THE DIABETES RELATED SELF-CARE ACTIVITIES OF PEOPLE WITH TYPE 2 DIABETES

Their level and associated factors

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To my mother and extended family

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ABSTRACT

The adherence to diabetes-related self-care activities (DRSCA) is not optimal, although studies about DRSCA have progressed much. Additional information about the factors associated with the level of DRSCA is necessary for supporting patients in diabetes management. This study aimed to examine the DRSCA of people with type 2 diabetes mellitus (T2DM) and associated factors. First, a systematic review with a meta-analysis was used to synthesize the effects of theory-based self-management education on DRSCA, which aimed to provide implications and clues for the second phase of the study. Second, an empirical study investigated background information and outcome information related to DRSCA. DRSCA were measured at two time points.

The systematic review included 22 studies with 6,099 participants after selecting the included studies from five databases. The empirical study used the survey method two times, involving 251 participants with T2DM the first time, and 155 participants completed a valid questionnaire about DRSCA the second time. At the first time point, the information was collected as follows: the background information consisted of demographic information, health information, social support and optimism; the outcome information included negative feelings and positive health. The subsequent DRSCA, covering three months, were measured in order to test the association of social support and optimism with subsequent DRSCA.

The systematic review indicated that theory-based self-management education had more effects on DRSCA than routine care, and this implied that it is necessary to encourage people with T2DM to actively perform DRSCA. The empirical study provided encouraging information with which patients with T2DM could improve DRSCA. The main findings showed that objective support, support utility and optimism were significantly and positively associated with the level of DRSCA. In addition, DRSCA were associated with reduced perceived stress (one component of negative feelings) but not with anxiety and fatigue after adjusting for covariates. DRSCA can improve one component of positive health but this is not significantly associated with resilience and DRQoL after controlling covariates. The study provides additional information to encourage patients to be more involved in DRSCA in order to improve their subjective well-being and to reduce perceived stress. In addition, the role of optimism in DRSCA was examined, and this may help to draw attention to its role in diabetes care.

KEYWORDS: diabetes self-care activities, negative feelings, positive health, optimism, social support

TIIVISTELMÄ

Hoitoon ei aina sitouduta parhaalla mahdollisella tavalla, vaikka tutkimusnäyttö diabeteksen omahoidosta (diabetes-related self-care activities, DRSCA) on vahvistunut. Lisätietoa omahoitoon liittyvistä tekijöistä tarvitaan tukemaan potilaita diabeteksen hoidossa. Tämän tutkimuksen tarkoituksena oli analysoida tyypin 2 diabetesta sairastavien henkilöiden omahoitoon liittyviä tekijöitä. Ensiksi, systemaattista katsausta ja meta-analyysiä käytettiin muodostamaan käsitys teoriapohjaisen omahoito-opetuksen vaikutuksista omahoitotoimenpiteisiin, ja perustakse empiiriselle tutkimusvaiheelle. Toiseksi, empiirisellä tutkimuksella analysoitiin omahoitotoimenpiteiden taustatekijöitä ja hoitotuloksia. Omahoitotoimenpiteitä mitattiin kahdessa aikapisteessä.

Systemaattisessa katsauksessa valittiin viidestä tietokannasta 22 tutkimusta, joissa oli yhteensä 6,099 tutkimushenkilöä. Empiirinen tutkimus koostui kyselyistä kahdessa aikapisteessä, joista ensimmäisessä 251 ja toisessa 155 tyypin 2 diabeetikkoa palautti omahoitoon ja siihen liittyviin tekijöihin kohdistuvat kyselylomakkeet. Ensimmäinen lomake sisälsi potilaiden taustatietoja demografista tekijöistä, terveydestä sekä tietoja sosiaalisesta tuesta ja optimismista; hoitotuloksiin liittyen kerättiin myös tietoa kielteisistä tunteista ja myönteisistä terveysvaikutuksista. Toisessa aikapisteessä tuen ja optimismin vaikutusta diabeteksen omahoitotoimiin mitattiin 3 kuukauden kuluttua.

Systemaattinen tarkastelu osoitti, että teoria-pohjainen omahoidon opettaminen vaikuttaa omahoitoon enemmän kuin rutiiniomainen opetus, ja että tyypin 2 diabeetikkoja tulisi motivoida ottamaan enemmän vastuuta hoidostaan. Empiirinen tutkimus toi esiin seikkoja, joiden perusteella voitaisiin kehittää omahoidon laatua. Sosiaalinen tuki, tuen hyväksyminen ja optimismi olivat merkitsevästi yhteydessä omahoidon tasoon. Omahoito liittyi matalampaan koetun stressin määrään, joka on yksi negatiivisten tunteiden komponenteista, mutta ei ahdistuneisuuteen tai väsymykseen, kun vakioivat tekijät huomioitiin. Omahoito voi parantaa koettua terveyttä ja hyvinvointia, joka on yksi hyvän terveyden komponenteista, vaikka tilastollista yhteyttä resilienssiin tai sairauteen liittyvään elämänlaatuun ei kyetty osittamaan. Tutkimus tuottaa lisätietoa siitä, miten yksilöitä voidaan rohkaista aktiivisempaan rooliin omahoidossaan subjektiivisen hyvinvoinnin parantamiseksi ja stressin vähentämiseksi. Lisäksi optimismin roolia omahoidossa tutkittiin, mikä saattaa auttaa optimismin merkityksen huomioimisessa diabeteksen hoidossa.

AVAINSANAT: diabeteksen omahoito, negatiiviset tunteet, positiivinen terveys, optimismi, sosiaalinen tuki

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Abbreviations

ADDQoL	Audit of diabetes-dependent quality of life (Bradley & Speight, 2002)
DRQoL	Disease-related quality of life
DRSCA	Diabetes-related self-care activities
PSS	Perceived stress scale
SAS	Zung Self-Rating Anxiety Scale (Zung, 1971)
SD	Standard deviation
SE	Standard error
SMD	Standardized mean differences
SPSS	Statistical Package for the Social Science
SS	Social support
SSCE	Standardized self-care education
SSRS	Social Support Rating Scale
SWB	Subjective well-being
T2DM	Type 2 diabetes mellitus
WHO-5 well-being	World Health Organization Well-being index-5 (Bech, 1996, 2003)
WMD	Weighted mean differences

List of Original Publications

This dissertation is based on the following original publications, which are referred to in the text by their Roman numerals:

I   Zhao FF, Suhonen R, Koskinen S, Leino-Kilpi H. The effects of theory based self-management intervention on patients with type 2 diabetes in randomized controlled trials: a systematic review with meta-analysis. Journal of Advanced Nursing. 2017;73(4): 812–833. doi: 10.1111/jan.13163.

II   Zhao FF, Suhonen R, Katajisto J, Leino-Kilpi H. The association of diabetes-related self-care activities with perceived stress, anxiety and fatigue: a cross-sectional study. Patient Preference and Adherence, 2018;12: 1677–1686. Doi: https://doi.org/10.2147/PPA.S169826.

III   Zhao FF, Suhonen R, Katajisto J, Stolt M, Leino-Kilpi H. The association of diabetes-related self-care activities, with positive health: a cross-sectional study. BMJ Open, 2019;9:e023878. doi:10.1136/ bmjopen-2018-023878

IV   Zhao FF, Suhonen R, Katajisto J, Leino-Kilpi H. Factors associated with diabetes-related self-care activities among people with type 2 diabetes: the role of social support and optimism. Nursing Open, 2019;00:1-11. doi.org/10.1002/nop2.379

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1   Introduction

Diabetes is a global health issue. Approximately 415 million people (9% of the population) were diagnosed with diabetes in 2015 and this will increase, maybe rising to 693 million by 2045 (IDF Diabetes Atlas, 2017). In China, 11.6% of females have type 2 diabetes mellitus (T2DM) and 9.9% of males have T2DM (Yang et al., 2016). The complications of diabetes can lead to multiple-organ damage and impact on the quality of life (QoL) (Chawla et al., 2016). The complications of diabetes can cause an economic burden for both individuals and the medical service system (Hu et al., 2015).

Therefore, to prevent complications, performing diabetes self-care activities well and achieving better health outcomes are important (Haas et al., 2014). It is of importance to encourage people with diabetes to improve their diabetes-related self-care activities (DRSCA) and make their own decisions in their care plan (Diabetes UK, 2007; Yang et al., 2015). However, it is no easy task to perform DRSCA, which demand great effort, and it has been found that it is difficult for people to integrate DRSCA into their daily life (Shaw et al., 2010). Some demographic and psychological factors related to diabetes care have been studied in China (Luo et al., 2015). However, a great number of people with T2DM fail to achieve good glycaemia control and experience complications (Shaw et al., 2010; Guo et al., 2012; Zhou et al., 2013). Therefore, for promoting DRSCA, it is of great importance to identify factors associated with DRSCA (Guo et al., 2018).

A review showed that perceived benefits, which belong to Rosenstock's health belief model (1974), can increase the corresponding self-care activities (Luo et al., 2015). *Perceived benefits* refer to one's belief about how effective an advised action will be in solving the health condition (Rosenstock, 1974). Therefore, providing more information for patients and health care staff about the benefits of DRSCA may encourage people to perform DRSCA. Of note is that evidence shows that there are few published studies on encouraging DRSCA by exploring the beneficial factors associated with DRSCA (Schulman-Green et al., 2016). Besides the benefits of controlling blood glucose (Zhou et al., 2013), DRSCA may also facilitate decreasing distress and improving positive health, which is also an important goal in pursuing a positive life (Sato & Yamazaki, 2012). In this study, the promotion of DRSCA was

studied from the following perspective: examining the level of DRSCA, the association of background information with DRSCA and the association of DRSCA with outcome information consisting of negative feelings and positive health.

The study aimed to provide new knowledge on the associated factors of DRSCA and to add information in order to increase the DRSCA and overall health of people with T2DM.

2   Review of the Literature

The literature review included four parts and summarized previous literature in the field of DRSCA and their possible associated factors, including background information and outcome information. The four parts are: the main concepts of the study, the level and importance of DRSCA, factors associated with the level of DRSCA and a summary of the literature review. To limit the research scope, the research was focused on two aspects of the associated factors: negative feelings and positive health. The components of *negative feelings* were based on the distress that commonly existed among people with T2DM (Eom et al., 2011; Grigsby et al., 2002; Drivsholm et al., 2005). The components of *positive health* were selected according to the common definitions of *positive health* in previous studies (Seeman, 1989; Locker & Gibson, 2006; Cloninger et al., 2012). The four parts were presented as follows: the main concepts of the study, the present level of DRSCA and the importance of DRSCA, factors associated with the level of DRSCA and a summary of the literature review is formed.

   In the literature review, a systematic exploration of the literature was conducted in the databases of PubMed and PsycINFO. The search items were based on the concepts of DRSCA, negative feelings, positive health and factors associated with the level of DRSCA. The search terms included: 'self-care activities', 'self-care' 'self-management' 'life style', 'T2DM', 'type 2 diabetes', 'type II diabetes', 'diabetes mellitus, Type 2', 'factors associated with self-care', 'factors associated with self-management', 'stress', 'anxiety', 'fatigue', 'resilience', 'subjective-well-being', 'disease-related quality of life' and 'health-related quality of life'. The Boolean operators 'and' and 'or' were used to limit the search phrases in order to get a view of the publications. The search was limited to publications published from 1980 (the related databases became dominant in the 1980s) to May 2018 and written in English. In total, 127 studies were selected and reviewed. In the associated factors about diabetes education, theory-based education has obtained increasingly attention (Glanz & Bishop, 2010; Michie & Prestwich, 2010; Craig et al., 2013), the sub-study (Paper I) systematically reviewed the effects of theory-based self-management education. The search terms included 'self-care education', 'self-management education', 'patient education', 'health care education', 'life style programme',

'diabetes mellitus', 'T2DM', 'Type 2' and 'randomized controlled trial'. The selection of published articles was based on screening from the title, abstract or full text, which included the theory basis for self-management education. In total, 22 randomized controlled trial (RCT) studies updated with 6,099 participants were selected in the meta-analysis. An overall risk of bias was found in seven of the 22 included studies.

2.1   The main concepts of the study

In this study, the main concepts included DRSCA, negative feelings, positive health, social support and optimism. Some of the definitions of the concepts were not determined in previous studies and were defined in this study based on previous literature.

The DRSCA of T2DM

DRSCA are defined as the activities of people taking care of themselves and managing the disease, which includes taking medication, regulating diet, self-monitoring blood glucose (SMBG) regularly, doing physical activities and foot care (Toobert et al., 2000). These activities play an important role in overall diabetes management (Zhou et al., 2013).

As for the definition of T2DM, the Chinese guideline recommends criteria for a diabetes diagnosis and the classification of the World Health Organization (WHO) (Guo et al., 2016). Type 1 diabetes mellitus is classified by autoimmune β-cell destruction, generally causing absolute insulin deficiency. T2DM is classified by the disease causing a progressive decrease of the function of β-cell insulin secretion due to insulin resistance (American Diabetes Association, 2018). In this study, the population of people with T2DM was investigated.

The medication used for people with T2DM includes oral medications, insulin and insulin analogues when life style interventions do not work for glycaemic control. There are three lines of oral anti-diabetes agents for people with T2DM (Hu & Jia, 2018). The first-line oral medication for people with T2DM is metformin. Chinese people with T2DM tend to have postprandial hyperglycaemia, alpha-glucosidase inhibitors or insulin secretagogue recommended for the treatment of newly diagnosed gastrointestinal side effects (Hu & Jia, 2018). If metformin monotherapy treatment cannot control glycaemic, secondary oral medications, such as sulfonylureas, thiazolidinediones and dipeptidyl peptidase 4 inhibitors, are recommended. The third oral medication option was a glucose-like peptide 1 analogue. People who are newly diagnosed with T2DM are recommended to use insulin and insulin analogues if they fail in taking oral medication or if they have

severe pancreatic islet β-cell dysfunction, poor blood glucose control for long-term, or acute or chronic complications (Hu & Jia, 2018). It is obvious that treatment with medication is important for diabetes management. However, beside medication use, other DRSCA, such as diet regulation, physical activity, foot care and SMBG, also belong to the main components of diabetes management (Wu et al., 2011).

In China, people with T2DM receive diabetes information from physicians, nurses, TV, other media and a small number of certified educators of diabetes (Zhou et al., 2013). People with T2DM in China have high adherence to medication but SMBG was least practiced, which may due to pain or the test cost (paid from one's pocket) (Yang et al., 2015) and the performance of foot care was also poor (Yang et al., 2015).

Negative feelings

There is no universal definition for *negative feelings*. In *Collins English Dictionary*, *feelings* are defined as emotion and/or bodily consciousness or sensation (*Collins English Dictionary*, 2018). *Negative* was defined as referring to a fact, situation or experience that is unpleasant, depressing or harmful (*Collins English Dictionary*, 2018). Previous studies have not given a universal definition for *negative feelings*, and they were defined or described based on the different study population and situation. For example, negative feelings were described as including tension, sadness and insecurity in a study of the desire to eat in bulimia nervosa (Alpers & Tuschen-Caffier, 2001). Negative feelings also were thought of as taking the forms of stress, anxiety, depression and pain in a study discussing the importance of the negative feelings of people when assessing well-being (Grinde, 2016). Negative feelings were regarded as similar to negative emotions, which included stress, anxiety, depression and burnout in a study about emotional intelligence and negative feelings among primary school teachers (Karakuş, 2013). Based on prior studies and the dictionary definitions, together with considering the situation of the study population, in this study, the concept of negative feelings was defined as unpleasant, depressing emotions and/or experiencing tiredness. In this study, people with T2DM had a high prevalence of negative feelings including stress (Eom et al., 2011), anxiety (Grigsby et al., 2002) and fatigue (Drivsholm et al., 2005).

Positive health

The definitions of *positive health* are ambiguous and not consistent (Locker & Gibson, 2006). For example, *positive health* has been defined as effective body functions, coping and responsiveness (Seeman, 1989). Positive health has been considered to include well-being, coping and adaptation (Locker & Gibson, 2006).

