results showed that self-care self-efficacy was not correlated with level of foot care. Patients appeared to not have considered foot care as an important part of self-care, similar to how they discounted the importance of vegetable intake. So the patients might have thought that their present level of foot care was already enough. Another possible explanation for this observation came as a side-effect of marketing efforts for diabetes-management–related products. There are a wide variety of dietary products that claim to be suitable for diabetes patients. And there are home glucose test kits available on the market for patients to monitor their glucose level. One can often find advertisements for those products on the street. However, there is simply no mention of product for foot care. Therefore, the disproportional amount of promotion efforts that were placed on controlling blood glucose level with a healthy diet and regular monitoring caused patients to focus all their efforts into those areas of self-care. There are not much commercial value for foot-care–related products, so the marketing imbalance will continue to exist. Health-care providers must step up and offer enhanced patient education program. Taking hints from the Health Belief Model,[170] aside from teaching patients how to carry out proper foot care, education program should remind patients about the dire consequences, and the increased risk of acquiring them, for not taking good care of their feet.

It came at a surprise that the severity of the clinical indicators was not correlated with levels of self-care. The patients might have internalized that they need to change their lifestyle and maintain those changes in order to control their diabetes. So the transient levels of clinical indicators were not as meaningful to them as one would have expected. Drawing from the Health Belief Model again, patients must be made to realise how levels of those clinical indicators translate into real-world risk of getting diabetes-related complications.

The levels mental distress were not significantly correlated with the level of self-care, which is different from other findings.[82,89,142,171] The low levels of mental distress in this sample of diabetes patients probably were not enough to cause and significant impact on self-care. It remains to be seen whether other diabetes populations in Hong Kong exhibit different pattern of mental distress, and how those affect their level of self-care.

Table 6.1: Linear regression for self-care (overall self-care and general diet)

	Overall self-care score			General diet		
	Mean (SD)	β_u (95% CI)	β_m (95% CI)	Mean (SD)	β_u (95% CI)	β_m (95% CI)
Gender						
Male	18 26(10 56)	*ref*	–	3 29(3 03)	*ref*	–
Female	19 46(10 51)	*NS*	–	3 80(2 93)	*NS*	–
Age (year)						
< 60	17 84(10 16)	*ref*	*ref*	3 16(2 88)	*ref*	*ref*
≥ 60	19 94(10 90)	$2\ 10(0\ 18, 4\ 02)^*$	*NS*	3 93(3 07)	$0\ 75(0\ 22, 1\ 29)^\dagger$	*NS*
Education level						
Primary or less	18 34(10 81)	*ref*	–	3 96(2 97)	*ref*	–
Secondary or above	19 07(10 41)	*NS*	–	19 07(10 41)	*NS*	–
Employment type						
Others	20 49(10 53)	*ref*	*ref*	3 96(2 97)	*ref*	*ref*
Full-time	16 74(10 22)	$-3\ 75(-5\ 65, -1\ 84)^\ddagger$	$-3\ 92(-6\ 07, -1\ 77)^\ddagger$	2 99(2 93)	$-0\ 97(-1\ 51, -0\ 44)^\ddagger$	$-0\ 86(-1\ 48, -0\ 25)^\dagger$
Duration of diabetes (year)		*NS*	–		*NS*	–
LN (Physical activity level (min week^{-1}))		$0\ 61(0\ 21, 1\ 01)^\dagger$	*NS*		$0\ 17(0\ 06, 0\ 28)^\dagger$	*NS*
Mental distress						
Depression		*NS*	–		*NS*	–
Anxiety		*NS*	–		*NS*	–
Stress		*NS*	–		*NS*	–
Social support		$4\ 45(2\ 83, 6\ 06)^\ddagger$	$2\ 26(0\ 51, 4\ 00)^*$		$0\ 97(0\ 51, 1\ 43)^\ddagger$	*NS*
Self-care self-efficacy score		$6\ 49(4\ 43, 8\ 55)^\ddagger$	$5\ 41(3\ 17, 7\ 66)^\ddagger$		$1\ 74(1\ 16, 2\ 32)^\ddagger$	$1\ 52(0\ 88, 2\ 17)^\ddagger$
Obesity						
Normal (BMI $< 25\ \text{kg m}^{-2}$)		*ref*	–		*ref*	–
Obese (BMI $\geq 25\ \text{kg m}^{-2}$)		*NS*	–		$-0\ 78(-1\ 32, -0\ 24)^\dagger$	$-0\ 70(-1\ 21, -0\ 18)^\dagger$
HbA1c						
Normal	18 27(10 25)	*ref*	–	3 51(2 99)	*ref*	–
High ($\geq 7\%$)	19 47(10 89)	*NS*	–	3 55(3 00)	*NS*	–
Blood pressure						
Normal	19 17(11 02)	*ref*	–	3 60(3 00)	*ref*	–
High ($\geq 130/80$ mmHg)	18 53(10 19)	*NS*	–	3 47(2 99)	*NS*	–
LDL cholesterol						
Normal	19 12(10 86)	*ref*	–	3 56(2 98)	*ref*	–
High ($\geq 2\ 6\ \text{mmol l}^{-1}$)	18 45(10 19)	*NS*	–	3 49(3 01)	*NS*	–

β_u Univariate linear regression coefficient, β_m Multivariate linear regression coefficient, – Variable not included in multivariate model, *NS* Not significant at $\alpha = 0\ 05$

* $p < 0\ 05$

† $p < 0\ 01$

‡ $p < 0\ 001$

Table 6.2: Linear regression for self-care (vegetable and fat intake)

	Increase vegetable intake			Decrease fat intake		
	Mean (SD)	β_u (95% CI)	β_m (95% CI)	Mean (SD)	β_u (95% CI)	β_m (95% CI)
Gender						
Male	3 01(3 08)	*ref*	–	3 36(2 67)	*ref*	–
Female	3 40(3 18)	*NS*	–	3 45(2 80)	*NS*	–
Age (year)						
< 60	3 25(3 10)	*ref*	–	3 24(2 67)	*ref*	–
≥ 60	3 12(3 18)	*NS*	–	3 60(2 78)	*NS*	–
Education level						
Primary or less	2 88(3 15)	*ref*	–	3 67(2 78)	*ref*	–
Secondary or above	3 36(3 11)	*NS*	–	3 26(2 69)	*NS*	–
Employment type						
Others	3 36(3 17)	*ref*	–	3 61(2 75)	*ref*	–
Full-time	2 99(3 08)	*NS*	–	3 15(2 69)	*NS*	–
Duration of diabetes (year)		*NS*	–		*NS*	–
LN (Physical activity (min week^{-1}))		0 12(0 00, 0 24)*	0 12(0 00, 0 24)*		*NS*	–
Mental distress						
Depression		*NS*	–		*NS*	–
Anxiety		*NS*	–		*NS*	–
Stress		*NS*	–		*NS*	–
Social support		*NS*	–		0 52(0 09, 0 95)*	–‖
Self-care self-efficacy		*NS*	–		0 72(0 17, 1 27)*	0 72(0 17, 1 27)*
Obesity						
Normal (BMI < 25 kg m^{-2})		*ref*	–		*ref*	–
Obese (BMI ≥ 25 kg m^{-2})		*NS*	–		*NS*	–
HbA1c						
Normal	3 20(3 14)	*ref*	–	3 21(2 69)	*ref*	–
High ($\geq 7\%$)	3 18(3 13)	*NS*	–	3 64(2 76)	*NS*	–
Blood pressure						
Normal	3 34(3 13)	*ref*	–	3 24(2 61)	*ref*	–
High ($\geq 130/80$ mmHg)	3 08(3 14)	*NS*	–	3 53(2 81)	*NS*	–
LDL cholesterol						
Normal	3 22(3 14)	*ref*	–	3 41(2 74)	*ref*	–
High (≥ 2 6 mmol l^{-1})	3 16(3 13)	*NS*	–	3 40(2 72)	*NS*	–

Note β_u Univariate linear regression coefficient, β_m Multivariate linear regression coefficient, – Variable not included in multivariate model, NS Not significant at $\alpha = 0$ 05

* $p < 0$ 05

‖ When both social support and self-care self-efficacy were entered into a multivariate model, both factors became non-significant Social support was the least significant of the two and was removed from the model

Table 6.3: Linear regression for self-care (foot care and SMBG)

	Foot care			Self-monitoring of blood glucose		
	Mean (SD)	β_u (95% CI)	β_m (95% CI)	Mean (SD)	β_u (95% CI)	β_m (95% CI)
Gender						
Male	1 98(2 47)	*ref*	–	1 31(1 83)	*ref*	–
Female	2 00(2 48)	*NS*	–	1 07(1 52)	*NS*	–
Age (year)						
< 60	1 90(2 46)	*ref*	–	1 24(1 68)	*ref*	–
≥ 60	2 11(2 49)	*NS*	–	1 16(1 71)	*NS*	–
Education level						
Primary or less	1 97(2 45)	*ref*	–	0 93(1 42)	*ref*	–
Secondary or above	2 00(2 49)	*NS*	–	1 35(1 81)	$0\ 41(0\ 10, 0\ 74)^*$	$0\ 33(0\ 00, 0\ 65)^*$
Employment type						
Others	2 23(2 55)	*ref*	–	1 16(1 60)	*ref*	–
Full time	1 70(2 35)	$-0\ 51(-0\ 98, -0\ 09)^*$	$-0\ 51(-1\ 00, -0\ 01)^*$	1 25(1 80)	*NS*	–
Duration of diabetes (year)		*NS*	–		$0\ 03(0\ 01, 0\ 05)^*$	$0\ 03(0\ 01, 0\ 05)^†$
LN (Physical activity (min week^{-1}))		*NS*	–		*NS*	–
Mental distress						
Depression		*NS*	–		*NS*	–
Anxiety		*NS*	–		*NS*	–
Stress		*NS*	–		*NS*	–
Social support		$0\ 86(0\ 48, 1\ 25)^‡$	$0\ 75(0\ 32, 1\ 17)^‡$		$0\ 39(0\ 13, 0\ 66)^†$	*NS*
Self care self-efficacy		$0\ 66(0\ 17, 1\ 16)^†$	*NS*		$0\ 75(0\ 41, 1\ 08)^‡$	$0\ 56(0\ 18, 0\ 94)^†$
Obesity						
Normal (BMI < 25 kg m^{-2})		*ref*	–		*ref*	–
Obese (BMI ≥ 25 kg m^{-2})		*NS*	–		*NS*	–
HbA1c						
Normal	1 80(2 31)	*ref*	–	1 23(1 67)	*ref*	–
High ($\geq 7\%$)	2 23(2 65)	*NS*	–	1 17(1 72)	*NS*	–
Blood pressure						
Normal	2 03(2 53)	*ref*	–	1 35(1 93)	*ref*	–
High ($\geq 130/80$ mmHg)	1 96(2 43)	*NS*	–	1 09(1 49)	*NS*	–
LDL cholesterol						
Normal	2 10(2 54)	*ref*	–	1 20(1 63)	*ref*	–
High ($\geq 2\ 6$ mmol l^{-1})	1 87(2 40)	*NS*	–	1 20(1 77)	*NS*	–

Note β_u Univariate linear regression coefficient, β_m Multivariate linear regression coefficient, – Variable not included in multivariate model, *NS* Not significant at $\alpha = 0\ 10$

$^* p < 0\ 05$, $^† p < 0\ 01$, $^‡ p < 0\ 001$

Chapter 7

Determinants of mental distress

7.1 Introduction

In this chapter, factors in association with levels of mental distress (depression, anxiety, and stress) were explored by using linear regression analyses. Mental distress was measured by using the Depression, Anxiety, and Stress Scales (DASS21). A higher DASS21 score represents more symptoms of depression, anxiety, or stress. First, factors in association with overall level of mental distress, as represented by the overall score for the DASS21, were identified by linear regression analysis. Then, factors in association with scores from each of the sub-scales of the DASS21 (depression, anxiety, and stress) were also identified.

Independent variables that were tested included socio-demographic variables which included gender, age, education level and employment type; diabetes-related variables (duration of diabetes, HbA1c level, blood pressures, LDL-cholesterol level), instrumental social support, time-spent on physical activities, and time-spent on exercise were also included in the linear regression analyses.

Distributions for scores from the DASS21 (overall, depression sub-scale, anxiety sub-scale, stress sub-scale) were skewed to the right, the scores were transformed using natural logarithm before they were put into the linear regression models as dependent variables. Each independent variables were first modeled in a simple linear regression model to test for correlation with the dependent variable. Independent variables that were significant ($p < 0.05$) in the simple linear regression were then modeled together in a multiple linear regression model.

7.2 Results

7.2.1 Factors in association with level of overall mental distress

Female patients had significantly higher natural logarithm transformed overall mental health score than the males ($\beta_m = 0.25$, $p < 0.05$; Table 7.1). Those who were better-educated and had better instrumental social support had significantly lower overall scores ($\beta_m = -0.26$ and -0.21, respectively; $p < 0.05$). The amount of time spent on physical activities or exercise were not significantly correlated with overall DASS21 score. Duration of diabetes, obesity, as well as severity of each of the three indicators for diabetes control, were not significantly correlated with overall mental distress ($p > 0.05$).

7.2.2 Factors in association with level of depression

Female gender was significantly correlated with depression sub-scale score of the DASS21 ($\beta_m = 0.24$, $p < 0.05$; Table 7.2). Instrumental social support was negatively correlated with depression ($\beta_m = -0.24$, $p < 0.01$). Education level was only found to be correlated with depression in simple linear regression ($\beta = -0.25$, $p < 0.001$). Time-spent on physical activities, time-spent on exercise, obesity, and all of the indicators for diabetes control were non-significant predictors of depression.

7.2.3 Factors in association with level of anxiety

Multiple linear regression analysis revealed that female patients had significantly higher anxiety score than the males ($\beta_m = 0.20$, $p < 0.05$; Table 7.3). On the other hand, higher education level (secondary school or above) was correlated with a lower score for anxiety than those who were less educated ($\beta_m = -0.31$, $p < 0.001$). Instrumental social support was only marginally correlated with anxiety even in simple linear regression ($\beta = -0.13$, $p < 0.10$). None of the other factors that were tested, including the amount of time spent on physical activities, time-spent on exercise, duration of diabetes, obesity status, HbA1c level, blood pressure, or LDL-cholesterol level, was significantly correlated with anxiety.