Positive health can also be summarized as comprising wellness and healthy functioning (Cloninger et al., 2012). In addition, according to Seligman (2008), positive health includes independent variables like subjective feeling (such as physical well-being and confidence), biological health and functional health. Based on these different definitions, the common meaning of *positive health* includes coping and adapting ability (resilience), subjective well-being (SWB), and physical and functional ability (diabetes-related QoL). In the present study, positive health consists of resilience, SWB and disease-related quality of life (DRQoL). *Resilience* means coping with difficulties, adapting to a stressful situation, recovery from setbacks and keeping an optimistic mind (Masten, 2014); *SWB* means experiencing a state of health, happiness and prosperity, and satisfaction with physical and mental well-being (New Economic Foundation, 2012); and *DRQoL* involves domains related to physical, mental and social functions (El Achhab et al., 2008).

Social support

Social support is defined as assistance from family, friends, neighbours or community organizations. The assistance can be practical help and emotional comfort (Koetsenruijter et al., 2015). Therefore, social support is regarded as the perceived supporting social resources or objective support provided in both formal and informal contexts and in helping relationships (Cohen et al., 2000). Therefore, in this study, the concept of social support includes perceived subjective support, objective support and also the utility of the support (which was also an important part in evaluating the role of social support based on the study of Xiao [Xiao, 1994;1999]).

Optimism

Optimism is defined as anticipating the most favourable outcome, looking on the positive side of the events of an endeavour (Matthews et al., 2004; Scheier & Carver, 1985). Optimism has been indicated to be associated with better problem-solving coping skills and using denial less frequently (Puig-Perez et al., 2017). People, who are optimistic, as compared to people who are pessimistic, are more active in pursuing their goals and they cope more effectively when confronting difficult life situations. In this study, optimism is defined as a tendency to expect favourable and desirable outcomes (Matthews et al., 2004; Scheier & Carver, 1985).

The definitions of the main concepts in this study are presented in Table 1.

Table1.   The definitions of the main concepts in this study

The main concepts	Their definition in this study
DRSCA	*DRSCA* means taking care of oneself and managing diabetes care in daily life. It included medication, regulating one's diet, regular physical activities, SMBG and foot care (Toobert et al., 2000; Zhou et al., 2013).
Negative feelings	*Negative feelings* mean unpleasant or harmful emotions or physical sensations. Negative feelings include perceived stress, anxiety and fatigue (*Collins English Dictionary*, 2018; Alpers & Tuschen-Caffier, 2001; Grinde, 2016; Karakuş, 2013).
Positive health	*Positive health* means human functioning and effective coping and adaptation. Positive health included resilience, SWB and DRQoL in this study (Locker & Gibson, 2006; Seeman, 1989; Cloninger et al., 2012).
Social support	*Social support* means the available or actual assistance from family, friends, neighbours or community organizations. Social support included subjective support, objective support (the actual help of financial support, comfort and care that have been received in solving practical problems) and support utility (Koetsenruijter et al., 2015; Cohen et al., 2000; Xiao SY, 1994;1999)
Optimism	*Optimism* means anticipating the most favourable outcome and looking on the positive side of an endeavour. Optimism is a positive life attitude and a tendency to expect that outcomes will be favourable and desirable (Matthews et al., 2004; Scheier & Carver, 1985).

2.2   The level and importance of DRSCA

This sub-chapter summarizes the information about the level and importance of DRSCA in order to provide the basic information with which to further explore the associated factors of DRSCA.

Diabetes mellitus (DM) has become one of the most common chronic health problems globally (Shaw et al., 2010). Diabetes self-care activities can prevent diabetes complications (Haas et al., 2014). It has been reported that poor levels of DRSCA were a barrier for the effective management of diabetes complications (Tiv et al., 2012). People with T2DM have to maintain lifelong self-care activities in daily life in order to prevent the development of complications (Frei et al., 2009; Kav et al., 2017). DRSCA constitute an essential part of the self-management of T2DM and are aimed at optimal glycated haemoglobin (HbA1c) and other health indicators (Zhou et al., 2013).

However, poor DRSCA (like SMBG and foot care) have been indicated among people with T2DM (Guo et al., 2012). Significant number of people with T2DM have poor DRSCA (Kassahun et al, 2016). People with T2DM only achieved 60% of self-care activities in previous studies (Simon-Tuval et al., 2016; Yang et al., 2017) and about 50–55% of them in another two studies (Wu et al., 2011; Yang et

al., 2015). Taking medication was the most frequently reported of the DRSCAs and SMBG was the least frequently reported (Wu et al., 2011; Al-Khawaldeh et al., 2012; Yang et al., 2015). Diet was the second most frequently performed activity (Al-Khawaldeh et al., 2012; Yang et al., 2015). In the exercise of DRSCA, specific exercise sessions and inspections of the inside of shoes were less frequently reported DRSCA (Al-Khawaldeh et al., 2012). An international survey showed that only 13.6% achieved HbA1c level of less than 6.5% (Fu et al. 2012). Blood glucose control has not been well achieved in China (Chen et al., 2017). The people with T2DM have to seek help from a hospital when their blood glucose is out of control. These previous studies provide insights into the level of DRSCA and have shown the necessity of understanding the level of DRSCA.

Therefore, in order to supplement the stable information of DRSCA and gain a deeper understanding of the DRSCA of people with T2DM, it could be good to test the subsequent DRSCA over some period of time, following the same people with T2DM through their normal life without intervention. In addition, diabetes can cause complications; besides understanding the level of DRSCA sufficiently, it is very important to promote DRSCA among people with T2DM. There are several reasons why performing DRSCA is important.

First, DM is a worldwide issue, and China has shown a rapidly increasing trend for the prevalence of DM, which may be due to the rapid changes in life habits and aging. DM affects over 425 million people globally in 2017, and it may affect 693 million people in 2045 (IDF, 2017). An epidemiological study conducted in China showed the prevalence of DM was 0.67% in 1980 (National Diabetes Research Group, 1981) and this increased to 10.96% (among people aged from 18 to 99 years old) (IDF Diabetes Atlas, 2017) over 37 years. The most common type of DM is T2DM (IDF Diabetes Atlas, 2017). There are many different treatment patterns for T2DM. However, the blood glucose control of people with T2DM is not adequate (Hu & Jia, 2018; Mash et al., 2014).

Second, a lot of global mortality is caused by DM and also decreased QoL has relationship with DM (Oliva et al., 2012). DM can cause long-term complications and has the potential for damaging organs. Serious long-term complications include kidney, vascular, retinal, renal and neurological complications and premature disability (Khaw et al., 2004). In addition, DM can cause the greater use of medical services and bring financial burdens to the national health system (Hu et al., 2015). In China, 6% of China's total health expenditure was accounted for by the DM health expenditure of adults aged 20–79 (Zhang et al., 2010). DM also has a financial burden on individuals and households. In mainland China, there are mainly four types of medical insurance: medical insurance for urban workers, medical insurance for urban residents, the new rural cooperative medical system and 'out-of-pocket' payments. On average, slightly higher than 30% of total expenses were paid out-of-

pocket by people with T2DM for their treatment (Chen, 2014). In view of the long-term health damage and economic loss caused by DM and their complications, it is very important to improve DRSCA and prevent the complications of DM

Third, DRSCA are important for people with DM to achieve better health outcomes (Haas et al., 2014) but are not optimal (Zhou et al., 2013). According to the Chinese guidelines for T2DM, DRSCA (including regulating diet and exercise regularly) are the foundation of DM treatment and these activities should be maintained throughout the whole DM control process (Hu & Jia, 2018). The DRSCA can be improved in different ways. Several forms of diabetes self-care education have been found to be effective in diabetes management among individuals with T2DM. For example, behavioural change techniques in web-based self-management programme can lead to positive outcomes (van Vugt et al. 2013). Peer education is more effective in improving self-management in people with T2DM than usual care groups (Liu et al., 2015). In addition, an online disease management program of a multidisciplinary health team can help people with T2DM achieve greater decreases in HBA1c at six months than usual care patients, but the difference was not significant at 12 months (Tang et al., 2013).

Some factors associated with diabetes self-care also have been identified in China (Luo et al., 2015). However, the adherence to DRSCA was not optimal although factors associated with the level of DRSCA, seen from multiple perspectives, have been explored internationally (Luo et al., 2015; Schulman-Green et al., 2016). A large multi-centred, cross-sectional study (Ji et al., 2013) was conducted in China, which was called the '3B Study'and aimed to survey the control of blood glucose, blood pressure and blood lipid (the 3Bs) in people with T2DM, the majority of people with T2DM (94.4% of them) did not achieve all three target goals (Ji et al., 2013). Poor DRSCA, like poor foot care and SMBG, have been reported among people with T2DM and the reason why Chinese adults have poor compliance with DRSCA is not clear (Guo et al., 2012). Given the increasing epidemiological and economic burden of DM, there is a critical need to identify factors associated with the level of DRSCA from multiple perspectives and to develop effective self-care education to target such factors (Guo et al., 2018; Schiotz et al., 2012).

DRSCA have gained global attention. For example, the DAWN™ (Diabetes Attitudes Wishes and Needs) programme was an international cooperation project that was initiated in 2001 and reissued in 2013 that aimed to build a foundation for improving diabetes care nationally and internationally (Novo Nordisk, 2014). DRSCA can reduce complications and benefit people with T2DM (Kent et al., 2013). Studies have started to focus on synthesizing the effectiveness of self-management interventions on T2DM in order to promote DRSCA (Minet et al., 2010). For example, researchers (Chrvala et al., 2016; van Vugt et al., 2013) have conducted systematic reviews of self-management in diabetes and web-based self-management

education with behavioural change techniques in order to produce positive outcomes in HbA1c or self-care behavioural change. Some systematic reviews (van Vugt et al., 2013; Chrvala et al., 2016) have pooled the effects of self-management education on people with T2DM. Researchers have also suggested that 'Health promotion interventions with a theoretical basis are more effective than interventions that lack a theoretical basis' (Glanz & Bishop, 2010, p. 399). Craig et al. (2013) also suggested that best practice for complex interventions should be based on proper theory. In diabetes management studies, theory-based education has been emphasized. However, robust evidence is needed to support and confirm the possible benefits of theory-based diabetes education on DRSCA. To add robust evidence of the effect of theory-based diabetes education on diabetes care and to add new knowledge to the study about the factors associated with diabetes care, a systematic review was conducted. The systematic review in the study aimed to synthesize the results of theory-based education in RCTs on people with T2DM (Paper I).

The whole study aimed to examine the factors associated with DRSCA. The perspective of the first phase was that of patient education. It synthesized the effects of theory-based education on diabetes management to robustly confirm that it is an important and effective factor associated with DRSCA in diabetes education. In diabetes education, the education method has been regarded as an important factor associated with DRSCA (van Vugt et al., 2013; Chrvala et al., 2016). However, the robust evidence of the effects of theory-based diabetes self-management education on DRSCA called for by researchers (Craig et al., 2013) was lacking. The systematic review in this study was adopted in order to confirm that theory-based diabetes self-management education is a strong factor contributing to DRSCA. On the other hand, this systematic review also provided the implications of and rationale for the factors that were still needed in order to further explore promoting DRSCA; the role of people needed to be more involved and more encouraging information about DRSCA should be provided for people with T2DM.

2.3   Factors associated with the level of DRSCA

A variety of factors associated with the level of DRSCA have been studied (Luo et al., 2015; Schulman-Green et al., 2016). However, there is still a lack of literature that also focuses on optimism and social support, and at the same time on subsequent DRSCA. Studying them together can provide a more comprehensive picture about the how social support and optimism considered together associated with DRSCA. On the other hand, some studies showed that depression and anxiety influenced DRSCA (Alavi et al., 2018; Devarajooh & Chinna, 2017; Pandit et al., 2014); these studies implied that negative emotions were a barrier for DRSCA. From a different perspective, whether or not taking the initiative in the actions of performing DRSCA

could reduce negative feelings and improve positive health was unknown. Therefore, examining whether actively performing DRSCA is associated with reduced negative feelings and improved positive health can provide important information for diabetes care. The following sub-chapter demonstrated the factors associated with the level of DRSCA and the necessity of this study.

Factors associated with the level of DRSCA have gained a lot of research attention. Schulman-Green et al. (2016) conducted a qualitative synthesis of 53 studies worldwide. The study found five categories of factors associated with the self-management of chronic disease: lifestyle characteristics, health status, resources, systems of health care and environmental characteristics. Recent studies from different countries (Pandit et al., 2014; Mut-Vitcu et al., 2016; Devarajooh et al., 2017; Browne et al., 2015) also indicate that anxiety and depression can lead to poor DRSCA. Diabetes education is also considered to be associated with the DRSCA and health of people with T2DM. According to a systematic review, diabetes self-care education can reduce HbA1c (Chrvala et al., 2016). Researchers also suggested that diabetes education with a theoretical basis tend to produce better and longer-lasting effects compared to those which have no theoretical base (Glanz & Bishop, 2010; Michie & Prestwich, 2010; Craig et al., 2013). Therefore, in order to provide strong evidence for this, another systematic review with a meta-analysis showed theory-based diabetes self-management education was more effective than routine diabetes education on HbA1c and DRSCA among people with T2DM (Paper I).

It is necessary to encourage people with T2DM to implement DRSCA well and by themselves. The systematic review with the meta-analysis in this study also implied that the role of people with T2DM should be more involved. It implied that there was a necessity for a study that could provide information that would encourage people with T2DM to be actively involved in DRSCA and pay attention to the internal strength of individuals to achieve clinical effectiveness of education.

In addition, based on the health belief model, the perceived benefits of outcome of performing an activity is a promoter of forming and sustaining the behaviour (Rosenstock, 1974; Becker, 1978). Beyond the known information that DRSCA are associated with HbA1c and lipid profiles (Rosal et al., 2011), this study aimed to provide more positive and encouraging information for promoting self-management, especially for the people who are newly diagnosed with DM. On the one hand, the verified association of DRSCA with improved positive health and reduced negative feelings in the study can become perceived benefits of performing DRSCA. On the other hand, according to social cognitive theory (Bandura, 1999), people can learn and maintain behaviour by self-experienced reinforcement and symbolic modelling. The association to be confirmed could act as a self-experienced reinforcement for the people with T2DM who perform DRSCA well, and it could also act as a symbolic

model (demonstrated via books, online media and other media sources) for those who fail to perform DRSCA and newly diagnosed DM patients. They can be encouraged to better self-manage their disease through such symbolic modelling and this can be reinforced again by improved positive health and reduced negative feelings.

It has also been suggested that both the clinical effectiveness and cost-effectiveness of education are needed (Teljeur et al., 2017). There was a necessity for a study that could provide information that would encourage people with T2DM to be actively involved in DRSCA and pay attention to the internal strength of individuals. Therefore, it is meaningful and imperative to mobilize people's inner enthusiasm and inherent resources in order to improve their self-care level. It is effective for people with T2DM to implement DRSCA well by themselves (Kent et al., 2013). People with T2DM must be stimulated to make their own decision to perform DRSCA based on their awareness and self-discipline. To be able to do this, more encouraging information about more benefits of DRSCA was needed in order to promote DRSCA (Luo, 2015). Correspondingly, more information about the factors associated with the level of DRSCA was necessary.

2.3.1 Background information

In this study, the background information consisted of demographic information, health information, and information on social support (including subjective support, objective support and support utility) and the optimism of the people with T2DM. In the next chapters, this information will be described in detail.

Demographic information on DRSCA

In the previous studies, the associations of demographic information with DRSCA were not consistent. Previous research has shown contradictory findings about the associations of demographic information (like age, gender and education) with DRSCA. There are studies that showed that advanced age was associated with regular T2DM self-care activities (Huang et al., 2014). In contrast, another study (Wu et al., 2007) showed that age had no relationship with self-care activities. Gender was also a factor that may associate with DRSCA. Gender was a factor associated with DRSCA, but the result was not aligned across different studies. Bai et al. (2009) found that men performed self-care activities better than women and men were reported to perform SMBG more frequently than their female counterparts (Mogre et al., 2017). Baumann et al. (2010) found that men tended to do more regular physical activity and women tended to follow the recommended diet. However, Luo et al. (2015) indicated in a review that women were found to have better overall

DRSCA performance than their male counterparts. Education was potentially associated with the level of DRSCA: people with T2DM who had low educational attainment were associated with low DRSCA ability (Bai et al., 2009) and people with T2DM who had a higher educational level performed DRSCA better (Huang et al., 2014). Another background information factor, living alone, was shown to have negative relationship with DRSCA (Luo, 2015). Given the lack of enough supporting studies or the inconsistency of the results regarding their association with DRSCA in previous studies, the association of demographic information and DRSCA included information on age, gender, education and living alone and was investigated in the population of this study.