7.2.4 Factors in association with level of stress

Only two independent variables were found to be significantly correlated with level of stress—gender and age. Females had higher stress score than the male patients ($\beta_m = 0.21$, $p < 0.05$; Table 7.4). Patients who were older than 60 years of age were significantly less stressful than the younger one ($\beta_m = -0.21$, $p < 0.05$). Instrumental social support was found to be marginally correlated with stress score in simple linear regression analysis ($\beta = -0.16$, $p < 0.10$) and was not included in the multiple linear regression model. Diabetes control, as measured by HbA1c level, blood pressure, and LDL-cholesterol level, were not significantly correlated with level of stress. The amount of time since diagnosed with diabetes also had no significant correlation with stress. Time-spent on both physical activity and exercise did not show any significant correlation with stress level. The correlation between obesity status and stress was also not significant.

7.2.5 Summary

Female patients had significantly higher level of depression, anxiety, and stress than the male patients. As a result, the overall level of mental distress was higher in females than the males. Instrumental social support was a significant predictor for overall level of mental distress, as well as for depression; however, it was only a marginal factor for anxiety or stress. The amount of time spent on physical activity or exercise had no correlation with any of the measures of mental distress. The three primary measures of diabetes control (HbA1c, blood pressure, and LDL-cholesterol) were not correlated with any measure of mental distress. The amount of time since diagnosed with diabetes did not predict mental distress. Being obese was not significantly associated with mental distress.

7.3 Discussion

Psychological distress in diabetes patients is gaining increasing attention in recent years. Depression, being one of the most-studied psychological problem in diabetes patients, was more prevalent in diabetes patients than those without diabetes[12] and was found to affect at least 20% of people with diabetes.[112]

The higher level of mental distress for female patients was similar to previous findings[12] and points to a potential need of mental health services for the female diabetes patients. However, the actual level of mental distress was quite low for this particular sample (see Table 3.21) when compared to both international[112] and local[17,82] samples. So there appears to be no immediate need to begin large scale mental health service.

Instead of mental health services, programs that aim at improving instrumental social support might be more beneficial to the patients. Instrumental social support is an important factor in correlation with depression, which is consistent with the findings of other studies.[16] The effect of instrumental social support on anxiety and stress was only marginal for this sample of patients with low level of anxiety and stress. Further research is needed on the effect of instrumental social support on higher levels of anxiety and stress.

Results from this chapter and Chapter 4 showed that mental distress in terms of levels of depression, anxiety, or stress, either as an independent or dependent variable, were not correlated with physical activity or exercise participation. This might be related to the relatively low level of mental health distress presented in our sample. So although exercise can reduce depression,[104] anxiety,[111] and stress,[22] exercising by patients who have low level of mental distress does not bring about any mental health benefit.

The low level of depression in our sample means that very few of them would have been diagnosed with clinical depression. As a result, although depressed diabetes patients were found to have longer duration of diabetes than the non-depressed patients in another study,[15] duration of diabetes was not correlated with depression, anxiety, or stress levels in this study.

Patients in this study appeared to be exceptionally resilient. None of the clinical indicators for diabetes control showed correlation with mental distress level. Not able to meet treatment targets had no impact on their mental health. The supportive environment provided by the diabetes treatment team probably helped the patients to deal with their diabetes. However, future studies into the non-respondents in the same clinical setting, or studies of patients who do not attend complication screening, are required to estimate the psychological needs of the diabetes patients.

Table 7.1: Linear regression for overall mental distress score

	LN (DASS21 overall score + 1)		
	Mean (SD)	β (95% CI)	β_m (95% CI)
Gender			
Male	1 66(1 15)	*ref*	*ref*
Female	2 03(1 21)	0 37(0 15, 0 58)[§]	0 25(0 03, 0 48)[†]
Age (year)			
< 60	1 91(1 19)	*ref*	
≥ 60	1 73(1 19)	−0 19(−0 40, 0 03)[*]	–
Education level			
Primary or less	2 06(1 18)	*ref*	*ref*
Secondary or above	1 69(1 17)	−0 37(−0 59, −0 15)[‡]	−0 26(−0 49, −0 02)[†]
Employment type			
Others	1 85(1 18)	*ref*	
Full time	1 80(1 20)	−0 04(−0 26, 0 17)	–
Duration of diabetes (year)		0 01(−0 00, 0 03)	–
LN(Physical activity (min week^{-1}))		0 01(−0 04, 0 05)	–
LN(Exercise (min week^{-1}))		−0 01(−0 05, 0 03)	–
Social support		−0 25(−0 43, −0 07)[‡]	−0 21(−0 40, −0 03)[†]
Obesity			
Normal (BMI < 25 kg m^{-2})	1 84(1 19)	*ref*	
Obese (BMI ≥ 25 kg m^{-2})	1 82(1 19)	−0 02(−0 24, 0 19)	–
HbA1c			
Normal	1 77(1 22)	*ref*	
High ($\geq$ 7%)	1 90(1 15)	0 13(−0 09, 0 35)	–
Blood pressure			
Normal	1 75(1 25)	*ref*	
High ($\geq$ 130/80 mmHg)	1 88(1 14)	0 13(−0 09, 0 35)	–
LDL cholesterol			
Normal	1 81(1 17)	*ref*	
High ($\geq$ 2 6 mmol l^{-1})	1 85(1 21)	0 03(−0 18, 0 25)	–

β Univariate linear regression coefficient, β_m Multivariate linear regression coefficient, – Variable not included in multivariate model

[*] $p < 0\ 10$

[†] $p < 0\ 05$

Table 7.2: Lınear regressıon for level of depressıon

	LN (DASS21 depressıon score + 1)		
	Mean(SD)	$\beta(95\%CI)$	$\beta_m(95\%CI)$
Gender			
Male	0 67(0 91)	*ref*	*ref*
Female	0 98(1 07)	$0\ 31(0\ 13, 0\ 49)^{\S}$	$0\ 24(0\ 05, 0\ 43)^{\dagger}$
Age (year)			
< 60	0 86(1 01)	*ref*	
≥ 60	0 75(0 99)	$-0\ 11(-0\ 29, 0\ 07)$	–
Educatıon level			
Prımary or less	0 97(1 07)	*ref*	*ref*
Secondary or above	0 72(0 95)	$-0\ 25(-0\ 43, -0\ 06)^{\S}$	*NS*
Employment type			
Others	0 86(1 01)	*ref*	
Full-tıme	0 76(0 99)	$-0\ 10(-0\ 28, 0\ 08)$	–
Duratıon of dıabetes (year)		$0\ 01(-0\ 00, 0\ 02)^{*}$	–
LN(Physıcal actıvıty (mın week^{-1}))		$0\ 01(-0\ 03, 0\ 05)$	–
LN(Exercıse (mın week^{-1}))		$0\ 00(-0\ 03, 0\ 04)$	–
Socıal support		$-0\ 27(-0\ 42, -0\ 11)^{\S}$	$-0\ 24(-0\ 39, -0\ 09)^{\ddagger}$
Obesıty			
Normal (BMI < 25 kg m^{-2})	0 82(1 02)	*ref*	
Obese (BMI ≥ 25 kg m^{-2})	0 80(0 98)	$-0\ 02(-0\ 20, 0\ 16)$	–
HbA1c			
Normal	0 78(1 00)	*ref*	
Hıgh ($\geq 7\%$)	0 86(1 01)	$0\ 08(-0\ 10, 0\ 26)$	–
Blood pressure			
Normal	0 81(0 98)	*ref*	
Hıgh ($\geq 130/80$ mmHg)	0 81(1 02)	$0\ 00(-0\ 18, 0\ 19)$	–
LDL cholesterol			
Normal	0 77(0 99)	*ref*	
Hıgh ($\geq 2\ 6$ mmol l^{-1})	0 86(1 01)	$0\ 08(-0\ 10, 0\ 26)$	–

β Unıvarıate lınear regressıon coeffıcıent, β_m Multıvarıate lınear regressıon coeffıcıent, – Varıable not ıncluded ın multıvarıate model, NS Not sıgnıficant at $\alpha = 0\ 05$

* $p < 0\ 10$

† $p < 0\ 05$

‡ $p < 0\ 01$

§ $p < 0\ 001$

Table 7.3: Linear regression for level of anxiety

	LN (DASS21 anxiety score + 1)		
	Mean(SD)	$\beta(95\%CI)$	$\beta_m(95\%CI)$
Gender			
Male	0 90(0 88)	*ref*	*ref*
Female	1 21(0 92)	0 31(0 14, 0 47)§	0 20(0 03, 0 37)†
Age (year)			
< 60	1 08(0 93)	*ref*	
≥ 60	1 00(0 88)	−0 08(−0 24, 0 09)	–
Education level			
Primary or less	1 29(0 93)	*ref*	*ref*
Secondary or above	0 90(0 87)	−0 38(−0 54, −0 22)§	−0 31(−0 48, −0 13)§
Employment type			
Others	1 10(0 89)	*ref*	
Full time	0 98(0 93)	−0 12(−0 29, 0 04)	–
Duration of diabetes (year)		−0 00(−0 01, 0 01)	–
LN(Physical activity (min week $^{-1}$))		0 01(−0 02, 0 05)	–
LN(Exercise (min week $^{-1}$))		−0 00(−0 04, 0 04)	–
Social support		−0 13(−0 27, 0 01)*	–
Obesity			
Normal (BMI < 25 kg m^{-2})	1 07(0 91)	*ref*	
Obese (BMI ≥ 25 kg m^{-2})	1 03(0 90)	−0 04(−0 20, 0 12)	–
HbA1c			
Normal	1 03(0 93)	*ref*	
High ($\geq 7\%$)	1 07(0 88)	0 04(−0 12, 0 20)	–
Blood pressure			
Normal	1 00(0 93)	*ref*	
High ($\geq 130/80$ mmHg)	1 08(0 89)	0 08(−0 08, 0 25)	–
LDL cholesterol			
Normal	1 03(0 89)	*ref*	
High ($\geq 2\ 6$ mmol l^{-1})	1 06(0 93)	0 02(−0 14, 0 19)	–

β Univariate linear regression coefficient, β_m Multivariate linear regression coefficient, – Variable not included in multivariate model

* $p < 0\ 10$

† $p < 0\ 05$

‡ $p < 0\ 01$

§ $p < 0\ 001$

Table 7.4: Linear regression for level of stress

	LN (DASS21 stress score + 1)		
	Mean(SD)	$\beta(95\%CI)$	$\beta_m(95\%CI)$
Gender			
Male	1 07(0 99)	*ref*	*ref*
Female	1 28(1 10)	0 21(0 02, 0 40)†	0 20(0 01, 0 39)†
Age (year)			
< 60	1 27(1 06)	*ref*	*ref*
≥ 60	1 05(1 02)	−0 22(−0 41, −0 03)†	−0 21(−0 40, −0 02)†
Education level			
Primary or less	1 27(1 06)	*ref*	
Secondary or above	1 11(1 04)	−0 15(−0 35, 0 04)	–
Employment type			
Others	1 11(1 02)	*ref*	
Full-time	1 24(1 07)	0 13(−0 06, 0 32)	–
Duration of diabetes (year)		0 01(−0 00, 0 02)	–
LN(Physical activity (min week^{-1}))		0 01(-0 02, 0 05)	–
LN(Exercise (min week^{-1}))		0 00(−0 03, 0 04)	–
Social support		−0 16(−0 31, 0 00)*	–
Obesity			
Normal (BMI $<$ 25 kg m^{-2})	1 19(1 05)	*ref*	
Obese (BMI $\geq$ 25 kg m^{-2})	1 15(1 04)	−0 04(−0 23, 0 15)	–
HbA1c			
Normal	1 13(1 05)	*ref*	
High ($\geq$ 7%)	1 22(1 04)	0 09(−0 10, 0 28)	–
Blood pressure			
Normal	1 14(1 06)	*ref*	
High ($\geq$ 130/80 mmHg)	1 19(1 04)	0 05(−0 14, 0 24)	–
LDL cholesterol			
Normal	1 16(1 02)	*ref*	
High ($\geq$ 2 6 mmol l^{-1})	1 18(1 08)	0 03(−0 16, 0 21)	–

β Univariate linear regression coefficient, β_m Multivariate linear regression coefficient, – Variable not included in multivariate model

* $p < 0\ 10$

† $p < 0\ 05$

Chapter 8

Determinants of insulin therapy and good diabetes control

8.1 Introduction

For patients with Type 2 diabetes, the treatment goals are usually to keep their "ABC" treatment targets under control (HbA1c $< 7\%$, blood pressure $< 130/80$ mmHg, LDL-cholesterol < 2.6 mmol l^{-1}) through oral medication and lifestyle modification. The requirement of insulin therapy is a result of poor glycemic control from just lifestyle modification and oral medication. Patients who required insulin therapy must be careful with their exercise plan because of the risk of acute hypoglycemia. We wanted to identify factors in association with insulin therapy in the first part of this Chapter.

In Chapter 4, it was found that severity of patients' diabetes, as indicated by the whether patients met the ABC targets, was not associated with physical inactivity. And in Chapter 6, those indicators also did not significantly correlate with any domain of self-care. So the traditional thinking of using the ABC clinical indicators to encourage patients to perform better self-care did not work for this group of patients. However, we know from a 10-year follow-up study of Type 2 diabetes patients in Hong Kong that number of ABC targets met had a dose-dependent protective effect against cardiovascular events. And that meeting at least two of the three ABC clinical targets at baseline offered the maximum protection.[172] Therefore, we were interested to find out what factors were in association with meeting at least two of the ABC targets.

8.2 Methods

Logistic regressions were used to model factors that predicted insulin therapy as well as meeting at least two of the ABC treatment targets. Independent variables were first tested in univariate logistic models. And variables that were significant were modeled together in multivariate logistic analysis.