Health information on DRSCA

Patient's health status was shown to be associated with self-care (Schulman-Green et al., 2016). Health information included health status and information associated with DM in this study, which acted as a potential factor that may associate with the level of DRSCA. Previous studies have preliminarily shown the association of diabetes information with DRSCA. For example, the diabetes information in the previous studies included diabetes duration and diabetes education. The association of diabetes duration with DRSCA was not identified consistently in previous studies. Bai et al. (2009) and Wu et al. (2007) indicated that the long duration of having T2DM was positively associated with high self-care ability, but this was not confirmed by another study (Huang et al., 2014). Diabetes education and a high level of general education in patients' background were shown to be associated with improved DRSCA. Diabetes education was associated with improved DRSCA (Wu et al., 2007). Another study discovered the disadvantage of the low educational attainment and awareness in relation to DRSCA (Samuel-Hodge et al., 2008).

Whether or not patients felt diabetes-related symptoms before getting a diabetes diagnosis and if this was associated with the level of DRSCA were not considered in previous literature. This issue was given consideration in this study as the researcher of this study was not sure if people with T2DM reacted differently in terms of their performance of DRSCA when they did not feel diabetes-related symptoms before diagnosis. If the person did not feel symptoms before his or her diabetes diagnosis, he or she may have made no psychological preparation and think that the onset of DM was sudden. In such cases, the adaptation time tended to be longer than those that had symptoms before being diagnosed. The prolonged and inadequate adaptive process possibly leads to reduced well-being and increased anxiety (Lehti, 2016). Other health information (like family history, body mass index, systolic blood pressure and diastolic blood pressure) was also considered in

this study as it contained important indicators in diabetes care (Khunti et al., 2012; Davies et al., 2008).

Social support and optimism in relation to DRSCA

It has recently been suggested that an individual's internal strengths can be used to promote the health behaviour of people with T2DM (Al-Hassan et al., 2017; Wu et al., 2011). For example, intrinsic motivation (Al-Hassan et al., 2017) and self-efficacy (Wu et al., 2011) were effective in promoting DRSCA. Optimism is an important inner strength which plays a protective role in taking care of oneself (Nabi et al., 2010). People with greater optimism are more likely to change behaviour or engage in behaviour that is helpful in adapting to situations (Matthews et al., 2004; Nabi et al., 2010). As people's efforts to maintain health behaviour often happen in a social context and in interaction with the social environment (Rintala et al., 2013), social support is an inevitable factor that should be considered in DRSCA.

Therefore, the association of both the social support from the social context and optimism from inner strengths with DRSCA were considered in this study. An increasing number of studies have contributed to diabetes self-management and the DRSCA of T2DM. Luo (2015) summarized multiple factors associated with the level of DRSCA including demographics and the health belief model among the Chinese population while Schulman-Green et al. (2016) conducted a qualitative synthesis from international studies and summarized five categories (lifestyle characteristics, health status, resources, environment and the system of health care) related to the self-management of chronic diseases, including DM DRSCA have been a focus of chronic disease research. However, a systematic review showed the performance of DRSCA among people with T2DM was not optimal (Luo, 2015). DRSCA take place in a social context (Rintala et al., 2013; Rosland et al., 2008). Understanding how social support associates with DRSCA can provide meaningful information for health practice (Miller & Dimatteo, 2013), especially for understanding its influence on DRSCA in combination with internal strengths.

Social support is an important environmental support resource in the family and social environments in which people's DRSCA are carried out (Rintala et al., 2013). In this study, social support covered three dimensions: subjective support, objective support and support utilization (Xiao, 1994). Based on earlier studies, social support is positively associated with the level of DRSCA among people with DM (Miller & Dimatteo, 2013; Schiotz et al., 2012). Studies showed the influence of social support on DRSCA, but how it associated with subsequent DRSCA is unclear, especially the details of its dimensions, including subjective support, objective support and support utility.

An individual's internal strengths have been suggested to be associated with DRSCA recently (Wu et al., 2011; Al-Hassan et al., 2017). One of the internal strengths is optimism, which can protect individuals from developing diseases, which has drawn the attention of researchers (Nabi et al., 2010). Optimistic people have more confidence, less perceived stress and they look for the best aspects of any situation in order to achieve goals (Puig-Perez et al., 2017). Thus, optimism is possibly associated with health-protecting behaviour (Matthews et al., 2004; Nabi et al., 2010). Given the association between optimism and health behaviour, it is necessary to consider the protective role of optimism in self-care behaviour among a vulnerable population with T2DM. This examination of their relationships would provide new knowledge and a new perspective for health policy and health promotion aimed at improving DRSCA.

Research on both how different levels of social support and optimism relate to subsequent DRSCA and on whether optimism mediates the relationships between social support and subsequent DRSCA can provide new information for diabetes management. Although optimism is possibly associated with DRSCA, how it mediates the relationships between social support and subsequent DRSCA has not been explored previously.

2.3.2 Outcome information

In this study, the outcome information consisted of negative feelings, including perceived stress, anxiety and fatigue, and positive health outcomes, including resilience, SWB and DRQoL. In the next chapters, these concepts and their possible relationships with DRSCA will be described in detail.

DRSCA and negative feelings

This sub-chapter mainly focuses on the necessity and possibility of the association of DRSCA with reduced negative feelings. The component concepts chosen for negative feelings were based on the definition in *Collins English Dictionary* (2018) and abstracting from previous studies. Regarding negative feelings, for people with DM the disease itself is an additional stressor as it brings the necessity of unwanted lifestyle changes. The long chronic stress and the risk of diabetes-related complications also induce anxiety (Bickett & Tapp, 2016). Moreover, the severity of diabetes symptoms (Fritschi & Quinn, 2010) and blood glucose level (Jain et al., 2015) are significantly related to fatigue.

On the basis of theory of stress and coping (Lazarus and Folkman, 1984; Lazarus,1999), a problem-focused coping strategy, formed of task-oriented actions (Folkman, & Moskowitz, 2000), allows for a sense of control in attaining a specific

goal, which is effective in managing the stress. Performing DRSCA regularly is a positively problem-focused reaction to the negative feelings, which include perceived stress, anxiety and fatigue. Therefore, DRSCA theoretically have a possibility to be associated with reduced perceived stress, anxiety and fatigue.

There are already studies about how negative emotions, like anxiety and distress, influenced the performance of DRSCA (Alavi et al., 2018; Devarajooh & Chinna, 2017; Pandit et al., 2014). But there is a lack of attention paid to whether taking the initiative to perform DRSCA can be associated with reduced negative feelings (consisting of perceived stress, anxiety and fatigue) (Alavi et al., 2018; Devarajooh & Chinna, 2017; Pandit et al., 2014).

DRSCA have been regarded as the cornerstone for diabetes management (Lee et al., 2016). Although people with T2DM understand the importance of DRSCA, it is still not easy to sustain them in daily life. Researchers have noticed this and begun to pay attention to how to stimulate people with T2DM to integrate their diabetic self-care into their lifestyle (Linmans et al., 2015; Meunier et al., 2016). People with T2DM tend to have stress, anxiety and fatigue compared to the general population (Eom et al., 2011; Drivsholm et al., 2005; Grigsby et al., 2002). DRSCA may have associations with negative feelings (consisting of stress, anxiety and fatigue). Previous studies have found that negative emotions, like anxiety, depression and distress, influence adherence to DRSCA (Alavi et al., 2018; Devarajooh & Chinna, 2017; Pandit et al., 2014). Patients with depressive symptoms (Kim et al., 2015) and distress were less likely to adhere to DRSCA (Pandit et al., 2014).

This study examined whether the high performance level of DRSCA was associated with reduced negative feelings (consisting of stress, anxiety and fatigue) in people with T2DM. The aim was to provide more encouraging information regarding performing DRSCA. The following paragraphs discuss about the rationale of studying the association of DRSCA with negative feelings based on the previous studies.

A study has indicated that people with T2DM have a higher perceived stress level than the general population (Eom et al., 2011). Perceived stress causes the body to release cortisol which helps individuals cope with events in life in the short term, but long-term perceived stress may lead to chronic disease and disease development. Therefore, it is essential to reduce the perceived stress of people with T2DM. Whether perceived stress leads to inadequate DRSCA has been studied recently (Chlebowy et al., 2018). From another perspective, taking the initiative to conduct DRSCA may also be associated with reduced stress. Esch et al. (2013) suggested that self-care strategies, like taking measurements, help oneself to cope with a difficult situation and decrease perceived stress in a health care programme. This suggestion implicated that DRSCA may possibly associate with reduced perceived stress. The limited available literature (Esch et al., 2013) implicated that examining

the relationship between DRSCA and perceived stress may add useful knowledge related to managing the perceived stress of people with T2DM.

Generalised anxiety disorder has 14% prevalence among adults with DM, and 40% of people with DM have anxiety symptoms based on the review conducted by Grigsby et al. (2002). More recently, a study showed the prevalence of anxiety symptoms in China was 43.6% (Sun et al., 2016). Smith et al. (2013) indicated that people with DM tend to have anxiety as individuals worried about the risk of diabetes-related complications (Bickett & Tapp, 2016) and failure to achieve the blood glucose level suggested by physicians (Fritschi & Quinn, 2010). Previous studies have indicated that people with DM who have anxiety were less adherent to DRSCA (Pandit et al., 2014; Devarajooh et al., 2017; Alavi et al., 2018). However, DRSCA were also intended to reduce the anxiety which is often linked with chronic illness (Riegel et al., 2012). There are a lack of studies addressing whether taking the initiative to perform DRSCA is associated with reduced anxiety.

Fatigue is a common problem and affects 61% of people with DM (Drivsholm et al., 2005). It is indicated that initiating insulin injection increases the burden of people with DM, which is related to fatigue (de Sonnaville et al., 1998). However, bringing blood glucose under control in turn may decrease fatigue. Poor disease management and elevated HbA1c have been indicated to be associated with fatigue (Park et al., 2015). Besides this, diabetes symptoms have been strongly associated with fatigue (Fritschi & Quinn, 2010). Therefore, it is implicated that DRSCA which control the blood glucose level and reduce diabetes symptoms (Kent et al., 2013) may have a relationship with fatigue. Although fatigue should receive more consideration for people with T2DM due to the high prevalence among them, the direct association of DRSCA with fatigue is not studied much in empirical research (Singh & Kluding, 2013).

In summary, there is limited evidence demonstrating how DRSCA relates to negative feelings (consisting of perceived stress, anxiety and fatigue).

DRSCA and positive health

In this study, positive health consisted of resilience, SWB and DRQoL. The component concepts chosen for positive health were based on a model of positive health (Seeman, 1989) and the definitions of other researchers (Locker & Gibson, 2006; Seligman, 2008; Cloninger et al., 2012).

More attention has been paid to preventing disease and restoring functions impacted on by disease in public health guidelines, and less attention has been paid to promoting positive health (Prendergast et al., 2016). Although previous findings have shown unhealthy behaviour was related to increased mortality or morbidity (Kvaavik et al., 2010), less is known about how health behaviour relates to positive

health (Prendergast et al., 2016). DRSCA have been indicated to be associated with HbA1c and lipid profiles (Rosal et al., 2011). However, the information on the association with other general indicators from other perspectives, like that of positive health, was limited. Although it has been shown that positive emotional health may benefit self-management (Robertso et al., 2012), it is unclear that whether DRSCA can adjust or improve positive health. Therefore, it is important to examine how DRSCA are associated with positive health. This may provide useful information for guiding further research on DRSCA and positive health.

Self-care activities have been shown to associate with resilience among the general population (Olsson et al., 2003; American Psychological Association, 2015). *Resilience* enables people coping with difficulties to make adjustment to changes and to fight against the negative effects of perceived stress (Frydenberg, 2004). Therefore, it is meaningful to advocate that people build resilience by individual activities. Resilience is not an innate ability and is believed that it can be built and enhanced during one's life (Olsson et al., 2003; Saletnik, 2018). For example, taking care of oneself has been suggested as a way to improve resilience among the general population (American Psychological Association, 2015). Therefore, providing evidence about whether DRSCA are associated with improved resilience may provide an important step in paying attention to resilience in diabetes care. Resilience has been shown to be associated with reduced diabetes distress (Wang et al., 2017). However, there are no studies about whether DRSCA could improve resilience among people with T2DM, which made it necessary for it to be examined in this study.

SWB is the self-assessment of how satisfied people are with their daily life and emotions (New Economic Foundation, 2012). SWB is related to physical health, longevity, excellence and optimal human functioning (Ryan & Deci, 2001). Research on how to increase SWB has increasingly become a hot topic recently (Alayli-Goebbels et al., 2014; World Health Organization, 2012). WHO published a report emphasizing the importance of evaluating SWB in health improvement programmes and services (World Health Organization, 2012). Previous research showed that self-care strategy was linked to improved subjective well-being in Swedish adults (Hansson et al., 2005). Based on the limited evidence (Hansson et al., 2005) and putting emphasis on SWB (Alayli-Goebbels et al., 2014; World Health Organization, 2012), it is necessary to understand whether DRSCA are associated with SWB in people with T2DM as hypothesized.

DRQoL means the extent that the disease affects daily life, including the social and physical functioning of people with DM (EI Achhab et al., 2008). DRQoL has caught researchers' attention recently. Previous literature has indicated that DRSCA were associated with DRQoL in people with T1DM (Chen et al., 2017) and T2DM (Wang et al., 2011) in Taiwan. As DRQoL is possibly influenced by culture

(Marshall, 1990), different types of associations between DRSCA and DRQoL should be evaluated on a per culture basis. Examining their connections in different cultural areas can add information for diabetes management.

Besides examining the background information promoting DRSCA, providing supporting information from the perspective of the association between DRSCA and outcome information may encourage people with T2DM to make their own decisions about DRSCA (Linmans et al., 2015). The background information of people with T2DM was also considered. In summary, this study explored the association of background information with DRSCA and the association of DRSCA with outcome information. The possible relationships of the study concepts to be examined are shown in Figure 1.
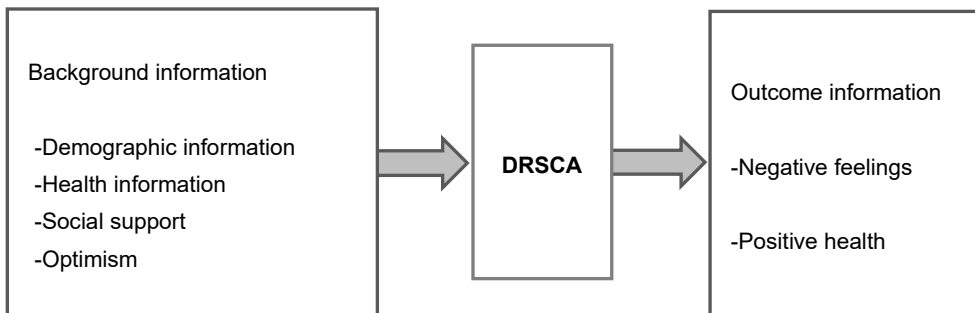

Figure 1.   The possible relationships of study concepts to be examined. DRSCA, diabetes related self-care activities.

2.4   Summary of the literature review

A summary of the literature review for the whole study

The summary of the literature review for this study, including what is already known and research gaps based on both the literature review and the result of the systematic review (both updated), is shown in Figure 2.

A summary of the literature review in this study			
Patient education on DRSCA	Background information	DRSCA level	**Outcome information** (negative feelings and positive health)
What is already known			
Researchers suggested that interventions based on theory tended to produce better and longer-lasting effects than those which had no theoretical base.	Background information is possibly associated with the level of DRSCA in previous studies. A variety of factors associated with the level of DRSCA have been studied.	The level of DRSCA is not high.	There is research on the associated factors with DRSCA based on univariate analyses. Negative feelings (with the components of stress, anxiety and fatigue) and positive health (with the components of resilience, SWB and DRQoL) have received little attention.
The research gap			
There was lack of robust evidence in previous studies about the effectiveness of theory-based self-management education.	Some background information, for instance, information on whether people with T2DM felt symptoms before their diabetes diagnosis, was not included in previous studies. In addition, the association of social support and optimism with subsequent DRSCA and the mediation of optimism in DRSCA both needed to be explored.	Exploring the DRSCA at two time points to see the information about the stability of DRSCA.	DRSCA are possibly associated with negative feelings and positive health. However, there was a lack of studies demonstrating whether DRSCA are associated with reduced negative feelings and improved positive health.
The present study			
The systematic review (Phase 1): The systematic review aimed to pool the effects of theory-based self-management education on DRSCA, HbA1c, self-efficacy, quality of life and diabetes knowledge.		**The empirical study (Phase II):** The reason for the poor performance of DRSCA is not well known. The empirical study aimed to provide new knowledge on the associated factors of diabetes-related self-care activities and provide information with which to increase the DRSCA and overall health of people with T2DM.	

Figure 2. The summary of the literature. Note: DRSCA = diabetes-related self-care activities; DRQoL = diabetes-related quality of life; HbA1c = glycated haemoglobin.

3 Aims

The aim of the study was to explore new knowledge on the associated factors of DRSCA and provide information for increasing both the level of DRSCA and the overall health of people with T2DM.

More specifically, the following research questions in the systematic review and empirical study were addressed.

The research questions:
3.1 What are the effects of theory-based self-management education on the HbA1c, self-efficacy, and diabetes knowledge, BMI and quality of life of people with T2DM? (Paper I)
3.2 What is the level of the DRSCA of people with T2DM? (Empirical study, Paper IV)
3.3 What factors are associated with the DRSCA of people with T2DM?
    3.3.1 What is the association between background information (including demographic information, health information, social support and optimism) and the level of DRSCA? (The empirical study, Papers II–IV)
    3.3.2 What is the association between DRSCA and outcome information (including negative feelings and positive health)? (The empirical study, Papers II–III)

4 Materials and Methods

There were two phases in this study. In the first phase, a systematic review was conducted (Paper I). The systematic review synthesised the effects of theory-based self-management educational interventions on HbA1c, BMI, self-efficacy, diabetes knowledge, and self-care activities.

In the second phase, new information was provided to encourage people with T2DM to improve DRSCA by identifying the associated factors of DRSCA. In the second phase, data were collected by two surveys, taken at two time points (Papers II, III, IV).

The materials and methods part is based on the systematic review phase and survey phase, covering two time points. In this chapter, the study design, study participants and settings, data collection, data analysis and ethical considerations are described (Table 2).

4.1 Study design

The study design included the literature review and the empirical study, which used survey design to examine the factors associated with DRSCA (see Table 2 and Figure 2).

Table 2. Design, sample, data collection and analysis in four sub-studies

Phase	Design	Paper	Sample	Data collection	Data analysis
I Literature review	Systematic Review	I	Studies published between 1980 and December 2018	A systematic search of research from databases. (N = 22 studies); 2015–2018	Meta-analysis.
II Empirical study	Cross-sectional survey design at time 1	II, III	People with T2DM that met the criteria. (N = 310; n = 251)	Data from two teaching hospitals in eastern China. Data collection for DRSCA, perceived stress, anxiety, fatigue, resilience, SWB, DRQoL, social support and optimism was done using a questionnaire survey; 2015–2016	Descriptive statistics, independent-samples t-tests, correlation analysis and hierarchical multiple regression analysis were used
	Survey	IV	People with T2DM that met the criteria. (N=251; n=155)	Data about DRSCA were collected by phone. 2015-2016	Descriptive statistics, chi-Square, t-tests (X^2 tests), independent-samples t-tests, hierarchical multiple regression analysis and mediation analysis were used

4.1.1 Phase 1: The systematic review with the meta-analysis

In Phase 1, the systematic review with the meta-analysis was conducted following the recommendations from the Cochrane guidelines (Higgins & Green, 2011).

Synthesizing the effects of theory-based education in diabetes management can robustly confirm its effective role in DRSCA (Paper I). In addition, the systematic review facilitated discovering the variables that needed to be examined and identified in the empirical study.

Systematic reviews typically include planning comprehensively and making a search strategy, using the procedure of identification, a critical appraisal, extraction

and synthetization from the related studies on a particular topic in order to reduce bias (Uman, 2011). A meta-analysis means systematically applying a statistical method in order to pool the quantitative results from selected studies into a single quantitative estimate or a summary of effect size (Uman, 2011). It uses objective formulas combining the results of scientific studies, yielding a weighted average from the results of studies. In this phase, a meta-analysis was used to pool the effects of theory-based self-management education.

4.1.2 Phase 2: The empirical study

The design of the empirical study included the following elements: considerations of the sample selection (the sample is from two tertiary hospitals in eastern China, based on the inclusion criteria of this study), requirements for the determination of sample size (sample calculation is done in G*Power in this study) and considerations of the selection of appropriate survey instruments (Glasow, 2005).

In this study, data have been collected at two times over the period between July 2015 and July 2016. At time 1, surveys were done that included gathering demographic information, health information and information on social support, optimism, DRSCA, negative feelings and positive health. The aim of the survey at time 1 was to examine the association of DRSCA with outcome information that included positive health and negative feelings (Paper II-III).

At Time 2, the information for DRSCA was collected over three months. The aim of adding the survey at Time 2 was to examine whether or not the background information associated with subsequent DRSCA (Paper IV). In order to supplement the stable information of DRSCA and gain a deeper understanding of the factors associated with the DRSCA of people with T2DM, it would be good to test the subsequent DRSCA over some period. The subsequent DRSCA over three months were collected by phone in the study. The participants were recruited from hospitals and they visited the hospitals for help. Many of them probably attended the routine diabetes self-care education class held by the related hospital staff. Therefore, they may have had some ideas regarding change in diabetes self-care behaviour during those days. People usually take an average of 66 days to form a habit if they decide to make a change (Lally et al., 2010).

Figure 3 shows the framework of the empirical study. The empirical study mainly examined the associations of background information (including demographics, health information, social support and optimism) with the level of DRSCA at Time 2 and the association of the level of DRSCA at Time 1 with outcome information, including information on negative feelings and positive health.
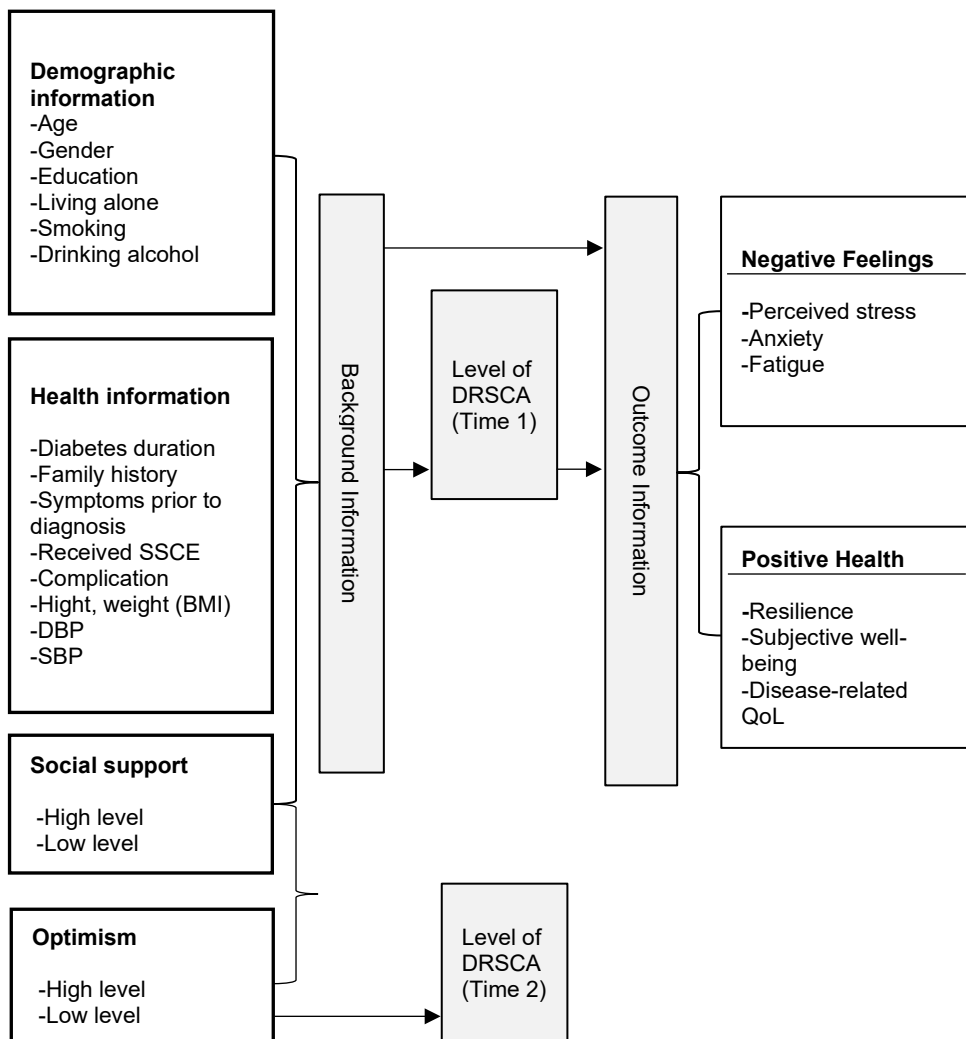
Figure 3. The empirical study framework of associated factors with DRSCA. Note: SSCE = standardized self-care education. BMI = Body mass index. SBP = systolic blood pressure; DBP = diastolic blood pressure. QoL = quality of life.

4.2 Setting and sampling

4.2.1 Phase 1: The systematic review with the meta-analysis

The databases MEDLINE, EMBASE, CINAHL, PSYCINFO and Web of Science were systematically searched and 2,439 potentially relevant articles were identified. The key words were 'self-management education', 'T2DM' and 'randomized

controlled trial'. The stages of selection included: identifying articles from databases, screening titles and/or abstracts for eligibility for inclusion and screening the full text of articles for eligibility. The selected criteria for articles in the systematic review were based on the PICOS (P: population or problem; I: intervention or exposure; C: comparison; O: outcome; S: study design) elements (O'Connor et al., 2008). Finally, 20 studies were included (Paper I). In the updated data (collected April 2015 to December 2018), the following databases were searched: MEDLINE, EMBASE, CINAHL, PSYCINFO and Web of Science. After screening, two new articles were selected from 137 studies that met the criteria. Detailed information of the inclusion and exclusion criteria is shown in Paper I.

4.2.2 Phase 2: The empirical study

A survey method was used to collect data in the empirical study at two times in summer 2015 and summer 2016. The inclusion criteria for the study participants were as follows: being age of 18 years old or older, having T2DM for three months or more, voluntarily participation and having no serious complications. A convenient sampling method was used to collect the data. The study setting was Nantong city, covering an area of 8,001 square km, belonging to Jiangsu Province, near the Yangtze River in central eastern China, with a population about 7,630,000 (Nantong Government, 2012). The older population percentage was higher than national average of 8.91% (Office of Population Census of State Council and Department of Population and Employment of National Statistics Bureau, 2013).

The sample size was calculated using G*Power software. For multiple regression analysis (using the multiple regression analysis method for analysing the DRSCA on positive health and negative feelings), the alpha was 0.05 and the power was 0.90, and the possible maximum number of independent variables analysed at one time was 15 (the number of variables in the background information and in study variables) for analysis of positive health and was 12 for analysis of negative feelings. The sample size needed to be at least 249 for multiple regression analysis for analysis of positive health and was 230 for analysis of negative feelings (Faul et al., 2013). After three months' follow-up, the DRSCA were surveyed again. The sample size for using a priori linear multiple regression in the second survey was calculated by setting the following parameters: an alpha of 0.05, an effect size of 0.15, a power of 0.80, both the number of tested predictors and the total number of predictors were set to 17. The sample size needed to be at least 146.

4.3   Instruments

The data collection included background information consisting of demographic information and health information (Table 3). The demographic information included age, gender, educational background, living alone (*Yes/No*), drinking alcohol (*Yes/No*) and smoking (*Yes/No*). The health information included family history, feeling symptoms prior to diagnosis, the duration of diabetes and if the participant had standard diabetes education prior to the survey, complications, height, weight (body mass index [BMI] was weight [in kilograms] over height^2 [in metres]), systolic blood pressure (SBP) and diastolic blood pressure (DBP). Other background information also included social support and optimism, providing information about the social situation and personal characteristics. The outcome information used was negative feelings (with the components of stress, anxiety and fatigue) and positive health (with the components of resilience, SWB and DRQoL). The instruments gained permission for use from the copyright holders when necessary.

Table 3.   Summary of collected information

Data collection information	Content
Background information	
Demographic in formation	Age Gender
	Education background
	Living alone
	Drinking alcohol habit
	Smoking
Health information	Family history
	Feeling symptoms prior to diagnosis
	Duration of diabetes
	If have standard Diabetes education prior to the survey
	Complication
	Height, weight (Body mass index was weight (in kilogram)/ height^2 (in meter)
	Systolic blood pressure (SBP)
	Diastolic blood pressure (DBP)
Other background information	Social support
	Optimism
Outcome information	Negative feelings consisting of stress, anxiety and fatigue
	Positive health consisting of resilience, SWB, and DRQoL.

The Diabetes Self-Management Scale

DRSCA were measured by using the Diabetes Self-Management Scale (DSMS), tested among Chinese populations (Xu et al., 2008). The definition of diabetes self-management in this study was defined as the self-management of medication adherence, the diabetic diet, exercise, SMBG and foot care (Xu et al., 2008). Therefore, the scale used the core items of the widely used diabetes self-care activities scale developed in the USA (Toobert et al., 2000). It includes ten items and five dimensions about diet regulation, medication, physical activity, SMBG and foot care. Each item is scored from 0–7, representing how many days they have

performed self-management care in the past week. A higher score shows a high level of self-care. The scale has acceptable reliability and good validity: about 91% of the variance was accounted for by eight items, loaded on five factors in the exploratory factor analysis and Cronbach's alpha was 0.68 (Xu et al., 2008). Thus, an eight-item version was used in this study. The results from this instrument were reported in Papers II–IV. The score index for DRSCA was calculated as the present score divided by the possible maximum score possible.

The Perceived Stress Scale

Perceived stress was measured by using the Perceived Stress Scale (PSS-10), developed in the USA by Cohen et al. (1983). The scale has a single dimension and includes ten items. Each item is scored from 0 to 4 according the frequency of occurrence. A higher score shows a higher level of perceived stress. The scale has good reliability and validity (Cohen et al., 1983; Lu et al., 2017). Previously, internal consistency by Cronbach's α for PSS-10 has ranged from 0.78 to 0.90 (Cohen & Williamson, 1988; Maroufizadeh et al., 2014). The results from this instrument were reported in Paper II.

The Zung Self-Rating Anxiety Scale

Anxiety was measured by the Zung Self-Rating Anxiety Scale (SAS) developed in the United states of America. The scale includes a single dimension and 20 items (Zung, 1971). Each item is scored from 1 to 4 according the frequency of occurrence. The raw score needs to be multiplied by 1.25 to convert it to an 'Anxiety Index'. The Anxiety Index can then be used to determine one's level of anxiety. A higher score indicates a tendency to have more anxiety symptoms. The scale has good reliability, and concurrent and convergent and discriminant validity (Samakouri et al., 2012). A split-half reliability of 0.71 for the scale has been reported (Zung, 1971). The results from this instrument were reported in Paper II.

The Fatigue Scale

Fatigue was measured by a fatigue scale developed in the UK (Chalder et al., 1993). The scale includes two dimensions, mental fatigue and physical fatigue, with 14 items. Each item is scored from 1 (*yes*) to 0 (*none*), and the three items 10, 13 and 14 are scored reversely. A higher score indicates higher fatigue. The scale has good reliability, sensitivity and specificity (Chalder et al., 1993). The Cronbach's alphas for the scale ranged between 0.88 and 0.90 (Chalder et al., 1993). The results from this instrument were reported in Paper II.