8.3 Results

8.3.1 Factors in association with insulin therapy

Female gender ($\text{OR}_m = 1.93$, $p < 0.05$), longer duration of diabetes ($\text{OR}_m = 1.15$, $p < 0.01$), and a high level of HbA1c ($\text{OR}_m = 3.29$, $p < 0.001$) were associated with higher likelihood of needing insulin therapy (Table 8.1). A high level of LDL cholesterol, however, was associated with a lower likelihood of insulin therapy. Blood pressure, while significantly associated with insulin therapy in univariate analysis ($\text{OR}_u = 1.66$, $p < 0.05$), was not significant under the multivariate model.

We expected patients who had better self-care to be less likely to require insulin therapy. But the results showed that even for univariate analyses, neither meeting the ADA-recommended physical activity level nor the overall self-care score was significantly associated with insulin injection ($p > 0.05$).

8.3.2 Factors in association with meeting at least two ABC targets

Being a current smoker ($OR_m = 0.46$, $p < 0.05$), having a higher BMI ($OR_m = 0.95$, $p < 0.05$), and longer duration of diabetes ($OR_m = 0.97$, $p < 0.05$) were associated with a lower likelihood of meeting at least two ABC treatment targets (Table 8.2). While insulin treatment was significant in univariate analysis ($OR_u = 0.54, p < 0.01$), it was not significant in the multivariate logistic model that we examined ($p > 0.05$).

Better self-care, by either meeting the ADA physical activity target, or a higher SDSCA self-care score, was not associated with meeting ABC targets ($p > 0.05$). Levels of mental distress also did not show any association with meeting at least two ABC targets ($p > 0.05$).

8.4 Discussion

The theme of this study is to examine the role of physical activity in diabetes management. Previous studies have found that patients who had better self-care had better control of their diabetes, and the whole diabetes management regiment was based on those findings.[7] The lack of association between physical activity level with insulin therapy and numbers of ABC targets met came as a surprise to us. This may suggest that at the level of physical activity recommended by the American Diabetes Association (150 min week^{-1} of moderate-intensity physical activity) is not adequate. Alternatively, since we used a relative measure of physical activity intensity that is influenced by fitness level, it is possible that the "moderate" activities that the patients participated in were not strenuous enough to generate health benefits. For example, from Chapter 3 we know that many patients reported walking as their exercise of choice. It is possible that they did not walk fast enough during their daily routine.

It is also possible that patients met the ADA-recommended level of physical activity felt that they did not need to be as careful with other aspects of diabetes self-care. Maybe those who were active thought that they could eat more. But we already know from Chapter 4 and Chapter 6 that this kind of behavior did not occur in our sample. A factor that we did not measure in this study was medication adherence. Although it is unlikely, but there is a possibility that those who had better self-care also perceived that they did not need good medication adherence. And the effect of poor medication adherence cancelled out the benefits of good self-care.

Interestingly, we found that patients who had high level of LDL cholesterol ($\geq$ 2.6 $\mathrm{mmol\,l^{-1}}$) were significantly less likely to be under insulin therapy. The goal of insulin therapy is to control blood glucose level caused by insulin resistance or deficiency. Therefore, it is expected that prevalence of insulin therapy would be higher in people who had a high level ($\geq$ 7 %) of HbA1c. Since, we know that LDL-cholesterol level did not correlate with HbA1c level in our sample (data not shown), the association between LDL-cholesterol level and insulin therapy was not caused by confounding effect from HbA1c level. While previous study found that insulin therapy did not significantly affect LDL-cholesterol concentration,[173] a study by Yee et. al found that statin use is associated with delay in insulin therapy.[174] And since patients with high level of LDL-cholesterol would be on statin therapy, that might be the cause of our observation that patients with high level of LDL-cholesterol were less likely to be on insulin therapy. However, it is important to note that the same study also found that even with the delay of insulin therapy, the proportions of patients who required insulin therapy were eventually the same for those who were taking statins and those who did not.[174] It is still unclear as to why we found such association.

In this Chapter, we examined the effect of meeting the physical activity level, as recommended by the American Diabetes Association, on its ability to control diabetes and reduce progression to insulin therapy and found no significant association. This came as a wake-up call to health care workers that patients might not be having enough physical activity to keep their diabetes under control. Patients might thought that they are active enough, but their understanding of what "moderate" physical activity entails need to be further studied.

Table 8.1: Logistic regression for use of insulin therapy

	% using insulin	OR_u (95% CI)	OR_m (95% CI)
Gender			
Male	18 0	1 0	1 0
Female	28 7	1 83 (1 24, 2 72)†	1 93 (1 15, 3 27)*
Age (yr)			
< 60	22 0	1 0	—
≥ 60	24 4	NS	—
Education level			
Primary or less	29 1	1 0	1 0
Secondary or above	19 5	0 59 (0 40, 0 88)†	NS
Employment type			
Others	26 5	1 0	1 0
Full-time	19 4	0 67 (0 44, 0 99)*	NS
Current smoker			
No	23 7	1 0	—
Yes	17 5	NS	—
Duration of diabetes (year)		1 16 (1 12, 1 19)‡	1 15 (1 11, 1 19)‡
Met ADA PA recommendation			
No	24 0	1 0	—
Yes	22 3	NS	—
Overall self-care score		NS	—
Mental distress			
Depression score		NS	—
Anxiety score		NS	—
Stress score		NS	—
Obesity			
Normal	21 3	1 0	—
Obese (BMI ≥ 25 kg m^{-2})	24 5	NS	—
HbA1c			
Normal	11 3	1 0	1 0
High ($\geq 7\%$)	35 9	4 41 (2 87, 6 92)‡	3 29 (2 00, 5 51)‡
Blood pressure			
Normal	18 1	1 0	1 0
High ($\geq$130/80 mmHg)	26 7	1 66 (1 10, 2 51)*	NS
LDL cholesterol			
Normal	27 1	1 0	1 0
High ($\geq$ 2 6 mmol l^{-1})	17 6	0 57 (0 38, 0 86)†	0 55 (0 34, 0 90)*

OR_u Univariate odds ratio, OR_m Multivariate odds ratio, — Variable not included in multivariate model, NS Not significant at $\alpha = 0$ 05
* $p < 0$ 05, † $p < 0$ 01 ‡ $p < 0$ 001

Table 8.2: Logistic regression for meeting ≥ 2 ABC targets

	% $\geq$ 2 ABC	OR_u (95% CI)	OR_m (95% CI)
Gender			
Male	46 7	1 0	—
Female	48 4	NS	—
Age (yr)			
< 60	47 3	1 0	—
≥ 60	48 0	NS	—
Education level			
Primary or less	46 5	1 0	—
Secondary or above	47 8	NS	—
Employment type			
Others	49 3	1 0	—
Full-time	45 2	NS	—
Current smoker			
No	49 1	1 0	1 0
Yes	32 7	0 50 (0 27, 0 90)*	0 46 (0 24, 0 83)*
Body Mass Index ($kg\,m^{-2}$)		0 95 (0 92, 0 99)*	0 95 (0 91, 0 99)*
Duration of diabetes (year)		0 97 (0 94, 0 99)†	0 97 (0 94, 1 00)*
Insulin required			
No	50 8	1 0	1 0
Yes	36 0	0 54 (0 36, 0 82)†	NS
Met ADA PA recommendation			
No	44 3	1 0	—
Yes	51 0	NS	—
Overall self-care score		NS	—
Mental distress			
Depression score		NS	—
Anxiety score		NS	—
Stress score		NS	—

OR_u Univariate odds ratio, OR_m Multivariate odds ratio, — Variable not included in multivariate model, NS Not significant at $\alpha = 0\ 05$

* $p < 0\ 05$, † $p < 0\ 01$

Chapter 9

Inter-relationship between physical activity participation, mental distress, and level of self-care in diabetes patients

9.1 Introduction

In previous chapters, we identified factors in association with physical activity (Chapter 4), mental health (Chapter 7), and self-care (Chapter 6) for the diabetes patients. In this chapter, structural equation modeling (SEM) was used to simultaneously model the complex inter-relationships between physical activity participation, mental distress, self-care.

SEM is a technique for modeling linear relationship between observable indicator variables, and hypothetical latent variables.[175] A structural equation model contains two parts—the measurement model, and the structural model. Measurement model shows the relationship between the latent variables and their indicators, which is similar to what can be accomplished with factor analysis. The structural model shows the relationships between latent variables and is usually the part that researchers are interested in. The structural model is similar to regression analysis. However, regression analysis only allows the modeling of a many-to-one relationship (many independent variables, one dependent variable). It was not possible to for the independent variables in a regression analysis to be dependent on other variables. Moreover, with factor analysis and regression analysis, the analyses are carried out independently from each other. And whatever happens during regression has no influence on results from factor analysis. On the other hand, simultaneous modeling of the measurement model and structural model in SEM allows difference in structural model to affect the relationships between latent and indicator variables in measurement models. Also, in regression analysis, measurements of independent variables are assumed to be error-free, which is often not the case in reality. For example, when both dependent variable and independent variable are not directly observable and have to be estimated by observable indicators. SEM will give more accurate results in such a case. Comparing goodness-of-fit indices of different structural equation models that are based on the same data allows researchers to identify a model that can best-represent the relationships between variables.

SEM have been used in studies of psychology, marketing, organizational research (see review by MacCallum and Austin[175]) and many other area of study. Not surprisingly, there have been numerous studies that utilize SEM to model factors that affect physical activity.[176–180] In diabetes research, examples of application of SEM included modeling of predictors of hypoglycemia,[181] relationships between clinical parameters,[182] dietary behavior,[183] quality of life,[184] among many other applications.

This chapter shows our attempt in modeling the relationships between physical activity, mental distress, and self-care, exercise efficacy, attitudes towards exercise, subjective norm, and instrumental social support in Type 2 diabetes patients. A conceptual model that shows the hypothesized relationships between variables are shown in Figure 9.1.

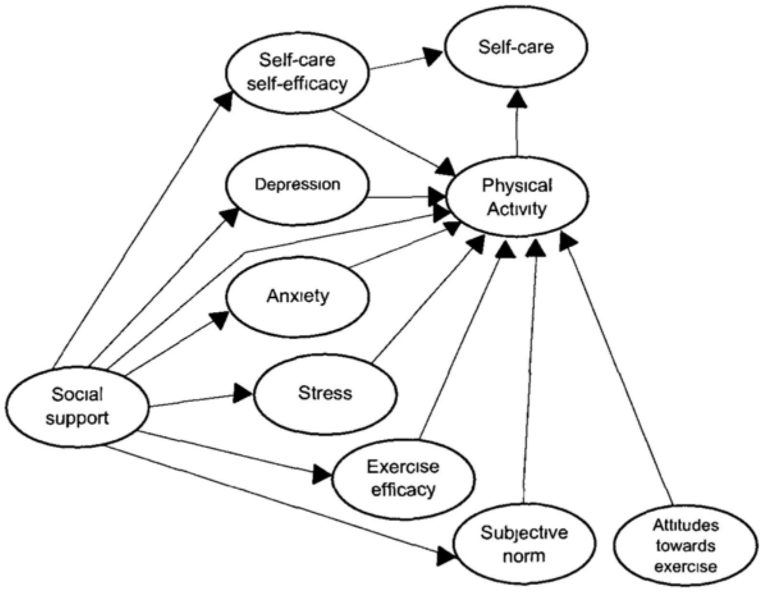

Figure 9.1: Conceptual model

Model fit was evaluated in several ways. First, χ^2 test was employed to evaluate the fit. χ^2 statistics are, however, sample-size dependent.[166] Therefore, goodness-of-fit indices, specifically, the Comparative Fit Index (CFI), Non-Normed Fit Index (NNFI), and the Root Mean Square Approximation Error (RMSEA) were also assessed. For CFI and NNFI, a value of greater than 0.90 indicates a good fit. For RMSEA, values of less than 0.05 indicate a close fit and values between 0.05 and 0.08 indicate an acceptable fit.[166] All of the loadings reported are standardized loadings.

Once the goodness-of-fit for the conceptual model was confirmed, the structural model was modified to general different models to test the inter-relationships between physical activity, mental distress, and diabetes self-care. In the conceptual model, physical activity was hypothesized to be affected by levels of depression, anxiety, and stress. But the reversed could be true as well since studies have found that physical activity can cause reduction in depression, anxiety, and stress.[22,104,111] Previous studies have also found that diabetes patients who had elevated level of mental distress did not perform adequate self-care. Therefore, we also modeled the relationships in which the mental distress variables affect diabetes self-care.

In order to have a more parsimonious model, variables that had no significant correlation with physical activity participation or level of self-care were removed from the model. Furthermore, paths that were non-significant were also removed to obtain the parsimonious model. The parsimonious model was modified to test the relationship between physical activity and level of self-care to check which variable affected the other, or that they affected each other simultaneously.

9.2 Results

9.2.1 Fitting the initial conceptual model

In this section, a structural equation model was first fitted in accordance with the conceptual model (Figure 9.1). Then, another structural equation model was fitted with the physical activity variable substituted with exercise.

Fitting a SEM model for physical activity

Figure 9.2 shows the results from fitting the conceptual model. This model showed good very good fit with the data (df = 1063, $\chi^2 = 2548.85$, RMSEA = 0.0538, NNFI = 0.933, CFI = 0.937). Exercise efficacy ($\beta = 0.478$, $p < 0.001$) and attitudes towards exercise ($\gamma = 0.231$, $p < 0.001$) were positively affecting physical activity. Physical activity level positively affected level of self-care ($\beta = 0.140$, $p < 0.01$). Level of self-care was also positively affected by self-care self-efficacy ($\beta = 0.277$, $p < 0.001$). Instrumental social support had an important role in the model by positively affecting self-care self-efficacy ($\gamma = 0.676$, $p < 0.001$), exercise efficacy ($\gamma = 0.194$, $p < 0.001$), and subjective more ($\gamma = 0.685$, $p < 0.001$). It had a negative effect on depression ($\gamma = -0.188$, $p < 0.001$), anxiety ($\gamma = -0.148$, $p < 0.05$), and stress ($\gamma = -0.138$, $p < 0.05$).

None of the mental distress variables, self-care self-efficacy, and subjective norm were found to be significant predictors of physical activity ($p > 0.05$; Figure 9.2) Social support did not significantly affect physical activity level ($p > 0.05$).