The Connor-Davison Resilience Scale

Resilience was measured by the Connor-Davison Resilience Scale, developed in the USA (Connor & Davidson, 2003). The scale was modified by Drs Campbell-Sills and Stein (2007) from the original 25-item scale (Connor & Davidson, 2003) in the USA. The scale has one dimension and ten items. Each item is scored from 0 to 4. The answer of *not true at all* was scored 0 and the answer of *true, nearly all the time* was scored 4. A higher score indicates better resilience. The scale has good reliability and validity (Connor & Davidson. 2003; Campbell-Sills & Stein, 2007). The Cronbach's alpha for the scale is 0.85 (Campbell-Sills & Stein, 2007). The results from this instrument were reported in Paper III**.**

The WHO-5 Well-Being Scale

Subjective well-being was measured by the WHO-5 Well-Being Scale, developed in Denmark, based on the WHO-10 Well-Being Index (Bech, 1996; 2003). The scale includes five items and uses a six-point Likert-type scale. The answer of *not present* was scored 0 and the answer of *constantly present* scored 5. Although the WHO-5 Well-Being Scale is short, it is a generic global tool for measuring subjective well-being (Topp et al., 2015) and global studies have shown the power of WHO-5 in measuring well-being (Bech, 2009; Bech, 2012). WHO-5 well-being has shown good internal and external validity (Bonsignore, et al., 2001). In this study, the Cronbach's α is 0.84. The results from this instrument were reported in Paper III**.**

DRQoL

DRQoL was measured by the Audit of Diabetes Dependent Quality of Life (ADDQoL-19), developed in the UK (Bradley & Speight, 2002), in order to evaluate how individuals perceive the impact of diabetes on their life domains. The scale has 19 domains. Each domain separates two items: the first one is DM's impact on the applicable domain, scoring from -3 to +1 according to the degree of negative impact and positive impact, and the second is about the importance of the domain, ranging from 3 to 0 according to the degree of importance. Important scores multiply corresponding impact scores get a weighted impact score in each domain ranging from -9 to +3. The answer for the most negative impact scored -9 and for the most positive impact scored 3. The average weighted impact (AWI) score is the total of the weighted impact scores divided by the number of the domains, ranging from 3 to -9 (from the most positive impact to the most negative impact) (Bradley & Speight, 2002). The scale has demonstrated good reliability and constructive validity (Kong et al., 2011). The Cronbach's α of 0.94 for the Chinese version of the scale has been

reported (Kong et al., 2011). The results from this instrument were reported in Paper III.

The Social Support Rating Scale

Social support was measured by the Social Support Rating Scale (SSRS) developed by Xiao (1994) in China. The scale has ten items and three dimensions (subjective support, objective support and support utility). Item 5 has five sub-questions for scoring. Each question is scored from 1 to 4 according to the response. A higher score shows better social support. The scale shows good validity. For example, Cronbach's alphas between 0.89 and 0.94 have been reported (Xiao, 1994). The scores for social support are classified as *low* for scores ≤44 and *high* for scores >44 (Dai et al., 2016). The social support scale has been widely used in China, and the Cronbach's α for this scale was 0.71 in this study. The results from this instrument were reported in Papers II to IV.

Optimism

Optimism was measured based on one single-item optimism scale (Kemper et al, 2011) developed in Germany, which uses one item to measure the construct of optimism. In the study of Kemper (2011), the correlation of single-item optimism with optimism with the life orientation scale was 0.63, showing the good criterion-related validity. The item used was: 'Please use 1–100 to indicate your optimism, with 1 being *pessimistic* and 100 being *very optimistic*'. The level of optimism was categorized by the median of its score. The use of a median split has been shown to have the same validity with a continuous variable (Iacobucci et al., 2015). The single item for optimism showed good criterion-related validity with the life orientation scale in the research of Kemper et al. (2011). The results from this instrument were reported in Paper IV.

A summary of the instruments used in this study has been listed in Table 4.

Table 4. A summary of the instruments used in this study

Variable	Instrument	Dimensions	Score
Self-care activities	A Self-Management Scale (DSMS), based on the core items of the self-care activity scale which measures the adherence of medication, the diabetes diet, physical activity, monitoring of blood glucose (SMBG) and foot care (Yin, et al., 2008; Toobert et al., 2000)	Eight items Five dimensions (medication, diet regulation, regular physical activity, foot care and SMBG).	The responses scored from 0–7. A higher score indicates a higher level of diabetes related self-care activities (DRSCA)
Perceived stress	The Perceived Stress Scale (PSS-10) (Cohen et al., 1983)	Ten items A single dimension	The response is scored from 0 to 4 to show the degree of frequency. A higher PSS-10 score shows that the individual finds it more difficult to cope with environmental demands.
Anxiety	The Zung Self-Rating Anxiety Scale (SAS). (Zung, 1971)	Twenty items A single dimension	The response of each item is scored from 1 to 4. A higher score means that the subject is more likely to become anxious. The raw score (range from 20–80) is converted into an 'Anxiety Index' score after being multiplied by 1.25. An Anxiety Index score of 50–59 indicates slightly clinically significant anxiety, 60–69 indicates middling anxiety and a score over 70 indicates serious anxiety.
Fatigue	A Fatigue Scale (Chalder et al., 1993)	Fourteen items Two dimensions (physical fatigue and mental fatigue)	The responses of each item were as follows: *Yes* = 1, *No* = 0. The total score ranged from 0 to 14. A high score indicates higher fatigue.
Resilience	The Connor-Davidson Resilience Scale 10 (CD-RISC-10) (Connor & Davidson, 2003; Campbell-Sills & Stein, 2007)	Ten items Single dimension	The response scored from 0 to 4. High score means high resilience.
Variable	Instrument	Dimensions	Score
Subjective well-being	The WHO-5 Well-Being Scale (Bech, 1996; 2003)	Five items A single dimension	The response is scored from 0 (*not present*) to 5 (*constantly present*). The total score for the 5 items ranges from 0–25 and the raw score was transformed to 0–100 in order to show the degree of thinkable well-being.

Variable	Instrument	Dimensions	Score
Disease-related Quality of Life	The Audit of Diabetes Dependent Quality of Life (Bradley & Speight, 2002).	Nineteen pairs (19 life domains) of items such as: leisure activities, working life, journeys, holidays, physical health, family life, friendship and social life, personal relationships, sex life, one's financial situation, dependence on others, freedom to eat, freedom to drink.	The scores ranged from −3 to 1 for their impact rating and from 0 to 3 for their importance rating for 19 pairs of items. A weighted score for each domain was calculated by multiplying the impact rating and importance rating (scored from −9 to 3). Higher scores indicated better QoL.
Social support	Social Support Rating Scale (SSRS) (Xiao, 1994;1999)	Ten items Three dimensions (subjective support, objective support, support utility)	Items 1–5 and 8–10 were scored 1–4. For item 5, the score was summarized from five questions. Each question was scored 1–4. Items 6–7 were scored 0–9. The total score ranged from 12 to 66. A higher score indicates a higher level of social support.
Optimism	Measured based on a single-item optimism scale (Kemper et al., 2011)	A single dimension	A single term: use 1–100 to indicate optimism.

4.4 Data collection

4.4.1 Phase 1: The systematic review with the meta-analysis

The published articles were selected from the databases MEDLINE (PubMed), EMBASE, CINAHL, PSYCINFO and Web of Science (from January 1980 to April 2015, and then updated to run to December 2018). Twenty-two studies were included for systematic review, and 20 were included in Paper I and two articles were added when updating the literature. Two researchers independently assessed the quality of the selected studies according to the Cochrane collaboration tool (Higgins et al., 2011). Three levels were identified: low, unclear and high levels. These were summarized to indicate the risk of bias of the selected studies. The indicators of the risk of bias were based on each criterion in the Cochrane collaboration tool to assess the risk of bias in the RCTs (Higgins & Green, 2011). The search terms can be seen in Figure 4. The data for the meta-analysis was extracted and recalculated from the included articles following the guidelines from the Cochrane handbook (Higgins & Green, 2011).
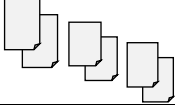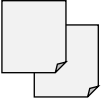
Items	Details
Searching terms	TOPIC: (self-management education or patient education or self-care or health care education or life style program) AND TOPIC (T2DM or Diabetes Mellitus or Type 2 diabetes) *AND* TOPIC: (randomized controlled trial) *AND* TOPIC: (theory)
Data bases	•MEDLINE (PubMed) •EMBASE •CINAHL •PSYCINFO •Web of Science (from 2015 April 2018 to December updated)
Searching outcome	137 records after removing duplicates

	Screening from title and abstract. N=22	115 records were excluded for the following reasons: • they were a web-based intervention • they were a review • they included type 1 diabetes • due to protocol • they were a pilot study • due to qualitative analysis • they were mobile phone based they included other disease
	Screening from full text. N=2	20 records were excluded for the following reasons: • they were not theory or model based • the outcome was qualitative data • there was a lack of the necessary data for extraction • they were not compared with standard or usual care • the mixed methods • the outcomes involved emotional • distress • they used one group, before and after design

Figure 4. Study selection (updated literature from 2015 to December 2018)

4.4.2 Phase 2: The empirical study

Prior to the data collection, eight research assistants were trained in terms of the study aim, the meaning of instrument items, the interviewing technique, ethical problems and the questionnaires' coding. The researcher and/or the eight trained research assistants explained the study's aim to the potential participants. The items of the questionnaires were read to the participants if they had problems reading. We tried to explain to the participants the importance of the research and their contribution via their participation in order to prepare them to complete each item patiently. Three hundred and ten voluntary participants were recruited and included

at time 1 and two hundred and fifty-one valid questionnaires were used for the analysis at time 2 after excluding those only reporting hospital care as self-care in the past week and incomplete questionnaires. In the survey, lasting over three months, 155 (60%) participants completed valid questionnaires. The interval time between the two surveys was three months. Figure 5.
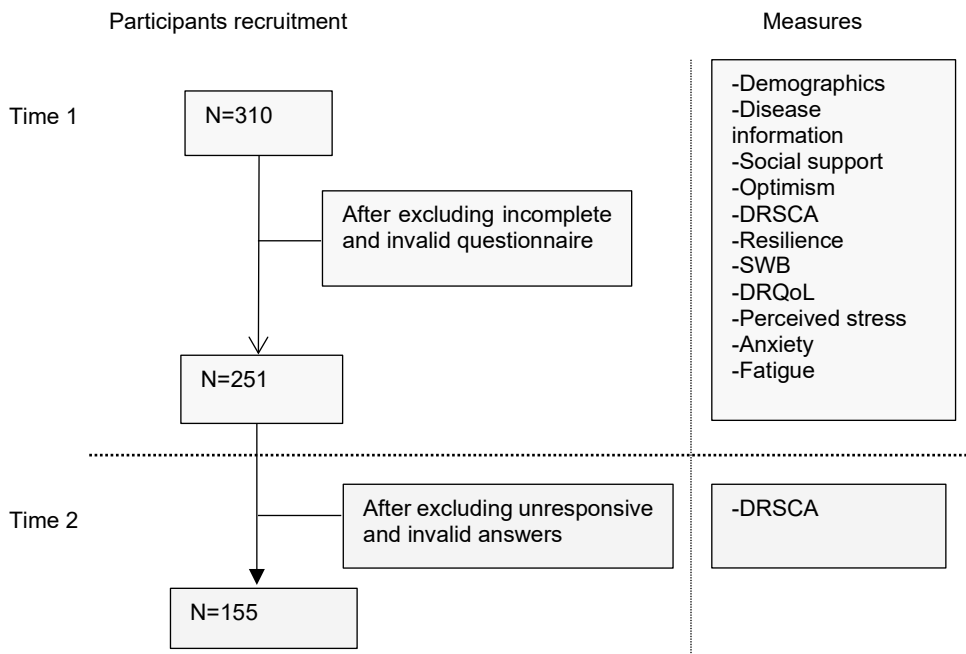

Figure 5. A flowchart of the data collection. Note: DRSCA = diabetes related self-care activities. DRQoL = disease-related quality of life.

The data collection was conducted at two time points for DRSCA without intervention. Although the percentage in the demographics and health information seemed different between people with T2DM who participated in both time points and those who were lost to follow-up, there was no significant difference in terms of demographics and health information between the two groups of people: those with T2DM participating both times and those who only participated the first time. In regard to the participants who were lost to follow-up, there seemed to be a high percentage of the following characteristics: females, participants over 65 years old, participants living with family/friends, participants having symptoms prior to diagnosis and participants having not previously received standardized self-care education (SSCE). Based on the National Standards for Diabetes Self-Management Education (Funnell et al., 2012; Renders et al., 2000) and the cultural background of

China, in this study, the standardised diabetes self-care education includes the following contents: having documentation of the organisational structure, goals and the process of providing services; curriculum-based practice guidelines, with a list of the content to be provided; an education plan considering individualised needs; diabetes self-care education, delivered in a systematic and understandable way; and education that is provided by one or more instructors who are certified diabetes educators or who have working experience in diabetes education and diabetes management. The demographic information of the participants at time 1 and at both times is shown in Table 5.

Table 5. The demographic information and health information of participants and participants lost to follow-up.

	Participants at time 1 n / M±SD; N=251	Participants at both times n / M±SD; N=155	p
Demographic information			
Gender			0.65
Male	140	90	
Female	111	65	
Age in years			0.52
<65	154	100	
≥65	97	55	
Living alone			0.48
Yes	57	40	
No	194	115	
Education level			0.97
Less than college education	189	117	
College level or higher	62	38	
Smoking			0.28
Yes	53	26	
No	198	129	
Drinking alcohol			1.00
Yes	68	42	
No	183	113	
Health information			
Have received SSCE			0.71
No	144	86	
Yes	107	69	
Disease duration			0.92
<5years	79	48	
≥5years	172	107	
Have symptoms prior to diagnosis			0.55
Yes	142	83	
No	109	72	
Family history of diabetes			0.96
Yes	67	41	
No	184	114	
Perceived complication			0.51
Yes	89	50	
No	162	105	
BMI	24.4±3.8	24.5±3.5	0.83
SBP	132.6±17.0	133.3 ±17.3	0.66
DBP	77.0±9.5	77.2±9.5	0.90

Note: SSCE = standardized self-care education. BMI = Body mass index. SBP = systolic blood pressure. DBP = diastolic blood pressure. *P<0.05. Modified from Original Publications II-IV.

4.5 Data analysis

4.5.1 Phase 1: The systematic review with a meta-analysis

RevMan 5.3 software was used to analyse the bias of the included studies in the systematic review. Stata 12.0 statistical software was used to calculate weighted mean differences (WMDs), standardized mean differences (SMDs) and 95% confidence intervals (CIs). The 95% CIs that did not include zero showed a statistical difference. Data changes from baseline were calculated. The I^2 statistic was used to test the heterogeneity of the studies in the meta-analysis. The publication bias of the main outcomes in the included studies was assessed by Egger's regression test (Egger et al., 1997) and Begg's adjusted rank correlation test (Begg & Mazumdar, 1994).

4.5.2 Phase 2: The empirical study

The Statistical Package for the Social Sciences (SPSS, version 23.0; SPSS, Inc, Chicago, IL) was used for data analysis. Before analysis, data were checked to correcting and removing the errors, including data transfer errors and outliers, by using the interquartile range to avoid an interpretation of statistics that was misleading (Van den Broeck et al., 2005). Missing data was <5%, but BMI, SBP and DBP (12%-15%). Missing values were replaced by imputation using the expectation-maximization (EM) method for each variable with missing values. EM is an iterative method used to find the maximum likelihood estimator of a parameter of a probability distribution (Chen & Gupta, 2010).

Descriptive statistics were computed to express the percentage, range, means, standard deviations (SDs), and the median and interquartile range (IQR) based on the distribution of samples. Cronbach's alpha was a reliability coefficient used to express the internal consistency of a scale, which shows whether all the items of a scale measure the same concept. Its range was between 0 and 1 and the higher the number, the higher the degree of internal consistency of the scale (Tavakol & Dennick, 2011). The independent samples t-test was computed for comparing the means of two independent groups. The independent samples t-test in this study was used to compute and compare the difference of DRSCA with different demographic and health information. A Pearson's correlation analysis was used to examine the associations between study variables, including DRSCA, background information and outcome information.

The statistical method of hierarchical regression was used for exploring the association between dependent variables (the outputs whose variation is being studied) and independent variables (inputs – potential reasons for variation) (Flom,

2017). In this study, hierarchical multiple regression analysis was performed to analyse the association between DRSCA and outcome information (which included negative feelings and positive health) (Papers II–III). Standardized coefficients (labelled with the Greek letter beta) were used in the multiple regression analysis to indicate the strength of the association between these study variables. R^2 values show the proportion of variance explained for dependent variables.

A chi-squared test (an X^2 test) was conducted to evaluate the differences in frequencies between different groups. In the analysis of the association of background information with DRSCA, first, a chi-square test was computed to analyse whether there is difference between the participants at both times and if there were participants lost to follow-up. Then, an independent samples t-test was used to compare the two means of DRSCA between different demographics and health information. Last, the Pearson correlation coefficient was used to test the correlation of the continuous variables in demographic information and health information with DRSCA.

The covariates including significant demographics and health information from the independent samples t-test and Pearson correlation were adjusted for in the hierarchical multiple regression analysis in order to analyse the association of social support and optimism with DRSCA (Paper IV). The mediation of optimism between social support and DRSCA was analysed by the bootstrapping method (Preacher & Hays, 2008). Covariates are variables that are not manipulated but can influence the outcome of a study. A p value ≤0.05 showed that a significant difference exists.

4.6 Ethical considerations

The research followed the principles and standards for ethically sound research and followed the international research ethics of scientific studies (Declaration of Helsinki [WMA, 2001; ALLEA, 2017]). In the systematic review phase, the Cochrane guideline was followed carefully. (Paper I).

In the empirical survey phase, the study obtained the approval from the Ethical Committee of the Affiliated Hospital of Nantong University (Approval Number: 2015-120), and the directors of nursing gave permission for the researcher and research assistants to approach the participants. Written informed consent was obtained from the participants after they were told the aims and process of the survey. Participation in this study was entirely voluntary and participants could withdraw at any time and in any situation.

During the survey, it was essential to create a comfortable physical and emotional climate (Adamson et al., 2012). When the participants felt tired or given their age and vision problems due to having diabetes, the research assistant read the questions for them. When the participants consulted the health information and

nursing practice, the researcher or research assistants told them. During the data collection process, the researcher and/or research assistants respected and cared about the emotions of the people with T2DM and did not only collect the information needed for this study. The participants decided for themselves if they would like to share the information on the questionnaires. The researcher and/or research assistants expressed thanks to all participants and told them their participation can benefit the development of diabetes self-care education.

Confidentiality is the key to respecting participant information. The confidentiality of all personal information is ensured. In the survey phase, numbers were used as codes and each code was linked to the identity of each participant. Thus the responses from participants at the two time points could be linked and matched for analysis, and the individual participants were anonymous in any written report. The coding numbers were kept separate from the electronic data, accessible to the researcher and not released, and they were kept on a file that could only be accessed with a password. Paper versions of questionnaires were locked in a filing cabinet in China and will be destroyed at the end of the project (Ridley, 2009).

As for the publication ethics, all the authors have made a significant contribution to the four articles and agreed about publication. Any views from other studies that were used were cited properly from the original resource. Permissions to use the instruments used in this study were granted by the copywriter holders if the instrument was not free and open for use (Table 6). Among the used scales in the study, the SAS (Zung, 1971), PSS-10 (Cohen et al., 1983) and the social support scale (Xiao, 1994) were open for non-profit research use.

Table 6. Permission to use the copyrighted instruments granted by the copywriter holders when necessary

Instruments	Reference	Permitted by copyright holder
Connor-Davidson Resilience Scale-10 (CD-RISC-10)	Campbell-Sills and Stein 2007; Connor & Davidson 2003;	Permitted by copyright holder (Chalder Trudie) in October 2014
Fatigue scale	Chalder et al., 1993	Permitted by copyright holder (Chalder Trudie) in July 2015
Diabetes self-management scale	Toobert et al., 2003; Xu et al., 2008;	Permitted by copyright holder (Deborah J. Toobert) in November 2011.
WHO-5 well-being scale	Bech 1996, 2003	Permitted by authorized coordinatior PhD Ernest Volinn in October 2014
Quality of life scale ADDQoL-19 (Audit of Diabetes Dependent Quality of Life)	Kong et al., 2011; Bradley & Speight, 2002	Permitted by Jonathan Gilbride authorized by copyright holder (Clare Bradley) in October 2014.

5 Results

The results are presented based on the study phase. First, the results of the first phase, the systematic review about the effects of theory-based self-management education on diabetes self-care, are presented. The systematic review implied that the role of people with T2DM should be more involved and stronger in the self-care, and more motivational information was needed in order to promote DRSCA (Paper I). Second, the results of the empirical study provided new knowledge with which to encourage people with T2DM to improve DRSCA by identifying the associated factors of DRSCA. In this chapter, three sections were included at the level of DRSCA; the factors associated with DRSCA included background information, and outcome information with DRSCA is described according to the research questions (Papers II–IV).

5.1 Phase 1: The systematic review

A systematic review of the effect of theory-based self-management education on diabetes self-care

This review included 22 studies. Half of the studies were conducted in the United Kingdom and United States. The results showed that theory-based self-management education was mostly based on mid-range theories and a few low-level theories. Educational methods and duration were diversified to strengthen the theory components in the education programme. Theory-based self-management was effective on DRSCA and other indicators, including HbA1c, BMI, self-efficacy, QoL and diabetes knowledge (Paper I).

The basic information of the characteristics of the selected studies from updated literature was abstracted (see Table 7). The updated information included two added articles (Whitehead et al., 2017; Wichit et al., 2018).

Table 7.   Characteristics of additional selected studies in updated literature (n=2 studies)

Author, year, country	Participants B(F)	Theory	Education style	Follow-up	Outcomes of endpoint of follow-up
Whitehead et al., 2017, Australia	157 (97)	Cognitive behaviour therapy	•Mindfulness and acceptance training. •The exploration of personal values related to diabetes	3months, 6months	•HbA1c was reduced •Self-care activities were improved
Wichit,et al., 2018, Thailand	140(134)	Self-efficacy	• Group based • Individualised •Follow-up telephone calls and home visits	5 and 13 weeks	Diabetes self-efficacy, self-care activities, a dimension of the quality of life and diabetes knowledge were improved but HbA1c levels were not

Note: B(F) = baseline/follow up

The synthesized outcomes of the theory-based education in the systematic review included DRSCA and other health indicators like HbA1c, BMI, self-efficacy, diabetes knowledge and QoL. In the studies selected in paper I and updated literature, twelve studies measured DRSCA, but most of these included studies did not report detailed enough data to conduct a meta-analysis. Therefore, it is difficult to synthesize the effects of theory-based education on DRSCA quantitatively. However, all these studies (except that of Mash et al., 2014) showed the positive effect of theory-based self-management education on DRSCA or some dimensions of DRSCA. For HbA1c, the results of sixteen studies including the updated literature were pooled and the pooling showed that theory-based education resulted in a more favourable reduction in HbA1c compared to routine care. The pooled WMD for 17 studies was -0.42 (unit: %), 95% CI [-0.55, -0.28]. The heterogeneity was not significant ($I^2 = 30\%$).

A total of seven studies were synthesized for the outcome BMI, the synthesized results showed that BMI did not have a statistically significant change in terms of theory-based interventions compared to routine care. To assess the outcome of self-efficacy, the results of eight studies including the updated literature were pooled. The meta-analysis showed that theory-based self-management education exerted more positive effects on self-efficacy than routine care. The heterogeneity was statistically significant for pooled self-efficacy. Therefore, the original five studies were synthesized for the meta-analysis after sensitive analysis (Paper I). For the outcome of diabetes knowledge, the pooled results from Paper I and the updated

literature together showed that the effects of theory-based self-management education on diabetes knowledge was significant compared to routine care (95% CI [0.37, 0.66], I^2 = 72%). The heterogeneity was significant for pooled diabetes knowledge and three studies remained for meta-analysis (Paper I). For the outcome of QoL, six studies including the updated literature were pooled for meta-analysis, showing the significant effect of theory-based education on QoL, and the pooled SMD for six studies was 0.22 (95% CI [0.06, 0.38]).

5.2   Phase 2: The empirical study

5.2.1 The level of DRSCA

Two hundred and fifty-one participants completed the questionnaires at time 1. One hundred and fifty-five people with T2DM completed the valid questionnaires both at time 1 and time 2. The level of DRSCA among people with T2DM was examined based on their self-reports about how many days they performed DRSCA. In this study population, DRSCA were at a middle level at both time points. The score of DRSCA for those who participated at both times (n = 155) was 33.4 (score index: 59.6%) at time 1 and 35.8 (score index: 63.9%) at time 2. The score for DRSCA did not show a statistical difference between the two time points (see Table 8).

Table 8.   The level of DRSCA at time 1 and time 2.

	Participants at time 1 (n=251)	Participants at both times (n=155)				p
	Mean±SD	T1		T2		
		Mean±SD	Score index	Mean±SD	Score index	
DRSCA	34.9 ±11.5	33.4 ±11.0	59.7%	35.8±10.1	63.9%	0.052

Note: DRSCA = diabetes-related self-care activities. SD = standard deviation.
Score index = score/possible maximum score. T1 = time 1. T2 = time 2.

The majority of the one hundred and fifty-five participants had taken medication and regulated their diet in the week prior to both times of survey. The sub-scores for exercise and foot care at both time points were approximately at the middle level. SMBG was the least performed activity (see Figure 6).
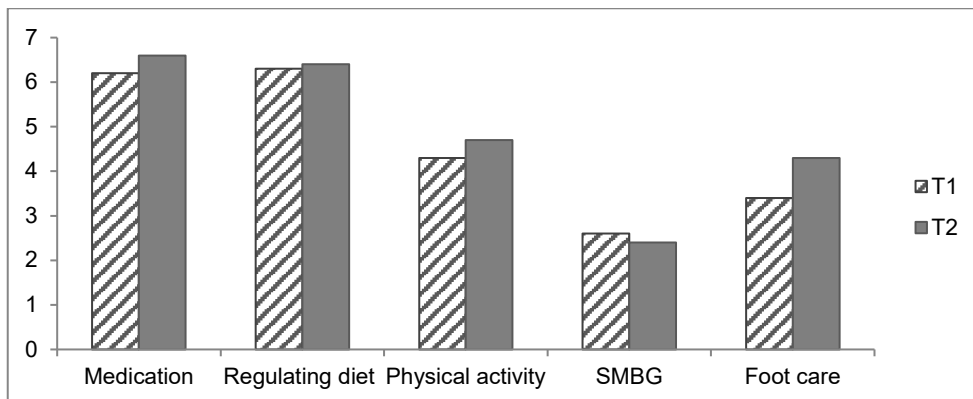
Figure 6. The distributions for dimensions of DRSCA at two time points (n = 155). Note: T1 = time 1. T2 time 2. SMBG = self-monitoring of blood glucose

5.2.2 The factors associated with the level of DRSCA

The empirical study (Papers II and III) at time 1 aimed to analyse the association of DRSCA with outcome information. The empirical study at time 1 and time 2 included 155 people with T2DM and aimed to investigate how background information was associated with DRSCA (Paper IV).

The background information included demographic information, health information, and information on social support and optimism. The outcome information included information on negative feelings and positive health (for details also see Chapter 4'Materials and methods', Section 4.3 'Data collection').

5.2.2.1 The association of background information with DRSCA

In investigating the association of background information with DRSCA, demographic information, health information, social support and optimism were analysed. Of the background information, people with T2DM who had a longer diabetes duration (lasting over five years) and SSCE were more likely to perform DRSCA well among the participants at time 1; social support and optimism were associated with DRSCA.

(1.) The effect of demographic information and health information on DRSCA

In the demographic information and health information, participants with a longer diabetes duration (≥5 years), and those having received SSCE seemed to have better DRSCA at time 1.

(2.) The effect of social support and optimism on the subsequent three months' DRSCA (Paper IV)

The results showed that the level of social support and optimism were significantly associated with the subsequent three months' DRSCA. Among the participants at both times, 43% participants had a high level of social support and 47.7% had a high level of optimism (median: 85).

The association between social support and optimism and the subsequent DRSCA over three months was analysed by hierarchical multiple regression analysis. Covariates for the analysis were selected according to the statistical significance level gained from the t-test and Pearson correlation analysis.

In the hierarchical multiple regression analysis, at step 1, prior DRSCA (at time 1) were positively and significantly associated with subsequent DRSCA ($p < 0.001$). At step 2, the dimensions of social support (subjective support, objective support and support utility) were analysed. Objective support ($p < 0.05$) and support utility ($p < 0.05$) were significantly associated with DRSCA but not subjective support ($p > 0.05$). At step 3, optimism ($p < 0.01$) was positively and significantly associated with DRSCA (R^2 for the whole model was 42.4%). No multi-collinearity is shown. Variance inflation factor (VIF) < 5 and tolerance (TOL) > 0.2). In the mediation analysis, subjective support, objective support and support utility were not indirectly associated with DRSCA (Paper IV).

(3.) The distribution of the DRSCA score (time 1) and the subsequent three months DRSCA (time 2) with different levels of social support and optimism

The participants who had a higher level of social support and optimism had a higher level of DRSCA. The ones who had the lowest level of social support and optimism had the lowest level of DRSCA at both time 1 and time 2 (n = 155) (see Figure 7).
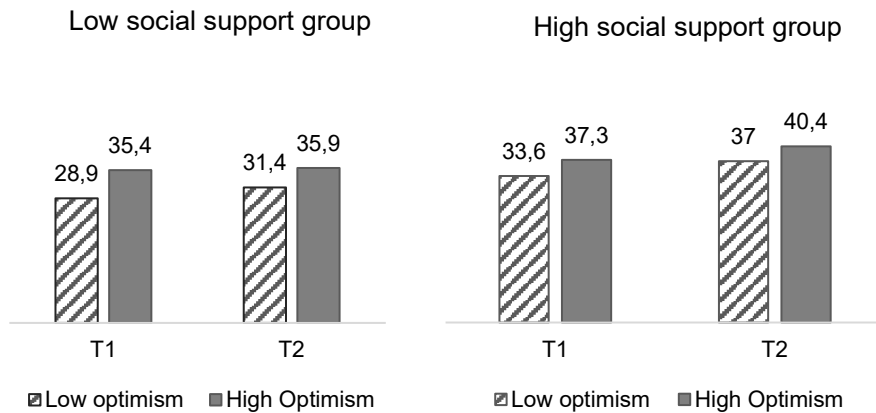
Low social support group | High social support group

Figure 7.A | **Figure 7.B**

Figure 7. B: The comparison of DRSCA mean score at different levels of optimism in high social support group. T1 = time 1. T2 = time 2. (*n* = 155). **A:** The comparison of DRSCA mean score at different levels of optimism in low social support group. T1 = time 1. T2 = time 2. (*n* = 155).

5.2.2.2 The association of DRSCA with outcome information

This section presents the results of the empirical study about the association of DRSCA with outcome information in five parts: (1) the level of outcome information, including negative feelings and positive health, (2) the association of demographic information and health information with outcome information, (3) a correlation analysis of DRSCA and outcome information, (4) the association of DRSCA with outcome information about negative feelings and (5) the association of DRSCA with outcome information about positive health. The outcome information in this study included negative feelings (which consisted of stress, anxiety and fatigue), positive health (which consisted of resilience, SWB and DRQoL), and information on social support and optimism (Papers II–IV).

(1.) The level of outcome information

The level of outcome information, including negative feelings and positive health, was examined. In the outcome information, the scores for the perceived stress level were slightly below the middle level (mean = 14.1, score index: 35.3%, which indicates the rate of the actual sore divided by the highest possible score), and fatigue (mean = 7.2, score index: 51.4%) was at the middle level. Based on the diagnosis cut-off value of the standard anxiety score in China, 19% of the participants probably had anxiety. The scores for resilience (M = 30.7, score index: 77%), SWB (M = 73.2, score index: 73%) and DRQoL (M = -1.9, range: -9-3) are higher than the middle level.

(2.) The association of demographic information and health information with outcome information

The results of the association between demographics and health information and outcome information were used for selecting covariates for analysing the association of DRSCA with outcome information. Women were more susceptible to perceived stress ($P < 0.05$) and anxiety ($P < 0.001$) compared to men. Participants who had had diabetes for over five years had a higher risk of anxiety. Social support had no significant influence on perceived stress, anxiety or fatigue.

Regarding positive health, men had a higher SWB than women ($P < 0.005$). The participants aged ≥65 had a higher DRQoL ($P < 0.05$) and participants who had higher education qualifications seemed to have higher resilience ($P < 0.01$) but a more impacted DRQoL ($P < 0.05$). The participants who had higher social support had higher resilience ($P < 0.001$), SWB ($P < 0.01$) and perceived more impact on their DRQoL ($P < 0.05$) (see Appendix2). More details are presented in Paper II and paper III.

(3.) The correlation analysis of DRSCA and outcome information

The correlation analysis of DRSCA and outcome information was used for selecting covariates when analysing the association of DRSCA with outcome information. DRSCA were negatively correlated with perceived stress ($p = 0.001$) but not with anxiety ($p = 0.900$) or fatigue ($p = 0.611$). DRSCA were positively correlated with resilience ($p = 0.009$) and SWB ($p = 0.001$) and not with DRQoL ($p = 0.072$). More details are presented in Paper II and paper III.