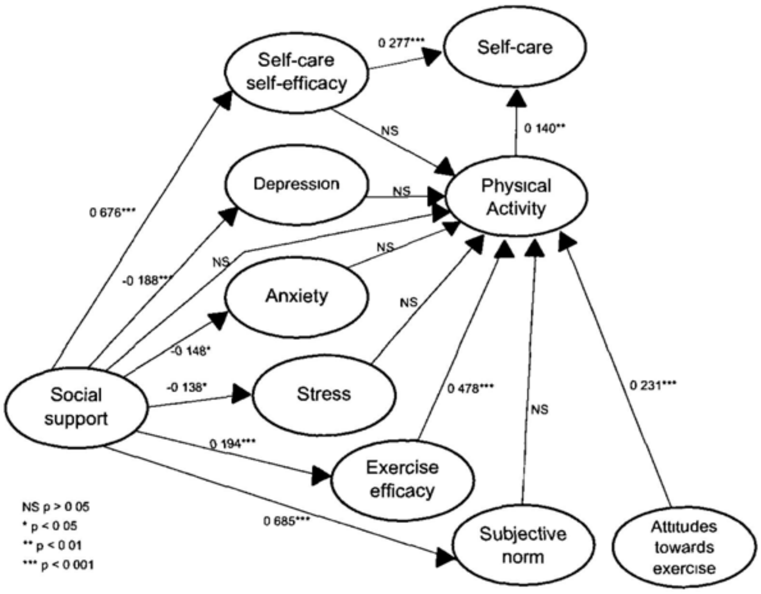

Figure 9.2: Structural model of the full model for physical activity

Fitting a SEM model for exercise

When the physical activity variable was substituted with one for exercise, similar relationships between the variables were found (Figure 9.3). This model also showed good fit with the data (df = 1063, $\chi^2 = 2498.688$, RMSEA = 0.0536, NNFI = 0.935, CFI = 0.939). Exercise level was positively affected by exercise efficacy ($\beta = 0.581$, $p < 0.001$) and attitudes towards exercise ($\gamma = 0.127$, $p < 0.05$). And in turn, exercise level affected overall diabetes self-care score positively ($\beta = 0.195$, $p < 0.001$). Self-care was also positively affected by self-care self-efficacy ($\beta = 0.252$, $p < 0.001$), which was affect by instrumental social support ($\gamma = 0.673$, $p < 0.001$). Social support also significantly affected other variables in the model, including depression ($\gamma = -0.186$, $p < 0.001$), anxiety ($\gamma = -0.149$, $p < 0.05$), stress ($\gamma = -0.136$, $p < 0.05$), subjective norm ($\gamma = 0.689$, $p < 0.001$), and exercise efficacy ($\gamma = 0.203$, $p < 0.001$). However, instrumental social support did not directly affect exercise level ($p > 0.05$; Figure 9.3). Depression, anxiety, and stress scores, subjective norm, and self-care self-efficacy were not significantly correlated with exercise level ($p > 0.05$).

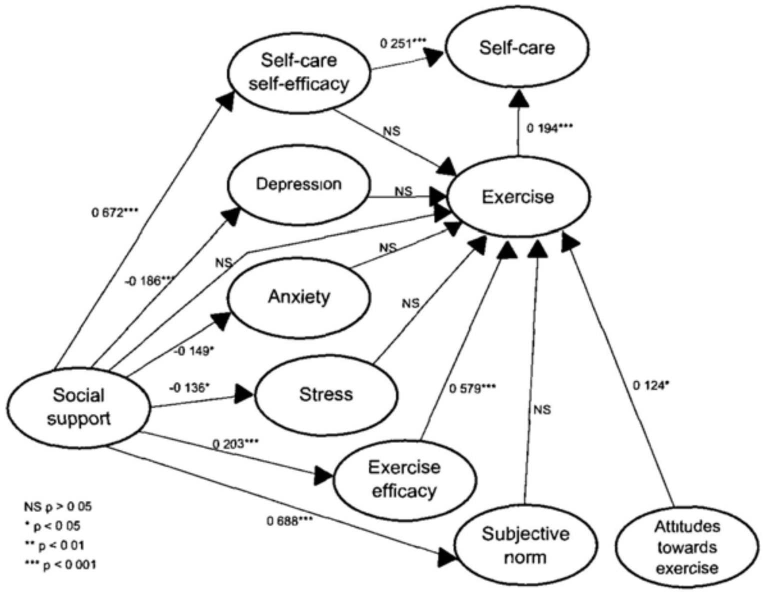

Figure 9.3: Structural model of the full model for exercise

9.2.2 Testing the inter-relationships between physical activity, mental distress, and diabetes self-care

Alternative SEM model: self-care affecting physical activity or exercise participation

The conceptual model was modified to test whether self-care affected physical activity / exercise. In an alternative model, the path from self-care to physical activity was non-significant (Figure 9.4, $p > 0.05$; df = 1063, $\chi^2 = 2556.446$, RMSEA = 0.0539, NNFI = 0.933, CFI = 0.937). In the alternative model with exercise level as a variable instead of physical activity, the path from self-care to exercise was found to be non-significant (Figure 9.5, $p > 0.05$; df = 1063, $\chi^2 = 2511.817$, RMSEA = 0.0538, NNFI = 0.935, CFI = 0.938).

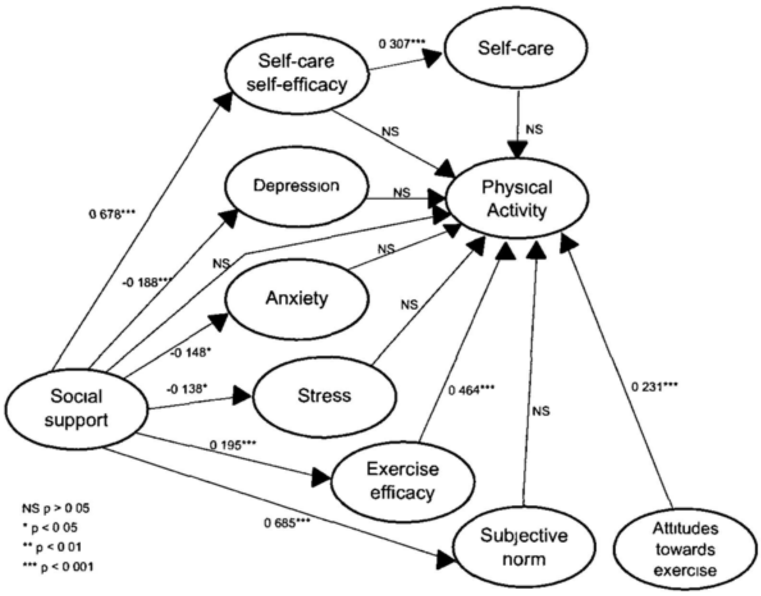

Figure 9.4: Alternative model with self-care affecting physical activity

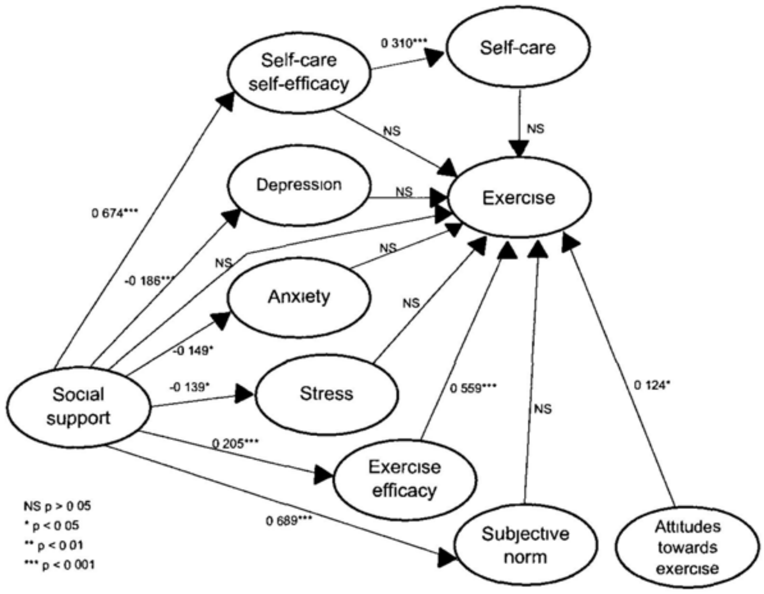

Figure 9.5: Alternative model with self-care affecting exercise

Alternative SEM model: mental distress levels affecting diabetes self-care

Alternative models were fitted based on the conceptual model to test whether level of mental distress affected diabetes self-care.

For models with physical activity level as the "physical activity" variable. When a path was added from depression to diabetes self-care, SEM showed that the path was not significant ($p > 0.05$, Figure 9.6; df = 1062, $\chi^2 = 2548.701$, RMSEA = 0.0538, NNFI = 0.933, CFI = 0.937). Another model was fitted with a path from anxiety score to self-care, and while the model showed good fit (Figure 9.7; df = 1062, $\chi^2 = 2548.842$, RMSEA = 0.0538, NNFI = 0.933, CFI = 0.937), the path loading was not significant ($p > 0.05$). Next, a path from stress score to diabetes self-care score was added to the conceptual model (Figure 9.8). SEM showed that this path was also not significant ($p > 0.05$; df = 1062, $\chi^2 = 2548.812$, RMSEA = 0.0538, NNFI = 0.933, CFI = 0.937).

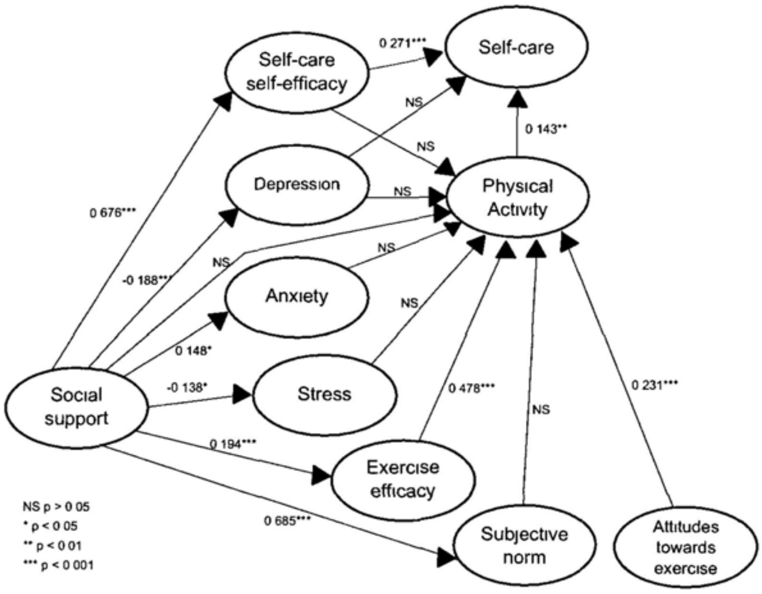

Figure 9.6: Alternative model for physical activity with added path for depression effecting self-care

When exercise level was used as the "physical activity" variable in the SEM. The path loadings from neither depression, anxiety, nor stress to self-care was significant ($p > 0.05$). All models had high degree of goodness-of-fit (Alternative model with path from depression to self-care (Figure 9.9): df = 1062, $\chi^2 = 2498.519$, RMSEA = 0.0537, NNFI = 0.935, CFI = 0.939; model with path added from anxiety to self-care (Figure 9.10): df = 1062, $\chi^2 = 2498.658$, RMSEA = 0.0537, NNFI = 0.935, CFI = 0.939; path from stress to self-care added to conceptual model (Figure 9.11): df = 1062, $\chi^2 = 2498.643$, RMSEA = 0.0537, NNFI = 0.935, CFI = 0.939).

Alternative SEM model: physical activity or exercise affecting mental distress levels

Structural equation models that tested whether physical activity or exercise affected mental distress levels in this sample of diabetes patients were fitted.

When the relationship between physical activity and depression was reversed. A significant relationship was found ($\beta = 0.067$, $p < 0.05$, Figure 9.12; df = 1063,

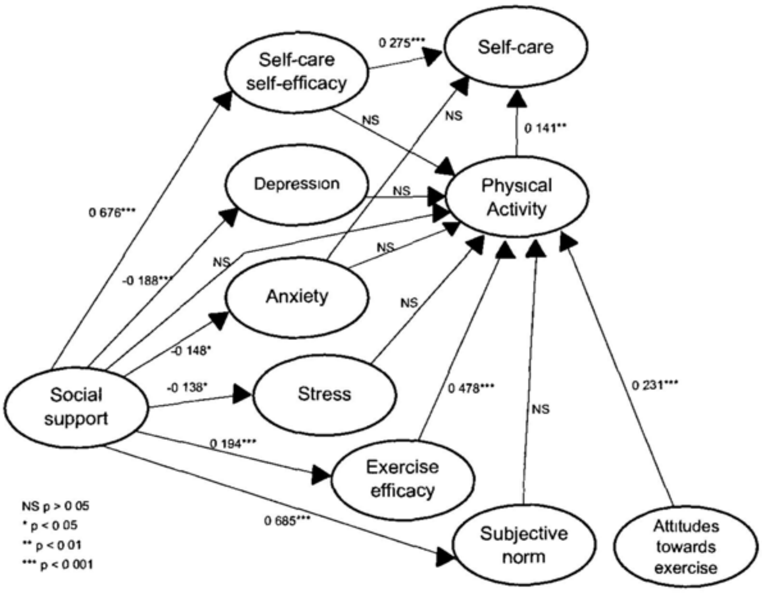

Figure 9.7: Alternative model for physical activity with added path for anxiety effecting self-care

$\chi^2 = 2546.443$, RMSEA $= 0.0538$, NNFI $= 0.933$, CFI $= 0.937$). Similar relationship was found for the model with reversed relationship between exercise and depression ($\beta = 0.083$, $p < 0.05$, Figure 9.13; df $= 1063$, $\chi^2 = 2495.852$, RMSEA $= 0.0536$, NNFI $= 0.935$, CFI $= 0.939$).

For models with path from physical activity or exercise to anxiety or stress. Although goodness-of-fit indices indicated that those models fit well with the data (alternative model with path from physical activity to anxiety (Figure 9.14): df $=$ 1063, $\chi^2 = 2548.037$, RMSEA $= 0.0538$, NNFI $= 0.933$, CFI $= 0.937$; model with path from physical activity to stress (Figure 9.15): df $= 1063$, $\chi^2 = 2548.828$, RMSEA $= 0.0538$, NNFI $= 0.933$, CFI $= 0.937$; SEM model with paths from exercise level to anxiety (Figure 9.16): df $= 1063$, $\chi^2 = 2498.055$, RMSEA $= 0.0536$, NNFI $= 0.935$, CFI $= 0.939$; model with path from exercise level to stress (Figure 9.17): df $= 1063$, $\chi^2 = 2498.493$, RMSEA $= 0.0536$, NNFI $= 0.935$, CFI $= 0.939$). The models showed that physical activity or exercise level did not have any significant

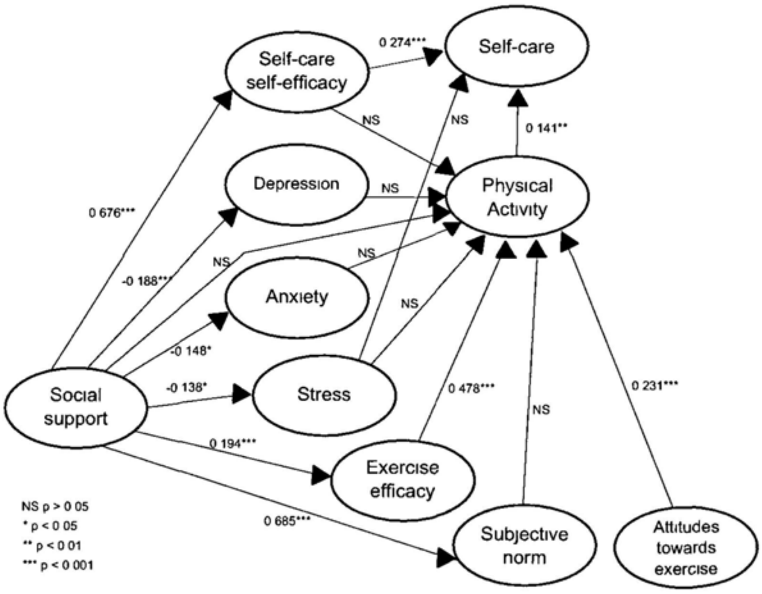

Figure 9.8: Alternative model for physical activity with added path for stress effecting self-care

influence on anxiety or stress ($p > 0.05$).

9.2.3 Summary

Activity participation, both by time-spent on physical activity and time-spent on exercise, were used in two separate structural equation models. In both models, it was found that higher activity participation led to a better overall level of diabetes self-care. But the influence was only one-way as self-care level was not correlated with activity participation.

Factors that were correlated with activity participation were the same for physical activity or exercise. Exercise efficacy and attitudes towards exercise were the two factors that significantly correlated with activity participation. These findings confirmed the results from linear regression analysis (Table 4.4).

Instrumental social support was tested for both direct and indirect influence on activity participation and the results revealed that it had indirect influence through

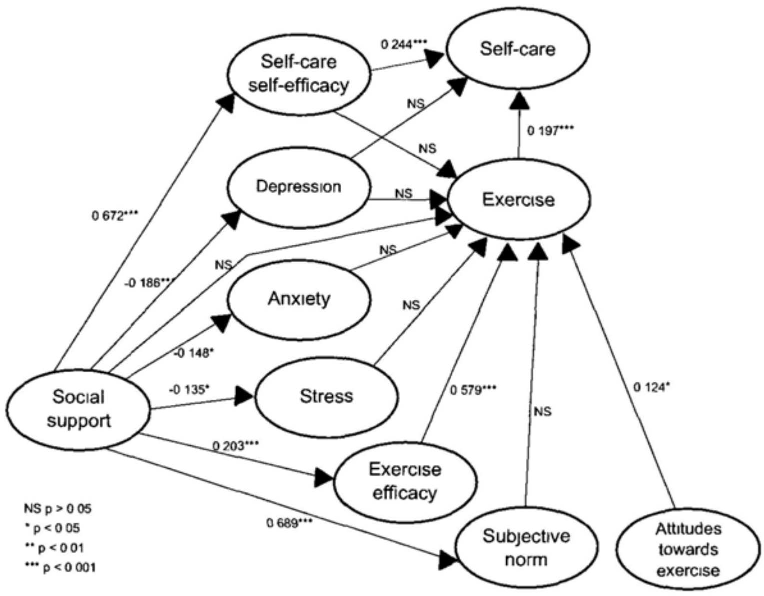

Figure 9.9: Alternative model for exercise with added path for depression effecting self-care

exercise efficacy. Although instrumental social support significantly influence a host of other variable that included self-care self-efficacy, depression, anxiety, stress, and subjective norm. Non of those variables had any influence on activity participation.

On the other hand, when models with a reversed relationship between depression and activity participation was tested. The results showed that higher level of activity participation was correlated with higher level of depression. There was no significant correlation when the activity/anxiety or activity/stress relationships were reversed.

Alternative models that tested the influence of mental distress levels on diabetes self-care showed that there was no correlation between them in this sample.

9.3 Discussion

This chapter shows the inter-relationships between physical activity/exercise, diabetes self-care, and mental distress through a series of structural equation models.

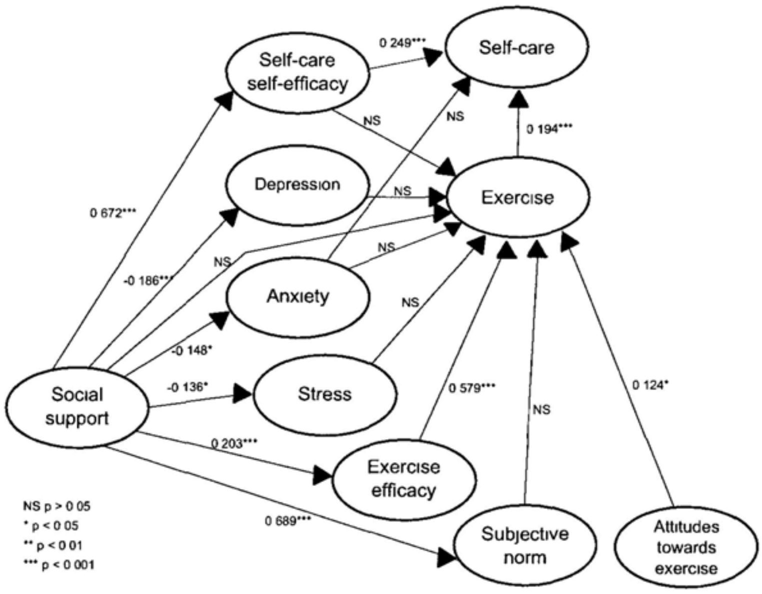

Figure 9.10: Alternative model for exercise with added path for anxiety effecting self-care

We found that while physical activity/exercise had a positive correlation with level of self-care, the reverse was not true. The results suggested that increasing physical activity level of diabetes patients can bring the added benefits of improving other aspects of self-care. The patients might have become more health-conscious through exercising and began to take care of themselves better. Also, since lifestyle change for diabetes management requires the patients to make multiple changes to their habits. Previous researches suggested that sometimes asking people to change multiple behaviors simultaneously was not as effective as targeting one behavior at a time. Increasing physical activity or exercise is a good starting point for the patients because there are wide varieties of activities that patients can participate. Barriers to participate in physical activities are relatively low when compared with dietary change or self-monitoring of blood glucose. For example, patients can start from walking longer distance, or walking for longer period, or walking faster. As their body fitness increase through increased physical activity, they can choose to engage

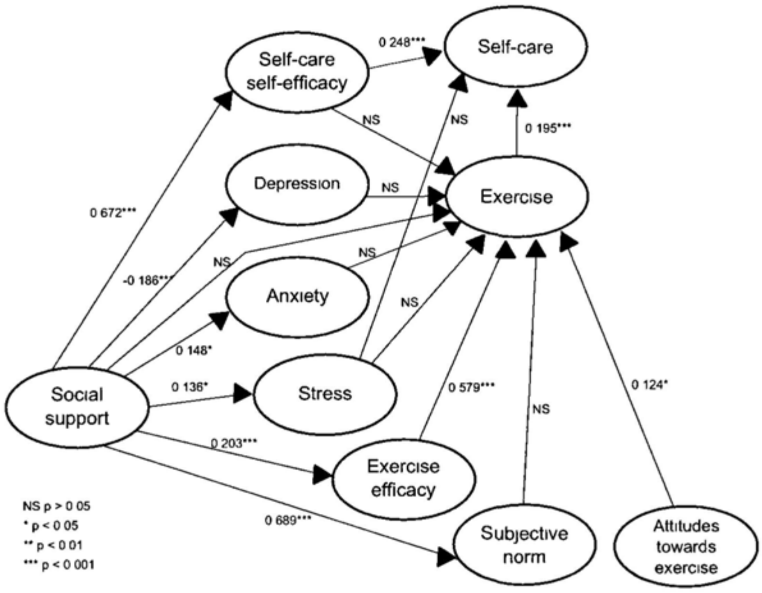

Figure 9.11: Alternative model for exercise with added path for stress effecting self-care

in more vigorous activities to rip further benefits.

The models reconfirmed findings from regression analyses that exercise efficacy and attitude towards exercise are important predictors of physical activity level. Strategies to improve those two constructs have been discussed in Chapter 4. Attitudes can be improved through better patient education. But getting results from exercising is also important since attitudes are formed from expectations and how those expectations are met. Health-care providers can help the patients by working together with the patients to set realistic short-term goals that the patients can achieve. Doing so can also increase the level of exercise efficacy because patients will gain confidence to exercise as they become more experienced with it through participation. Recent study of application of the Theory of Planned Behavior, an extension of the Theory of Reasoned Action, in diabetes patients found that attitudes and subjective norm were both significant predictors of physical activity in Type 2 diabetes patients.[185] The lack of correlation between subjective norm and physical

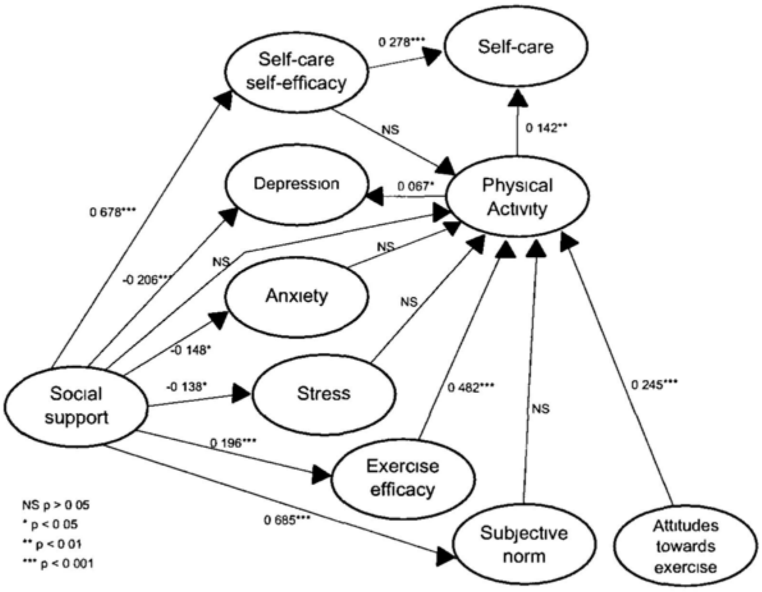

Figure 9.12: Alternative model with physical activity affecting depression

activity in our sample suggests a possible cultural difference.

In addition, we found that instrumental social support plays a significant role in improving exercise efficacy. Peer-support programs for patients to obtain support from other patients who are more experienced in dealing with the obstacles to become more active can be organized. Note that since subjective norm was not a significant factor in physical activity participation, peer-support programs need to involve more than just transfer of knowledge. Emphasis of future peer-support programs can focuses on improving instrumental social support that diabetes patients can provide to each other. For example, the patients can form exercise groups for various activities. And by supporting each other's exercise efforts, patients can build-up their efficacy to exercise more. Health-care providers can facilitate the formation of such peer-support groups instead of directly managing each program and concentrate on clinical management of the disease.

Enhancing social support has the added benefits of reducing symptoms of depres-

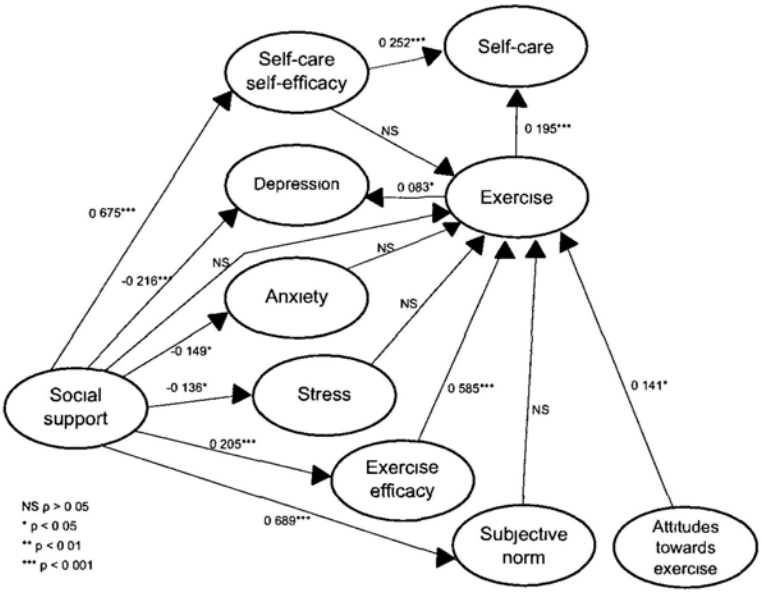

Figure 9.13: Alternative model with exercise affecting depression

sion, anxiety, and stress. While those mental health variables were not association with physical activity or diabetes self-care in our study, the benefits of improving psychological health should be a strong motivation to enhance social support of the patients.