(4.) The association of DRSCA with outcome information (negative feelings) (Paper II)

DRSCA were significantly associated with reduced perceived stress, one component of negative feelings, but not with other components (anxiety and fatigue) after controlling the covariates. Covariate selection was done according to the significance of the *t*-test results (Appendix 2) and Pearson's correlation analysis. In the category positive health, the BMI was included in the analysis. The detailed information follows:

For perceived stress, gender was the independent variable included in step 1, anxiety was added in step 2 and DRSCA were added in step 3. Gender, anxiety and DRSCA were negatively associated with perceived stress. The variance in perceived stress accounted for by these independent variables was 20.2%.

For anxiety, gender and diabetes duration were the independent variables included in step 1, perceived stress and fatigue were added in step 2 and DRSCA were added in step 3. Gender, diabetes duration, perceived stress and fatigue were associated with anxiety and DRSCA were not statistically significantly associated

with anxiety. The variance of anxiety accounted for by these independent variables was 25.4%. DRSCA were also not associated with fatigue after controlling covariates.

For variable fatigue, anxiety was the independent variable included in step 1 and DRSCA were added in step 2. Anxiety was associated with fatigue and DRSCA were not significantly linked with fatigue. These independent variables accounted for 4.4% of the variance in fatigue.

(5.) The association of DRSCA with outcome information (positive health) (Paper III)

The results indicated that DRSCA were positively associated with SWB, one component of positive health, but not with the other components (resilience and DRQoL) after controlling covariates. Covariates were selected according to the significance of the *t*-test results and Pearson's correlation analysis. The detailed information follows:

For resilience, in step 1, higher education and social support were associated with increased resilience. In step 2, SWB was positively linked with resilience. In step 3, DRSCA were found to not be significant for resilience after controlling the covariates. The percentage of variance in resilience accounted for by these independent variables was 17.3%.

DRSCA were associated with SWB after controlling covariates. For SWB, in step 1, gender, BMI, and social support were associated with SWB. In step 2, resilience was positively linked with SWB, and in step 3, DRSCA were significantly associated with SWB. The percentage of variance in SWB explained by these independent variables was 18.6%.

DRSCA were associated with DRQoL after controlling covariates. For the DRQoL, in step 1, age, education and social support were not related with DRQoL. In step 2, DRSCA were also not significantly associated with DRQoL after controlling covariates. The percentage of variance in DRQoL explained by these independent variables was 5.6% (see Figure 8).
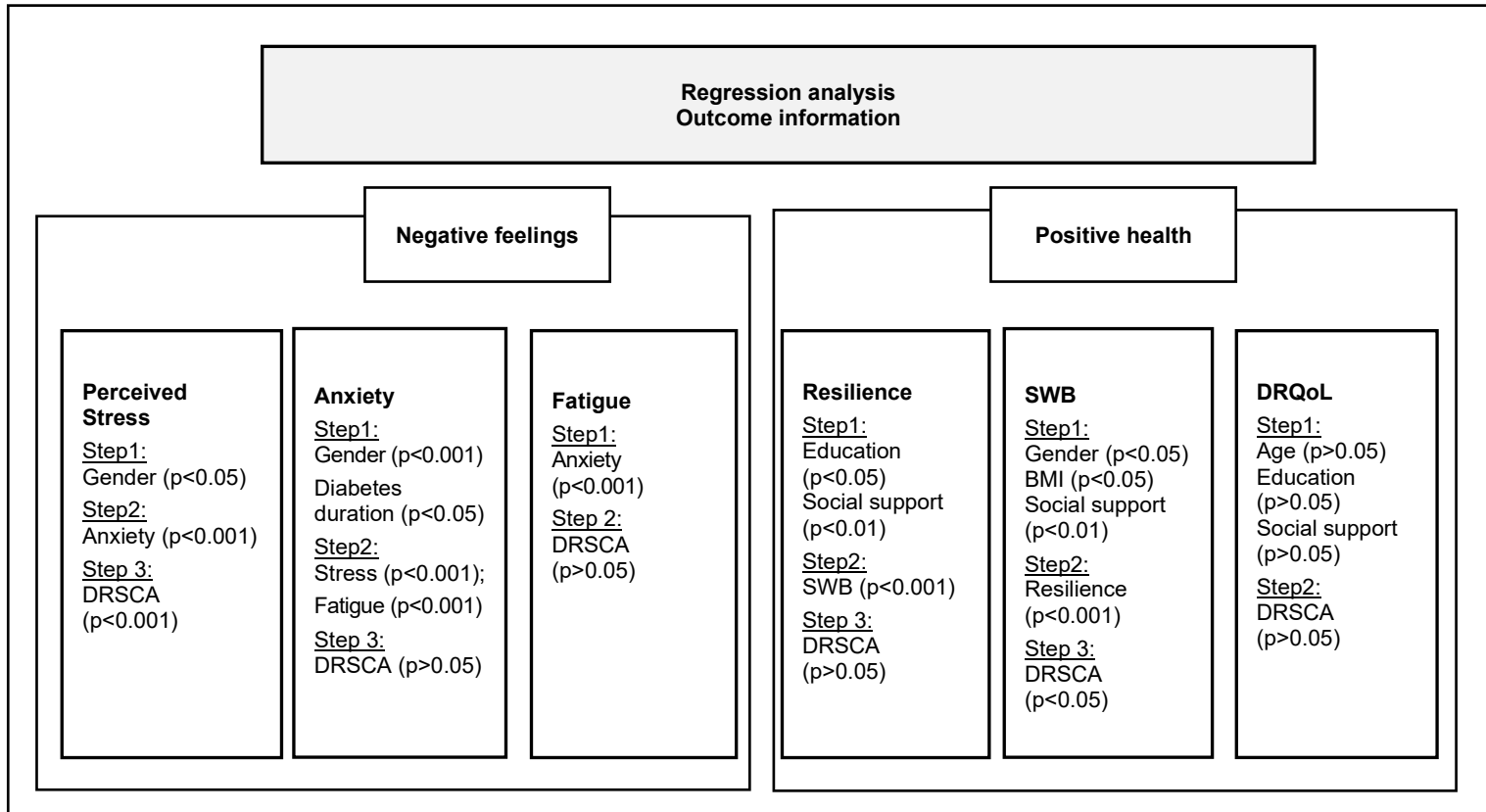
Figure 8. The regression analysis on negative feelings and positive health. Modified from Original Publications II-III

5.3 Summary of the results

5.3.1 A summary of the results of the systematic review

The outcomes of this systematic review indicated the significant effects of theory-based self-management education on DRSCA. Theory-based self-management education also had other significant effects on decreased HbA1c, increased self-efficacy and diabetes knowledge but resulted in no significant improvement in BMI. As for the effects on QoL, no conclusions were drawn due to the fact that the synthesised result was the opposite after removing one study to reduce heterogeneity in paper 1. The studies included the selected studies in paper I and updated literature studies showed the significant effect of theory-based education on QoL in the thesis, The results of the systematic review with the meta-analysis also implied that the role of people with T2DM should be more involved and they should be more motivated. More encouraging information was needed in order to promote DRSCA.

5.3.2 A summary of the results of the empirical study

The summarized results of the empirical studies can be described in two parts: (1) In the background information, diabetes duration and SSCE were positively associated with DRSCA and social support and optimism were associated with DRSCA (see Figure 9). (2) In the outcome information, DRSCA were positively associated with reduced perceived stress but not with anxiety and fatigue after controlling covariates. DRSCA were positively associated with increased SWB, one component of positive health, but not with resilience and DRQoL after controlling covariates (see Figure 9).
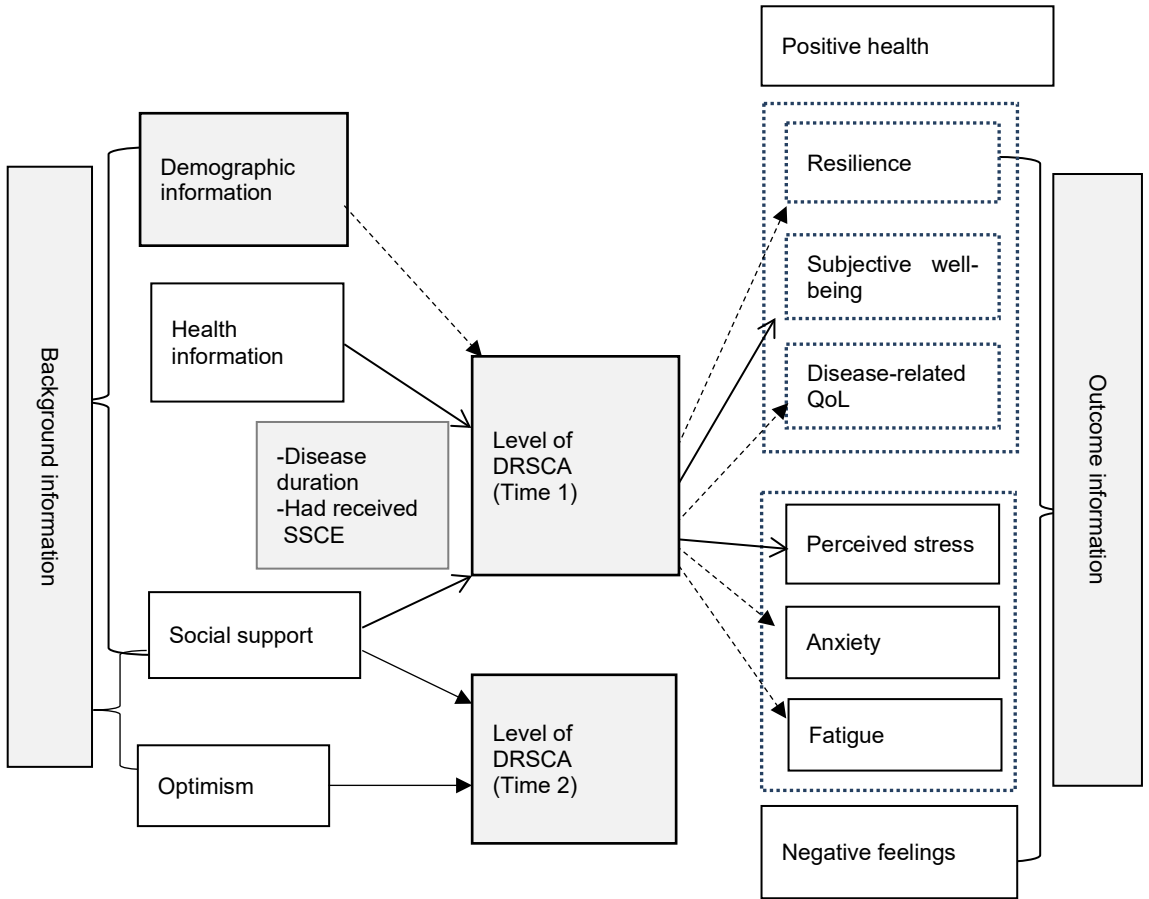
Figure 9. A summary of the results regarding the possible associated factors of DRSCA in empirical studies. Note: The solid line indicates significant association between variables and the dashed line indicates non-significant association between the variables. SSCE = standardised self-care education. DRSCA = diabetes-related self-care activities. QoL = quality of life.

6 Discussion

This chapter discusses the results of the study, including the effects of theory-based education, in the systematic review and the factors associated with the level of DRSCA in the empirical study. The perspective of the systematic review was that of patient education and this strongly proved the important role of theory-based education in DRSCA. The perspective of the empirical study was that of DRSCA and their associated factors. A discussion on the validity and reliability of the study is also presented.

6.1 Discussion of the results

6.1.1 Phase 1: The systematic review: The effects of theory-based self-management education on DRSCA

In this first phase, the perspective was that of patient education about diabetes management. The results of the systematic review supported the benefits of the theory-based education with robust evidence. The outcomes of this review include the effects of theory-based education on DRSCA. In this systematic review, compared to routine education, theory-based education was not strongly associated with DRSCA, but the review also showed more benefits in reducing HbA1c, improving self-efficacy, QoL and diabetes knowledge. For future studies or health education programmes, it is showed robust evidence that theory-based education is more effective compared to routine education (in the study *routine care* means that the diabetes care education was usually and normally done by health care staff in their daily caring). In addition, the outcome of the review also implied that the role of people with T2DM should be more involved in DRSCA. Therefore, exploring further the associated factors promoting people with T2DM to manage their DRSCA well has been increasingly needed. The review provides the basis for further exploring the associated factors of DRSCA in order to promote people with T2DM performing DRSCA actively and fully.

In the systematic review, the effects of theory-based diabetes self-management education on DRSCA, self-efficacy, QoL and diabetes knowledge were firstly

synthesised. The importance of self-management has gained increasing attention. Although some systematic reviews have been conducted in order to synthesise the effects of self-management education on patients with T2DM (Chrvala et al., 2016, Sherifali et al., 2015; van Vugt et al., 2013), the effects of theory-based self-management interventions were focused on in this study. In the updated literature, the systematic review indicates the positive and significant effects of theory-based self-management educational interventions on the HbA1c, self-efficacy, diabetes knowledge and self-care activities of patients with T2DM. However, BMI was not found to be significantly reduced after the theory-based education. In a systematic review of lifestyle-based weight loss interventions for adults with T2DM, Terranova et al. (2015) found that lifestyle interventions only achieved modest reductions in weight. Therefore, it seems that it may not be easy to achieve significant weight reduction over a short period of time.

Although it is difficult to identify which theory was the most effective, robust evidence supporting theoretically based self-management education was provided. The results support the concept that theory enables education to target key concepts related to behaviour and therefore makes educational intervention more effective (Michie & Prestwich, 2010). Therefore, the study confirmed that diabetes education based on theory is an effective factor contributing to improved DRSCA among people with T2DM.

In the included studies, we classified the theories into low-level theories and mid-range theories. Mid-range theories were more frequently applied. The theory levels' boundaries may overlap and may also be transcended as time passes (Noyes et al., 2016). Theory classification can promote a better understanding of their application in clinical practice and help develop a universal theory for understanding and facilitating behaviour change (Noyes et al., 2016).

Besides considering a robust theory framework for the self-management education, it is imperative to consider time requirements and cost effectiveness (Teljeur et al., 2017) in the self-management education programme. When we evaluate the effects of a programme aimed at improving the health of people, we should count in the time, budget and efforts of all the people involved. The systematic review proved the effects of theory-based education on DRSCA, which can in turn facilitate the further DRSCA education programme's design and implementation. It is suggested that people with T2DM should be empowered to be more participant in their diabetes self-care. To make the DRSCA of people with T2DM more sufficient, encouraging information was needed in order to promote them performing DRSCA. In the first phase, the review found the necessity for further exploring more associated factors for promoting DRSCA.

6.1.2 Phase 2: The empirical study: The level of DRSCA and factors, including background information and outcome information, associated with DRSCA

The following paragraphs present a discussion of the findings of the empirical study: the level of DRSCA among people with T2DM and the factors, including background information and outcome information, associated with DRSCA.

6.1.2.1 The level of DRSCA among people with T2DM

The level of the DRSCA index was about 60% correspondingly similar to the reports of previous studies (Simon-Tuval et al., 2016; Yang et al., 2017) but still higher than in another mainland sample in China (Yang et al., 2015). This indicates that the level of self-care activities does not seem to be adequate in general, according to the advice for the full adherence to DRSCA (American Diabetes Association, 2018).

In the five dimensions of DRSCA, the people with T2DM exhibited different performances. Medication adherence scored highest and SMBG scored lowest. These results were in line with other studies (Wu et al., 2011; Al-Khawaldeh et al., 2012; Yang et al., 2015). This may due to medication being considered the most effective method of controlling diabetes, and it was easy to take medication with instructions from doctors and nurses (Yang et al., 2015). Another explanation was that people with T2DM pay more attention to medication adherence as they may have more serious symptoms shortly before being admitted to hospitals. SMBG scored lowest, which may be due to the financial burden caused by blood glucose testing, the fear of pain or possibly due to a lack of knowledge about how to test blood glucose. In this study, the dimension of diet regulation scored second highest; this is understandable as this is an important economic dimension and an effective way to control diabetes. The score for the level of foot care and exercise was middling. Like the implications of another study (Yang et al., 2015), the levels of the two dimensions also needed to be improved by providing corresponding knowledge and input to encourage information.