Among the models, it was interesting to find that although depression did not affect exercise participation, the reversed relationship—that exercise affects level of depression—was found to be significant. Even more curious is the fact that the relationship pointed to the counter-intuitive effect of higher level of exercise resulted in higher degree of depression. Since this is a cross-sectional study, we cannot rule out the possibility that exercise was was used to ease symptoms of depression. Also note that although exercise did affect depression, physical activity did not show such relationship. This is understandable since physical activity includes activities that one might not enjoy. Previous study of diabetes patients who were above 60 years of age found 26% to have elevated symptoms of depression.[17] However, the prevalence

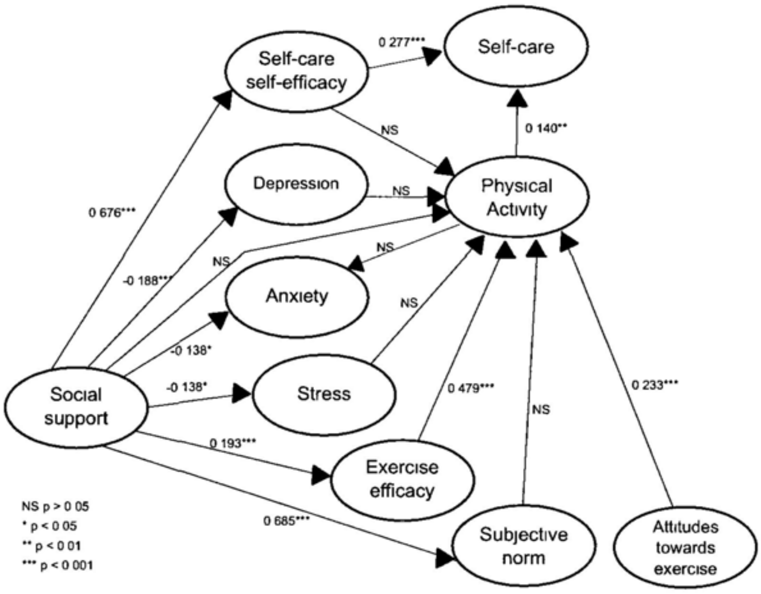

Figure 9.14: Alternative model with physical activity affecting anxiety

and severity of depression in diabetes patients in Hong Kong, especially for those who are younger, remains unclear.

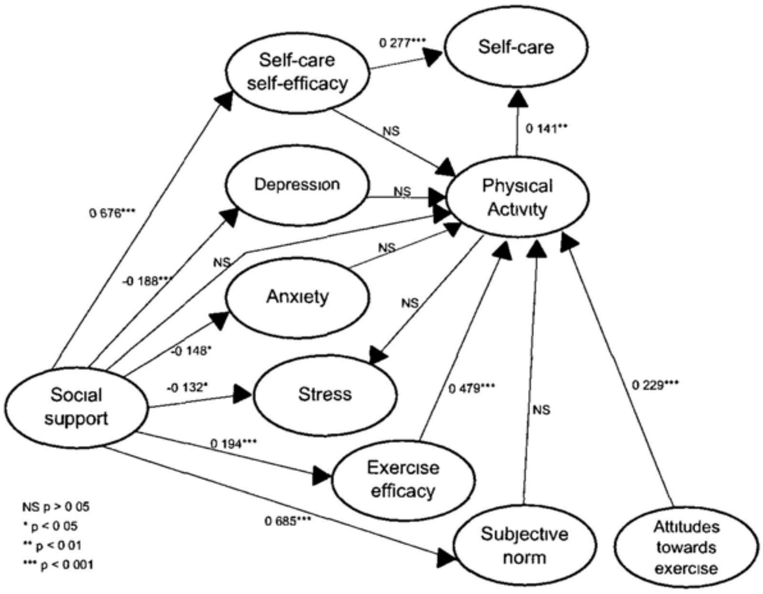

Figure 9.15: Alternative model with physical activity affecting stress

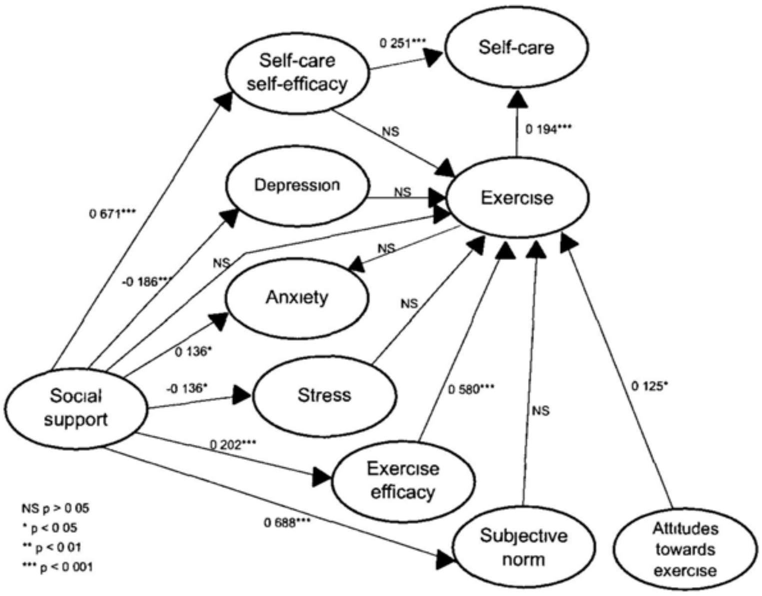

Figure 9.16: Alternative model with exercise affecting anxiety

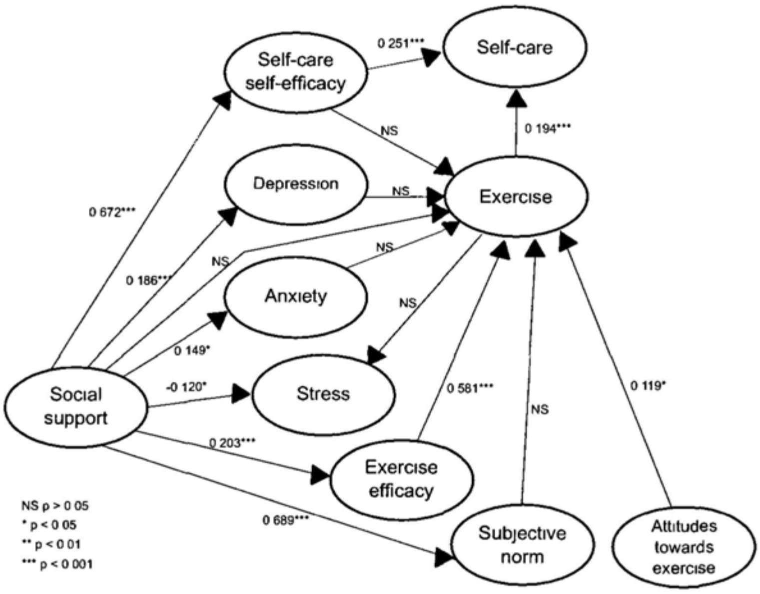

Figure 9.17: Alternative model with exercise affecting stress

Chapter 10

Predictors of cognitive factors for physical activity participation

10.1 Introduction

In the previous chapters, two cognitive factors (exercise efficacy and attitudes towards exercise) repeatedly showed their correlation with physical activity participation and was suggested to be the primary targets for stage-matched intervention in physical activity enhancement programs. In this chapter, predictors of those two factors were identified. The aim is to identify key characteristics of the patients for patient stratification. Intervention providers can then delivery customized intervention to different groups to maximize the effect.

Linear regression analyses were used to identify the correlation of exercise efficacy and attitudes towards exercise with a number of variables that included gender, age, education level, employment type, instrumental social support, duration of diabetes.

10.2 Results

10.2.1 Factors in association with exercise efficacy

Having a full-time job was associated with lower exercise efficacy ($\beta_m = -1\ 44$, $p < 0.001$; Table 10 1). Attitudes towards exercise ($\beta_m = 0.63$, $p < 0.01$) and control of barriers ($\beta_m = 0.15$, $p < 0\ 001$) were both positively correlated with exercise efficacy. Interesting, although instrumental social support was found to be correlated with exercise efficacy in the structural equation models in Chapter 9, the correlation became non-significant when considered with other variables in this multivariate linear regression model. Age was significantly correlated with exercise efficacy in univariate analysis ($\beta = 1.33$, $p < 0\ 001$), but the relationship became non-significant in the multivariate model ($p > 0.05$) Gender and education level appeared to have no correlation with exercise efficacy ($p > 0.05$).

Table 10.1: Factors in association with exercise efficacy

		Univariate linear reg		Multivariate linear reg	
	Mean±SD	β	(95% CI)	β_m	(95% CI)
Gender					
Male	5 59±4 28	*ref*		–	
Female	5 64±4 39	0 05	$(-0\ 67, 0\ 76)$	–	
Age					
< 60	5 02±4 14	*ref*		*ref*	
≥ 60	6 35±4 45	1 33	$(0\ 52, 2\ 04)^{\ddagger}$	*NS*	
Education level					
Primary or below	5 57±4 54	*ref*		–	
Secondary or above	5 64±4 21	0 07	$(-0\ 68, 0\ 82)$	–	
Employment type					
Others	6 51±4 35	*ref*		*ref*	
Full-time	4 51±4 03	−2 00	$(-2\ 71, -1\ 30)^{\ddagger}$	−1 44	$(-2\ 25, -0\ 62)^{\ddagger}$
Attitudes towards exercise		0 56	$(0\ 16, 0\ 96)^{\dagger}$	0 63	$(0\ 23, 1\ 03)^{\dagger}$
Control of barriers		0 16	$(0\ 13, 0\ 19)^{\ddagger}$	0 15	$(0\ 11, 0\ 18)^{\ddagger}$
Social support		1 03	$(0\ 41, 1\ 65)$	*NS*	

– Variable not included in multivariate model, *NS* Not significant at $\alpha = 0\ 05$
* $p < 0\ 05$
† $p < 0\ 01$
‡ $p < 0\ 001$

10.2.2 Factors in association with attitudes towards exercise

A secondary or high education level were correlated with attitudes towards exercise ($\beta_m = 0.15$, $p < 0.05$; Table 10.2). Subjective norm had a very significant positive correlation with attitudes ($\beta_m = 0.21$, $p < 0.001$). Exercise efficacy, while significant in univariate analysis ($\beta = 0.02$, $p < 0.01$), was not significantly correlated with attitudes when modeled together with education level and instrumental social support in a multivariate linear model. Instrumental social support was the other factor that was found to be significant in univariate analysis but not in multivariate analysis.

Gender, age, and employment type did not show any significant correlation with attitudes. Duration of diabetes was not correlated with attitudes even during univariate analysis ($p > 0.05$). Control of barriers to exercise also showed no significant correlation with attitudes ($p > 0.05$).

10.3 Discussion

It came at no surprise that the control of barriers to exercise was correlated with exercise efficacy in the regression model. Control of barriers is a closely related construct to exercise efficacy. It is a combination of how often patients encountered barriers to exercise and patients' perceived effect of those barriers on their exercise participation. Patients with higher exercise efficacy are expected to be less-influenced by the barriers. If patients can reduce the occurrence of barriers to exercise, then their control of barriers score should increase and then their exercise efficacy should also improve. In Chapter 3 we found that the barriers that were encountered most by patients were long working hours (for males) and having to look after family (for females). Those barriers also reported to cause significant negative impact on exercise participation.

Table 10.2: Factors in association with attitudes towards exercise

		Univariate linear reg		Multivariate linear reg	
	Mean±SD	β	(95% CI)	β_m	(95% CI)
Gender					
Male	1 23±0 90	*ref*		–	
Female	1 15±0 93	−0 08	$(-0\ 24, 0\ 08)$	–	
Age					
< 60	1 24±0 86	*ref*		*ref*	
≥ 60	1 14±0 96	−0 09	$(-0\ 25, 0\ 06)$	–	
Education level					
Primary or below	1 07±0 88	*ref*		–	
Secondary or above	1 27±0 93	0 20	$(0\ 04, 0\ 36)^*$	0 14	$(0\ 00, 0\ 27)^*$
Employment type					
Others	1 13±0 89	*ref*		*ref*	
Full-time	1 28±0 93	0 15	$(-0\ 01, 0.31)$	–	
Duration of diabetes		−0 00	$(-0\ 01, 0\ 01)$	–	
Exercise efficacy		0 02	$(0\ 01, 0\ 04)^\dagger$	*NS*	
Subjective norm		0 23	$(0\ 20, 0\ 26)^\ddagger$	0 21	$(0\ 17, 0\ 24)^\ddagger$
Control of barriers		−0 00	$(-0\ 01, 0\ 00)$	–	
Social support		0 56	$(0\ 44, 0\ 69)^\ddagger$	*NS*	

– Variable not included in multivariate model, *NS* Not significant at $\alpha = 0\ 05$
* $p < 0\ 05$
† $p < 0\ 01$
‡ $p < 0\ 001$

Long working hours is often not something that can be controlled by the patients. A possible way to decrease that impact is to incorporate physical activity into the working environment. For example, get off motorized transport before the destination stop in order to increase walking distance, and increase the intensity by increasing the walking pace to a brisk walk.

For patients who need to take care of family. Maybe they can discuss with their family member about sharing domestic responsibilities. Or else try to incorporate more physical activities into their daily activities, such as walking longer distance to get groceries.

Attitude towards exercise significantly predicted exercise efficacy, but the revers was not true. This supports the stage-specific intervention planning that we proposed in Chapter 5. Our plan to first increase attitudes in the precontemplation stage can have the added benefits of causing a greater increase in exercise efficacy during the transition from contemplation to preparation stage.

The strong correlation between subjective norm and attitudes towards exercise, when considered together with findings from Chapter 4 that subjective norm did not correlate with physical activity while attitudes is an interesting finding. It points to a potentially interesting re-configuration of those two constructs from the Theory of Reasoned Action in the case of physical activity participation. So while subjective norm does not directly affect physical activity level, it might have indirect influence through changing patient's attitudes. Future longitudinal study is needed to untangle the relationships of those variables.

Chapter 11

Utilization of behavioral change theories to enhance physical activity in patients with Type 2 diabetes mellitus

11.1 Overview

Diabetes mellitus is an increasingly serious problem in Hong Kong. Prevalence of the disease is expected to keep going up in the coming years and recent projection estimated that 10.2% of Hong Kong's population will be living with diabetes by Year 2030.[186] Burden of caring for this incurable disease is expected to increase. Although prevention should be the primary strategy for combating this problem, we also need to help people who are already suffering from diabetes to live a more healthy life. Physical activity is an pivotal part of diabetes management. International guidelines recommend moderate-intensity physical activity on most days of the week, for at least 30 minutes per day.[7,8] Physical activity is very accessible to patients without physical disabilities. It does not require a lot of skills, and there is minimal environmental barriers. Patients can choose an activity that they can perform and gradually increase the frequency, duration, and intensity of the activity. However, a lack of study into this crucial component of diabetes care in Hong Kong made it difficult for intervention planners to gauge the needs of the patients.

This study represents the first detailed study of physical activity participation in Type 2 diabetes patients in Hong Kong. We gathered information on physical activity participation, such as level of participation and whether they met international recommendations. Those data give us a cross-sectional view of the situation. However, for public health purpose, we are also interested in factors that can help the patients to further increase their physical activity participatiobn such as cognitive factors, mental distress, social support, and severity of diabetes.

From this group of patients, we found that the majority (~83%)of physical activities performed by the patients were planned exercise. About half of the diabetes patients in this sample were able to meet physical activity recommendations set by international organizations. This level of physical activity is better than expected, but it is still lower than that of the general population.[5] Our results also told us that almost half of the sample did not even think about increasing their physical activity to the recommended level. That means, for those who did not meet the recommended physical activity level, almost non of them were ready to make any change to their physical activity habit. There is definitely a need to help this group of patients to be more active. But traditional methods of physical activity promotion seems to have little effect on them.

Stage of change is one of the main constructs of the Transtheoretical Model for behavioral change. Stage-matched interventions have shown to be more efficacious in oversea studies,[129,130] but it remains to be seen how to translate those findings to Hong Kong's situation. The importance of exercise efficacy in physical activity or exercise participation for diabetes patients was re-confirmed by various analyses in this study. In general, the patients hold a favorable attitude towards using exercise for diabetes management. However, when the patients were looked at separately according to their readiness to exercise at the recommended level, we found that only patients who were able to meet the recommended level of exercise showed any difference in attitudes towards exercise when compared to patients who did not think about regular exercise. According to the Transtheoretical Model, intervention to increase attitude should be carried out at the precontemplation stage. Health-care providers can investigate more efforts into identification of patients who are at the precontemplation stage and offer enhanced education to them for optimal effects. The improved attitude might also led to higher exercise efficacy.

We observed a large increase in exercise efficacy from patients in the contemplation stage to patients in the preparation stage. Exercise efficacy can be increase through participation in exercise. Initial level of exercise should be at a low enough level that the participant can handle and then increase gradually until the recommended level. This process should be individualized and includes a goal-negotiation process between the the patient and the intervention providers to achieve the best results. Instructor-led exercise class can be considered for patients who do not have confidence to exercise by themselves. Exercise that can be recommended to the patients include strolling, stretching, jogging, swimming, and hiking. Those were found to the preferred types of exercise by this group of patients. Strolling is the most popular type of exercise for both genders. Pilot study of a nurse-led walking program for diabetes patients was effective in raising patients' efficacy to exercise.[187] Stretching, which included various forms of "morning exercises", "health dance", and Tai-Chi, etc. was practiced by more females than males. Males were more likely to have participated in more vigorous forms of exercise such as jogging and hiking. Swimming was equally popular in both gender groups for the most part. Those results suggested that female patients were less likely to participate in exercise that makes them feel sweaty. Intervention planners and providers should keep this difference in mind when recommending exercise for the patients.

Originally, we expected that in a Chinese society, subjective norm would have been the dominant TRA constructs in predicting physical activity participation, but instead we found attitudes to be dominating instead. Hong Kong is a heavily Westernized society with a Chinese cultural base. The balance seems to have tipped towards the Western value of individualism. The lack of correlation between instrumental social support and physical activity also gave support to existence of a individualistic society. Future programs for physical activity enhancement can capitalize on the people's individualism and offer appropriate interventions, which goes back to exercise efficacy enhancement and positive attitude change.

On the other hand, we observed a strong correlation between subjective norm and attitudes. It is likely that by improving subjective norm, patients' attitudes towards exercise would show further increase. Currently, motivation to comply with normative believes of other referent groups were higher groups such as family members, friends, and doctors. Motivation to comply with opinion of other diabetes patients still has some room for growth, which makes it the focal area for intervention. There is an increasing interest in peer-supported intervention program for diabetes self-care.[169] The efficacy of peer-support programs will depends on how they enhance the trust between the program participants. Among the various aspects of diabetes self-care, the patients were able to adhere to a healthy diet about half of the time. However, they did not do as well on foot care and self-monitoring of blood glucose. Males appeared to get higher level of instrumental social support than the females. For diseases that require multiple behavioral change, it is more effective if the effort to change is concentrated on one behavior at a time. We had hoped that a higher level of physical activity would lead to better self-care in other aspects. However, we found that although patients who spent more time on physical activity or exercise had higher level of diabetes self-care, the reversed was not true. In addition, even though physical activity was found to be correlated with overall level of self-care in the structural equation model, the correlation was only valid for vegetable intake. Therefore, additional interventions to change patients' behavior of other aspects need to be planned.

Severity of the three diabetes control indicators (HbA1c, blood pressure, LDL-cholesterol) appeared to have no influence on physical activity or exercise, mental distress levels, or level of self-care. Those indicators were used by doctors to assess diabetes control, but they were also used to convey the severity of the disease to the patients so that patients can adjust their self-care behaviors. This school of thought is represented by the Health Belief Model,[170] where perceived threat of diabetes complications should drive patients to better self-care. However, patients' self-care behaviors appeared to be dissociated from how well they did on diabetes control. This group of patients have been living with diabetes for quite some time already (mean duration of diabetes is ~ 9 years). It is possible that their perceived susceptibility and perceived severity of getting diabetes-related complications are both quite low. It might have been a result of the level of clinical care that they received. They might thought that even if they come down with a complication, they will be taken care of. This level of complacency is detrimental to their own health. The increased risk of diabetes complication also drain resources from the health-care system, and might keep people who really need medical care from getting adequate care. The significance of the indicators and how those affect future risk of complications need to be emphasized to the patients early, and repeatedly, to make sure they understand the gravity of not keeping those indicators under control.

The levels of depression, anxiety, and stress were very low for these patients and did not exert any influence on physical activity or exercise participation. The low level of mental distress suggests that there might not be an immediate need for the integration of screening for mental health problems and mental health services in regular diabetes care in Hong Kong. It is paradoxical that our sample of diabetes patients had better mental health than the general population when previous research suggested the other way around.[16] More research is needed on a more representative sample to accurately assess the mental health needs of the patients.

11.2 Recommendations for future

At the policy level, Hong Kong's public policy, of lack thereof, often make it hard to conduct a physically active life. People in Hong Kong lead a very busy lifestyle, and lack of time is often quoted as the number one reason for the lack of physical activity.[190] Employers in Hong Kong notoriously expect their employees to work over-time. People often have to work for more than eight hours per day, and that would make it very difficult for them to exercise after a long day of work—most people would opt for resting instead.

There have been calls for legislation on maximum working hours from some parts of the society. Business sector are worried that a maximum working hour legislation would impact their productivity and bottom-line. However, it is possible that workers would become more productive during the normal working hours if they are well-rested. Not to mention that a more physically active workforce should be more healthy, both physically and mentally, which might lead to reduce sick leave and absenteeism. In addition, employers can reduce medical insurance costs because their employees make less medical claims. The government should start some pilot projects to explore the effects of maximum working hour.

The Hong Kong SAR Government's own policy on sport development also need to be reviewed. The Governement's "vision" for sports development are a) promoting "Sports for All"; b) fostering high performance sports; and c) equipping Hong Kong to host international sports events.[191] Of the three visions, only promoting "Sports for All" has anything to do with public participation in sports. That aim was put into action through multiple programs, committees, projects, campaign, etc.. However, the efficacy of those policies and actions are rarely evaluated.

Moreover, there is no infrastructural support such as new facility for the general public. At the same time, the Hong Kong Sports Institute is on track for redevelopment[192] and a new multi-purpose stadium was proposed for spectator sports and events.[193] The Government need to invest more in public sport facilities to encourage people to be physically active. This is especially important with the recent trend of increasing temperature, which is found to be a major deterrent of exercise participation.[194]

At the service level, currently, doctors have very specific role to play in diabetes management—they manage diabetes through medication. How patients should change their lifestyles and manage their day-to-day lives is often delegated to the nurses and other allied health professions. Even then, physical activity receives amazingly little attention. Patients received nutritional information from dietitian, but when it comes to physical activity, they have to find the information by themselves. For example, there are exercise classes for diabetes patients, but those are not compulsory for the patients. In addition, those classes are often instructor-led and only run for a few sessions. So there is a lack of continuous monitoring to ensure that patients are active enough.

Traditionally, clinical indicators such as HbA1c, blood pressure, and LDL-cholesterol provide clinicians with data that are useful for diagnosis and prognosis. And those same indicators were used to encourage patients to adopt better self-care practices. The logic is that patients who have non-optimal levels of those clinical indicators would take better care of themselves. However, we found that those indicators had no association with patients' self-care decisions. Therefore, health-care providers and health promoters need to find alternative angles to get people to adopt better self-care practices.

For physical activity, this study suggests that implementation of stage-matched exercise intervention program for diabetes patients should be considered for the future. The following structures can be used as a reference for future exercise programs.

- Precontemplation: For patients who have not thought about regular exercise, programs should aim at improving their attitude towards exercise through patient education. Other possible strategies include using family interventions to prompt the patients to think about how being inactive could led to development of diabetes complication and how that would affect their social lives. Another strategy that can be considered is to employ personal testimonies of other patients about how becoming physically active helped them dealing with diabetes. Peer-support programs might also prove to be an useful strategy for improving attitudes.

- Contemplation: For patients who started thinking about regular exercise in the next six months. It is better to offer exercise programs that aim at increasing exercise efficacy. Those programs can be either instructor-led, the pace of which can be controlled by the instructor during the training sessions. Or they can have program manager that keeps track of the patients' physical activity level, and set incrementally higher goals until the recommended level is reached. Intensity of the exercise offered can be increase incrementally to a vigorous level, which should result in a bigger increase in exercise efficacy.

- Preparation: Patients in this stage of change should be ready to engage in regular exercise within a month. If exercise efficacy increase from previous stage is sufficient, patients should be confident enough to transit from this stage into the action stage where the patients start to engage in regular exercise.

- Action: To move from initial adoption of regular exercise to long-term practice, it will be necessary to draw from other processes of change which need continue support from others, as well as controlling temptations to relapse into an inactive lifestyle. A high level of exercise efficacy carry-over from previous stages is a pivotal factor in overcoming the temptations.

Successful implementation of such program requires the support of a health psychologist during program development. However, it is not a common practice to enlist the help of such professionals when designing exercise programs. Programs should focus on setting small, individualized goals for each patient according to their ability. Then, the goals need to be raised little by little during subsequent goal negotiation and goal setting until the recommendations are met. For extra health benefits, there can be extended programs that encourage patients to go beyond the recommended minimum levels. Such programs need to be monitored closely to make sure the patients do not over-exercise.

Longitudinal study of the proposed stage-matched intervention will tell us whether it is a worthwhile endeavor. Aside from showing the effectiveness of such program. Other factors must be considered if it is to gain wide-spread acceptance. Drawing from the RE-AIM framework from the field of translational research, successful intervention should be able to Reach many of the target population, be Effective, can be readily Adopt by other organizations, easy to Implement and Maintain.[188,189]

11.3 Limitations of the study

The study has a few limitations. We are unable to establish causal relationships between the variables because of the cross-sectional nature of the study design. Recruitment of patients from complication screening sessions at specialized diabetes clinics might have caused potential bias in our sample. Patients who cared about themselves enough to attend the complication screening service, which is optional, might be more motivated than the average diabetes patients. This might affect the generalizability of the results. However, if it is made clear that the study population includes those who utilize such services (about 50% of the diabetes patients would be included), the results are still valid and would facilitate health improvement of these service users. The modest recruitment rate of this study might be another cause of sampling bias. DASS21 is a screening instrument and hence the measurement of mental distress may not be accurate enough. Whilst validated instruments were used whenever feasible, some measures such as those on exercise self-efficacy, attitudes towards exercise, and instrumental social support, are based on self-constructed indicators. In particular, the self-reported physical activity data acquired from IPAQ, like many other questionnaires, often over-reports daily physical activity, and considerable care needs to be taken when interpreting the results. This over-reporting can be up to 100% above that measured using objective measures such as accelerometry.[146,195] The use of objective measures such as accelerometry or pedometry are therefore warranted, although not without some limitations—especially gaining respondent compliance over the necessary 5–7 days is often problematic. Care also is required when interpreting the performance of activities such as stretching- and

Tai-Chi–related activities as being adequately intense in the elderly to be categorized as moderate activity, and hence health-promoting, as limited clinical evidence is available to support the health-promoting status of such activities.

Appendices

Appendix A

Questionnaire used in this study

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香港中文大學
公共衛生學院 及 內科及藥物治療學系 合辦
糖尿病人運動及生活習慣調查

研究編號： 日期：

【SD1】性別：☐男 / ☐女

【SD2】年齡：________歲

【SD3】教育程度：

☐冇正式教育
☐小學
☐中學
☐大學或以上

【SD4】工作性質：

☐已經退休　☐學生　☐文職
☐失業/沒有工作　☐專業人士　☐服務性行業
☐家庭主婦　☐管理層　☐技術性勞動行業
☐非技術性勞動行業

【SD5】請問過去十二個月你的**個人**每月平均收入大約係多少？

☐冇收入　☐20,000—29,999
☐<5,000　☐30,000—39,999
☐5,000—9,999　☐40,000—49,999
☐10,000—19,999　☐50,000+

【SD6】請問過去十二個月你的**家庭**每月平均收入大約係多少？

☐冇收入　☐20,000—29,999
☐<5,000　☐30,000—39,999
☐5,000—9,999　☐40,000—49,999
☐10,000—19,999　☐50,000+

【SD7】你幾時發現自己患上糖尿病？

已經________年（或、從________年開始）

【SD8】你患的是什麼形糖尿病？

☐I［甲］　☐II［乙］　☐不知道

【SD9】你現在有冇注射胰島素？

☐沒有　☐有

【SD10】你有沒有吸煙？

☐從未　☐已戒煙　☐吸煙者

【PA1】你身體有冇任何令你不能運動的毛病？

☐沒有　☐有：____________

【PA2】請問你平日通常做什麼運動？

☐散步　☐晨運　☐球類運動
☐行山　☐太極　☐游水
☐跑步　☐氣功　☐健身
☐其他：　☐瑜伽　☐健康舞
☐沒有運動

【PA3】請問你**現在**有幾多成信心可以做到一星期**三日**，每日三十分鐘中度或以上的運動？

________成

【PA4】請問你**現在**有幾多成信心可以做到一星期**五日**，每日三十分鐘中度或以上的運動？

________成

【PA5】如果定期運動係指一星期**五日**，每日三十分鐘中度或以上的運動。

（注：如受訪人於任何 PA5 的問題回答『十分同意』，跳過餘下的題目至 PA6）

你同不同意 ..	十分不同意	不同意	同意	十分同意
(a) . 於未來六個月內，你沒有打算開始定期做運動。	☐	☐	☐	☐
(b).. 你打算於未來六個月內開始定期做運動，但不會於下個月開始。	☐	☐	☐	☐
(c)...你打算由下個月起定期做運動。	☐	☐	☐	☐
(d)...你現在已經可以做到定期運動，但還未持續做足六個月。	☐	☐	☐	☐
(e)...你現在已經可以做到定期運動，並已持續了六個月或以上	☐	☐	☐	☐

【PA6】請問喺過去 7 日，你有幾多日曾經想過做運動？ ______________日

【PA7】喺過去 7 日你有**幾多**日曾經...	日數	【PA8】你認為這對你做唔做運動有**什麼影響**？ 大大增加	增加	沒有影響	減少	大大減少
a. 工作時間長過 8 小時		☐	☐	☐	☐	☐
b. 參加其他休閒活動		☐	☐	☐	☐	☐
c. 須要照顧家庭		☐	☐	☐	☐	☐
d. 精神/體力不足		☐	☐	☐	☐	☐
e 和朋友一同運動		☐	☐	☐	☐	☐
f. 覺得有興趣去運動		☐	☐	☐	☐	☐
g. 覺得健康唔好		☐	☐	☐	☐	☐

	很多好處	有好處	沒有影響	有壞處	很多壞處
【PA9】你認為運動對你有什麼影響？	☐	☐	☐	☐	☐

請問你同不同意以下的描述？	十分同意	同意	沒有意見	不同意	十分不同意
【PA10】一般來說，你認識的人相信運動對你有益。	☐	☐	☐	☐	☐
【PA11】運動可以幫你控制糖尿病。	☐	☐	☐	☐	☐
【PA12】你的家人認為運動對你有益。	☐	☐	☐	☐	☐
【PA13】你的朋友認為運動對你有益。	☐	☐	☐	☐	☐
【PA14】你的醫生認為運動對你有益。	☐	☐	☐	☐	☐
【PA15】其他糖尿病人認為運動對他們有益。	☐	☐	☐	☐	☐
【PA16】你重視家人的意見。	☐	☐	☐	☐	☐
【PA17】你重視朋友的意見。	☐	☐	☐	☐	☐
【PA18】你重視醫生的意見。	☐	☐	☐	☐	☐
【PA19】你重視其他糖尿病人的意見。	☐	☐	☐	☐	☐
【PA20】運動會**增加**體重。	☐	☐	☐	☐	☐
【PA21】運動會**增加**糖尿併發症的機會。	☐	☐	☐	☐	☐
【PA22】運動可以降低血糖。	☐	☐	☐	☐	☐
【PA23】運動令我精神飽滿。	☐	☐	☐	☐	☐

	很多好處	有好處	沒有影響	有壞處	很多壞處
【PA24】你認為**增加**體重對你有什麼影響？	☐	☐	☐	☐	☐
【PA25】你認為**增加**糖尿併發症的機會對你有什麼影響？	☐	☐	☐	☐	☐
【PA26】你認為降低血糖對你有什麼影響？	☐	☐	☐	☐	☐
【PA27】你認為精神飽滿對你有什麼影響？	☐	☐	☐	☐	☐

我現在想知道你日常的**體能活動**習慣。以下的問題是有關在過去七天中你花在體能活動的時間。請你想一想你在工作、做家務、交通、休閒、和訓練時的活動。

首先，請你回想過去七天的劇烈體能活動。劇烈體能活動即是那些需要用大量身體力量並會令你呼吸比平時更為吃力的活動，包括搬運重物、掘地、行山、健康舞、跑步等。你只須要想你在過去七天內曾經連續進行至少十分鐘的活動。

【IPAQ1】在過去七天內，你曾經有多少天連續進行至少十分鐘的劇烈體能活動？
______天
☐唔知道
☐拒絕回答

【IPAQ2】在你有進行劇烈體能活動的日子，你每天通常會用多少時間去進行劇烈體能活動？
每天______小時
每天______分鐘
☐唔知道
☐拒絕回答

接著我想問你過去七天的中度體能活動。中度體能活動包括那些會令你呼吸比平時吃力一點的活動，如搬運輕便物品、打掃屋企、打太極、緩步跑等。你只須要想你在過去七天內曾經連續進行至少十分鐘的活動。

【IPAQ3】在過去七天內，你曾經有多少天連續進行至少十分鐘的中度體能活動？
______天
☐唔知道
☐拒絕回答

【IPAQ4】在你有進行中度體能活動的日子，你每天通常會用多少時間去進行中度體能活動？
每天______小時
每天______分鐘
☐唔知道
☐拒絕回答

接著我想知道你在過去七天內步行的情況。你只須想你在過去七天內曾經需要**連續步行**至少十分鐘的路程。

【IPAQ5】在過去七天內，你曾經有多少天需要連續步行至少十分鐘？
______天
☐唔知道
☐拒絕回答

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【IPAQ6】在那些日子裏面，你每天通常會步行多少時間？

每天＿＿＿＿小時
每天＿＿＿＿分鐘
☐唔知道
☐拒絕回答

以下請你回想剛剛過去的星期一至五，你有多少時間是坐著或是躺臥著呢？這包括工作、在家、和其他空閒時間。例如坐在檯前工作、在沙發上看電影、看書等等。

【IPAQ7】在剛剛過去的星期一至五，你每天通常會用多少時間坐著或是躺臥著？

每天＿＿＿＿小時
每天＿＿＿＿分鐘
☐唔知道
☐拒絕回答

【PATTERN】請問在過去一星期內，你每日進行多少分鐘中等或以上程度的運動？

	星期一	星期二	星期三	星期四	星期五	星期六	星期日
時間(分鐘)							

請問你同不同意以下的句子？	十分同意	同意	沒有意見	不同意	十分不同意
【SS1】你覺得你的家人或朋友都很支持你應付糖尿病	☐	☐	☐	☐	☐
【SS2】你的家人或朋友會提醒你定時服食糖尿藥	☐	☐	☐	☐	☐
【SS3】你的朋友或家人會鼓勵你多做運動	☐	☐	☐	☐	☐
【SS4】你會和朋友或家人一同運動	☐	☐	☐	☐	☐
【SS5】你和他人食飯時，他們為你而食得清淡一點	☐	☐	☐	☐	☐

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指導語 「我現在將唸一些句子，這些句子代表了一些人的感受和行為。請問在過去一星期中，你認為那些句子對你適用與否？」

【DASS】		不適用	頗/間中適用	很/經常適用	最/常常適用
1	我覺得很難讓自己安靜下來	☐	☐	☐	☐
2	我感到口乾	☐	☐	☐	☐
3	我好像不能再有任何愉快、舒暢的感覺	☐	☐	☐	☐
4	我感到呼吸困難（例如不是做運動時也感到氣促或透不過氣來）	☐	☐	☐	☐
5	我感到很難自動去開始工作	☐	☐	☐	☐
6	我對事情往往作出過敏反應	☐	☐	☐	☐
7	我感到顫抖（例如手震）	☐	☐	☐	☐
8	我覺得自己消耗很多精神	☐	☐	☐	☐
9	我憂慮一些令自己恐慌或出醜的場合	☐	☐	☐	☐
10	我覺得自己對將來沒有甚麼可盼望	☐	☐	☐	☐
11	我感到忐忑不安	☐	☐	☐	☐
12	我感到很難放鬆自己	☐	☐	☐	☐
13	我感到憂鬱沮喪	☐	☐	☐	☐
14	我無法容忍任何阻礙我繼續工作的事情	☐	☐	☐	☐
15	我感到快要恐慌了	☐	☐	☐	☐
16	我對任何事也不能熱衷	☐	☐	☐	☐
17	我覺得自己不怎麼配做人	☐	☐	☐	☐
18	我發覺自己很容易被觸怒	☐	☐	☐	☐
19	我察覺自己在沒有明顯的體力勞動時，也感到心律不正常	☐	☐	☐	☐
20	我無緣無故地感到害怕	☐	☐	☐	☐
21	我感到生命毫無意義	☐	☐	☐	☐

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【SC0】 醫護人員建議你每星期測試自己的血糖________天？每天________次？

【SC1】 過去七日，你有多少天跟隨健康的飲食計劃？

□0 □1 □2 □3 □4 □5 □6 □7

【SC2】 過去一個月，平均每星期你有多少天跟隨健康的飲食計劃？

□0 □1 □2 □3 □4 □5 □6 □7

【SC3】 過去七日，你有多少天進食五份或以上的生果及蔬菜？

□0 □1 □2 □3 □4 □5 □6 □7

【SC4】 過去七日，你有多少天進食高脂肪食物如紅肉或全脂製成品？

□0 □1 □2 □3 □4 □5 □6 □7

【SC5】 過去七日，你有多少天參與最少三十分鐘的體能活動？（持續的活動，包括步行，並以分鐘計算）

□0 □1 □2 □3 □4 □5 □6 □7

【SC6】 過去七日，你有多少天刻意做一些運動（如 游泳、步行、騎單車）而不是在你家或工作之內的呢？

□0 □1 □2 □3 □4 □5 □6 □7

【SC7】 過去七日，你有多少天曾測試自己的血糖？

□0 □1 □2 □3 □4 □5 □6 □7

【SC8】 過去七日，你有多少天曾按醫護人員建議的次數測試自己的血糖？

□0 □1 □2 □3 □4 □5 □6 □7

【SC9】 過去七日，你有多少天曾檢查自己的雙腳？

□0 □1 □2 □3 □4 □5 □6 □7

【SC10】 過去七日，你有多少天檢查你鞋子的內部？

□0 □1 □2 □3 □4 □5 □6 □7

【SC11】 過去七日期間，你曾否抽煙-即使一口?

□沒有 □有，平均每日________支

下列句子是量度你控制糖尿病帶來的心理和社交問題的能力。有些問題像是重複，但其實每一條的重點都有些不同。你只須說出你同不同意每一句的描述便可以。

【DES】一般來說，你相信你		十分不同意	不同意	中立	同意	十分同意
1	可以選擇切實可行的目標以控制糖尿病。	□	□	□	□	□

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【DES】一般來說，你相信你		十分不同意	不同意	中立	同意	十分同意
2	知道哪一個控制糖尿病的目標對你來說**最**重要。	☐	☐	☐	☐	☐
3	能夠將自己的控制糖尿病目標變成可以實行的計劃。	☐	☐	☐	☐	☐
4	只要立定主意，便可以達成自己的控制糖尿病目標。	☐	☐	☐	☐	☐
5	知道有某些**障礙**，使你更難達成控制糖尿病目標。	☐	☐	☐	☐	☐
6	可以想出不同的方法以克服那些障礙。	☐	☐	☐	☐	☐
7	可以嘗試用不同的方法以克服那些障礙。	☐	☐	☐	☐	☐
8	能夠決定某一個最有效的方法以克服那些障礙。	☐	☐	☐	☐	☐
9	可以應付糖尿病引致的情緒低落。	☐	☐	☐	☐	☐
10	知道患上糖尿病會在你生活上的某些地方帶來壓力。	☐	☐	☐	☐	☐
11	能夠好好應付糖尿病帶來的壓力。	☐	☐	☐	☐	☐
12	知道自己正在用什麼**積極**方法，以應付糖尿病帶來的壓力。	☐	☐	☐	☐	☐
13	知道是什麼事物，支持你照顧自己的糖尿病。	☐	☐	☐	☐	☐
14	知道可以在什麼地方取得支持，以面對和照顧自己的糖尿病。	☐	☐	☐	☐	☐
15	在有需要的時候，可以要求別人給予上述的支持。	☐	☐	☐	☐	☐
16	知道如何取得需要的資料，以選擇適合你的自我照顧方法。	☐	☐	☐	☐	☐
17	對糖尿病有足夠的認識，懂得選擇適合你的自我照顧方法。	☐	☐	☐	☐	☐
18	對自己有足夠的認識，懂得選擇適合你的照顧糖尿病方法。	☐	☐	☐	☐	☐
19	知道如何增加對自己的認識，以選擇適合你的照顧糖尿病方法。	☐	☐	☐	☐	☐
20	有能力衡量是否值得改變自己的自我照顧方式。	☐	☐	☐	☐	☐

Appendix B

Scoring algorithm

B.1 Attitudes towards exercise

Attitude score = (PA12 × PA16) + (PA13 × PA17) + (PA14 × PA18) + (PA15 × PA19)

B.2 Subjective norm

Subjective norm score = (PA20 × PA24) + (PA21 × PA25) + (PA22 × PA26) + (PA23 × PA27)

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