6.1.2.2 Factors, including background information and outcome information, associated with DRSCA

(1.) The association of background information with DRSCA

The following paragraphs discuss the association between DRSCA and background information, which includes demographic information, health information and information on social support and optimism.

The main result of the association between the background information and DRSCA showed that in social support, objective support and support utility were significantly associated with subsequent DRSCA over three months, as was optimism. As for the demographics and health information, the study did not find a significant association between DRSCA and age, gender, education level or living alone, which is different from previous studies (Huang et al., 2014; Luo, 2015), maybe due to the different distribution of the population. For example, the study population was in eastern China whose older population rate was higher than the national average (Office of Population Census of State Council and Department of Population and Employment of National Statistics Bureau, 2013). The study indicated that people who had a longer diabetes duration and who had received SSCE showed better levels of DRSCA. Diabetes education seemed to be helpful in guiding people with T2DM to conduct self-care (Wu et al., 2011), especially when people have had an early diagnosis of diabetes and need related knowledge about the disease. These factors in the background information (including diabetes duration and diabetes education) should be considered when planning programmes in order to increase the level of DRSCA.

Prior studies indicated that the support of family members and friends was associated with positive glycaemic control (Lee et al., 2018; Baig et al., 2015). This study indicated further that objective support and support utilization were significantly associated with subsequent DRSCA. That is to say, providing patients with actual support and encouraging them to make full use of the support is significant in promoting DRSCA. This may be due to the fact that it is more helpful for patients to make full use of actual objective support when overcoming the obstacles of DRSCA on some occasions. For example, the support from friends and families may help people with T2DM resist the temptation of delicious food and alcohol. Some studies also indicated that elderly people with diabetes who live alone have barriers, such as preparing meals (Suhl, 2006) and forgetting to take medication on time (Munshi et al., 2006), and face the problem of isolation (Miyawaki et al., 2016). Therefore, the finding suggested that nurses or other health care practitioners can encourage getting more social resources in order to involve patients in self-care education, provide actual support and encourage them to make full use of the resources. In addition, the finding also suggested that nurses or other health care practitioners can also play an important supporting role for people with T2DM (Miyawaki et al., 2016). There are challenges to delivering high-quality care included complex, difficult patient situations. Thus, information, support, and professional cohesion are also needed for the health care staff to perform the supporting role and diver high-quality care (Graue, et al., 2013).

Evidence of the association of optimism with DRSCA among people with T2DM has been limited in earlier studies. Optimism was positively associated with health

behaviour in middle-aged women and associated with the reduced incidence of stroke among adults (Matthews et al., 2004; Nabi et al., 2010) in previous studies. The finding in the present study provides the new knowledge that in programmes promoting self-care behaviour, it is important to consider that optimism can be a protective factor in the face of setbacks (Puig-Perez et al., 2017). The findings imply the necessity to promote DRSCA by improving optimism. Therefore, the study suggests that employing resources to improve optimism is beneficial for DRSCA.

Another finding is that optimism was not significantly mediated in the relationships between objective support and support utility. One explanation may be that controls reduce the power for detecting true mediator effects. Another reason was that there are other powerful factors related to optimism, such as psychological well-being and QoL (Rai et al., 2019). The mediation of optimism between social support and DRSCA needs to be addressed in further studies and in different situation. However, as they are important, inner strength, optimism and social support showed their direct significance for patients with T2DM in relation to engaging in self-care activities. It may also imply that both a high level of optimism and social support were strongly significantly associated with the level of DRSCA.

(2.) The association of DRSCA with outcome information

This study examined the association of DRSCA with outcome information, which includes negative feelings and positive health. The negative feelings consist of perceived stress, anxiety and fatigue, and positive health includes resilience, SWB and DRQoL.

Based on the findings, the association of DRSCA with perceived stress and SWB was significant. Evidence was provided that taking the initiative to carry out DRSCA is beneficial for reducing perceived stress and improving SWB. These findings are significant for clinical practice. First, encouraging information can stimulate people with T2DM to implement DRSCA in order to attain positive health. DRSCA do not just bring diabetes in control (Zhou et al., 2013), they also make life more positive and produce psychological health, which is all people should pursue during their daily life. In people's minds, striving for a better life is more easily accepted than managing a disease. Second, the attention of the health care staff can help reduce negative feelings and improve positive health in a chronic disease like T2DM.

The results in this study showed significant association of DRSCA with perceived stress. DRSCA have been association with reduced perceived stress, and stress can make blood sugar increase or become unstable (Lynch et al., 2012). Therefore, the study provided new knowledge about the positive role of DRSCA, which can be included in the educational information and outcome evaluation for self-care education.

This study provided empirical evidence about how DRSCA relate to anxiety and fatigue. The findings showed that DRSCA did not significantly relate to anxiety and fatigue. Therefore, the positive influence of DRSCA may be offset by the restricted life in daily DRSCA. At least because DRSCA were not a factor contributing to anxiety and fatigue, it is not reasonable to consider DRSCA to cause anxiety and fatigue and thus be used as an excuse to not sustain DRSCA. A review found little research linking emotional distress to fatigue (Fritschi & Quinn, 2010). Our study supplements the information and indicates that anxiety, belonging to emotional distress, is correlated with fatigue.

In regard to positive health, the association between DRSCA and DRQoL in this study was not significant, which is not in accordance with a study that found that DRSCA were positively associated with health related quality of life (Chen et al., 2017; Wang et al., 2011), maybe due to the different measures for quality of life. In our measure, the perception of the impact of diabetes on life was measured. The management of diabetes is a challenge, especially for elderly people. In our study, most of the participants were elderly people and the medication care, SMBG and insulin injections make them seek the help of their families or health care staff and this makes them more dependent on others. Therefore, the participants felt diabetes impacted on their life and DRSCA did not change the perception of that impact. Diet therapy is a very important treatment in controlling the disease. In addition, diet is also an important factor in preventing T2DM; a review of meta-analyses showed that increases in red and processed meat intake over time were associated with risk of developing T2DM (Neuenschwander et al., 2019; Pan et al., 2013). The participants felt DRSCA impacted on their life domains, including the daily diet therapy. To maintain the pleasure of eating, an individual's food preferences should be considered when planning nutrition therapy, thus a tailor-made diet should be created (Khazrai et al., 2014). The nutrient ratio also should be considered as it has recently been indicated that the intake of polyunsaturated fatty acids was more beneficial for the long-term health of people with T2DM when compared to total carbohydrates (Jiao et al., 2019).

The relationships between DRSCA and DRQoL are still open to discussion. However, DRSCA have a positive influence on subjective well-being through the improved disease condition. Although the participants felt that diabetes impacted on their lives in terms of DRSCA, they could finally feel well-being after the restriction of life. The disciplined life of DRSCA was positive from the long-term perspective. People should be motivated to take the initiative to perform DRSCA and sustain them. Finally, performing DRSCA well not only produces positive effects for physical health but also positively affects SWB.

This study first investigated how DRSCA related to resilience. The finding indicated that the variance of resilience accounted for by DRSCA was not

statistically significant after adjusting covariates. Therefore, researchers should also consider other factors that could promote resilience, like peer support (Zhao et al., 2016). In addition, resilience can be supported and enhanced by employing and exploring psychological, social and physical resources (Chandler et al., 2015).

Besides DRSCA, we also have other new findings and found resilience to be significantly correlated to subjective well-being. He et al. (2013) indicated that psychological resilience was significantly correlated with SWB among burn victims. In addition, high resilience means better coping adaptation and higher resilience is strongly related to psychological well-being (Christopher, 2000). Ezeamama et al. (2016) thought that strategies that enhance resilience in older individuals could reduce excessive health care utilization and increase subjective well-being, which translate to better health outcomes. This finding supplements the results of previous studies that resilience was prone to be associated with increased positive health in different disease groups (He et al., 2013; Christopher, 2000; Ezeamama et al., 2016). Therefore, this finding adds the new knowledge that resilience could improve SWB among people with T2DM. In this study, the importance of the role of DRSCA in reducing perceived stress and improving SWB could be applied in diabetes care practice. The finding should also be enhanced by further support from evidence from clinical practice and further studies in multi-cultural environments.

In summary, the main findings of this study showed that objective support, support utility and optimism were associated with subsequent DRSCA over three months, and DRSCA were associated with resilience in relation to positive health and with stress in relation to negative feelings.

6.2   The validity and reliability of the study

Validity and reliability were considered in this study. In the review phase, the method included a systematic review with a meta-analysis. In the empirical study phase, a survey at two time points was used. In the following chapters, the validity and reliability of this study are examined from the point of view of sampling, data collection and data analysis.

6.2.1   The validity and reliability of the systematic review

In the systematic review, a meta-analysis method was conducted to pool the effects of RCTs in order to gain increased power in the quantified synthesis.

In the systematic review, a range of commonly used databases were searched, including MEDLINE, EMBASE, CINAHL, PSYCINFO and Web of Science, in order to find more related articles. The selected process included identification, screening, eligibility and inclusion. The studies that met the inclusion and exclusion

criteria were selected based on the PICOS elements (O'Connor et al., 2008). The study selection was conducted based on PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) to ensure validity.

Quality appraisal of the selected studies was conducted by two reviewers and independently evaluated according to the Cochrane Collaboration tool for assessing the risk of bias in randomized trials (Higgins et al., 2011). This process involved two reviewers to make sure that the quality of the selected studies was evaluated adequately and consistency. Most of the included studies in the systematic review were middle or high quality and ensured the validity and rigor of the synthesized results. Biases can lead to the incorrect estimation of an intervention's effect. Less rigorous studies may overestimate the effects. Therefore, the assessment of the bias of the included studies ensured the synthesized effects (see Figure 10). The data for the meta-analysis was extracted and recalculated from the included articles following the guidelines from the Cochrane handbook (Higgins & Green, 2011).
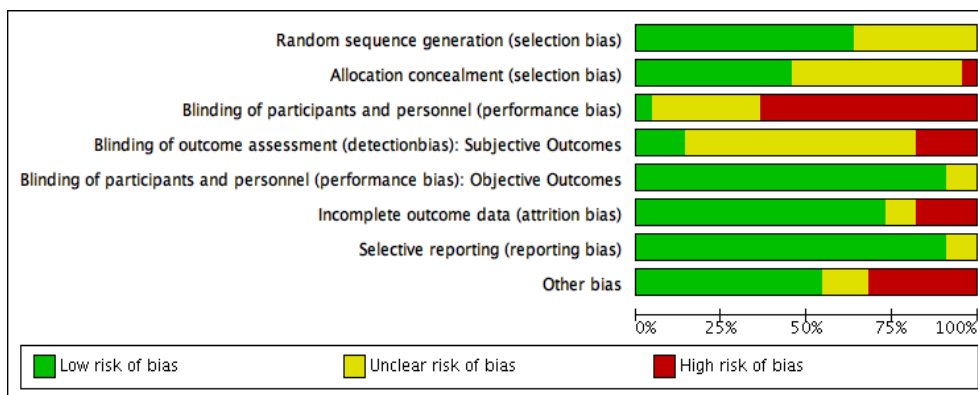
Figure 10. Summary of risk of bias of these included studies (updated 2015 April-2018 December)

Data synthesis

The data synthesis was conducted based on the guidelines in the Cochrane handbook (Higgins et al., 2011). In order to make the process more robust, we also contacted the first author in order to consult her or him about the necessary information for meta-analysis if it was not detailed in the published article.

Ideally, in a meta-analysis, the studies being pooled should be conducted in the same way, but the ideal is not usually fully met in reality. Therefore, the heterogeneity needed to be tested in the meta-analysis. The I^2 statistic was tested and over 50% of the selected studies were considered to have significant heterogeneity (Schroll et al., 2011).

Another consideration is publication bias as positive results are usually favoured for publication by journals. Publication bias was examined in order to see if the included studies in the review had publication bias, which was tested by using Egger's test and Begg's tests. The systematic review showed that there was no publication bias among the included studies. Therefore, the synthesized results are representative of the study topic in these published articles and the conclusion can be generalized to this population.

6.2.2 The validity and reliability of the instruments, data collection and analysis in the empirical study

In the empirical study, the validity and reliability of this study with structured questionnaires is examined in two parts: (1) the instruments and (2) the sampling, data collection and data analysis.

6.2.2.1   The validity and reliability of instruments

The validity of a measure is the extent to which it measures its purpose. The reliability is the extent to which a measure is consistent and reproducible. The closer the reliability coefficient or the variance explained by items is to 1.0, the better the validity and reliability are (Polit &Beck, 2010). There are nine scales used in the survey of the study and eight scales among these scales have been used worldwide and have good validity and reliability (details are given in Chapter 4 'Materials and methods', in Section 4.3's data collection section: 'Instruments'). Cronbach's alpha coefficient was used to test the internal consistency of the items in each scale in this study. These widely used scales have good reliability; Cronbach's alpha coefficients of 0.70 or >0.60 indicate the lowest acceptable threshold before an instrument was used. It was acceptable for the Cronbach's alpha coefficients of scales to range from 0.64 to 0.94 (AGREE Collaboration, 2003). In the study Cronbach's alpha ranged from 0.64 to 0.94 (see Table 9). A Cronbach's alpha over 0.8 is considered good and over 0.9 is considered excellent (Tavakol & Dennick, 2011). The reliability of these scales was tested and shows well in these original scales (see Table 9).

Table 9.   Cronbach's alphas for the scales in this study

Scales	Variables tested	Number of items	Cronbach's Alpha in this study
Diabetes self-management scale (Xu et al., 2008)	DRSCA	8	0.64
Perceived stress scale (Cohen et al., 1983)	Perceived stress	10	0.90
Zung Self-Rating Anxiety Scale (Zung, 1971)	Anxiety	20	0.78
Fatigue scale (Chalder et al., 1993)	Fatigue	14	0.87
Resilience scale (Drs. Campbell-Sills and Stein 2007; Connor & Davidson 2003)	Resilience	10	0.94
WHO-5 well-being scale (Bech 1996, 2003)	Subjective well-being	5	0.84
ADDQoL(Kong et al., 2011; Bradley & Speight, 2002)	DRQoL	19pairs	0.90
Social support rating scale (SSRS) (Xiao, 1994;1999)	Social support	10	0.71
Single-item optimism scale based (Kemper et al, 2011)	Optimism	1	Not appropriate

Note: ADDQoL = Audit of Diabetes Dependent Quality of Life

The instruments above have been indicated to be valid in previous studies (included using content validity, construct validity, criterion validity or concurrent validity and convergent validity) and reliable (Xu et al., 2008; Cohen et al., 1983; Zung, 1971; Chalder et al., 1993; Campbell-Sills & Stein, 2007; Connor & Davidson, 2003; Bech, 1996; 2003; Kong et al., 2011; Bradley & Speight, 2002; Xiao, 1994; Kemper et al., 2011).

In addition, a survey is one of the most feasible data collecting methods. Self-report instruments in the method can offer actionable information (Stirratt et al., 2015). Another consideration in this study was that optimism was measured using a single item. For the validity of a single-item optimism scale, combining it with an objective measurement will make future studies more valid. The reliability of the scales used in this study was tested in terms of internal consistency. The validity of these scales was based on the previous studies and had been proven to have good validity.

Completing a whole questionnaire including these scales needed up to 50 minutes. The answering time varied between 30 and 50 minutes. Some of the participants quit halfway through completing the questionnaire, when they were tired with the long questions. In the future, the efficiency of the questionnaire could be increased by shortening and validating the survey questionnaire.

6.2.2.2 Validity related to the sample, data collection and analysis

In the empirical study, the study sample should be representative of the population. The external validity is the degree to which the observed relationships are generalizable (Polit & Beck, 2008). The sample in this empirical study was small and it is from one district of China. However, as the sample had three hundred and ten participants it was adequate for multiple regression analysis according to the sample size calculation in software. Therefore, this study could produce a meaningful conclusion and provide insights into the associated factors of DRSCA from multiple perspectives based on these results. But the generalization of the results should be considered with caution.

Regarding the sample size, it could have been possible to make stronger conclusions about the association of DRSCA with the background information and outcome information if it had been bigger. However, these samples cover the diversified background demographic information: the gender ratio and mean age in this study were consistent with an earlier study among people with T2DM conducted in this area (Su et al., 2017). Thus, the study could produce meaningful conclusions and provide insight into the associated factors of DRSCA from multi-perspectives based on these results. Another consideration was that some people with T2DM were lost to follow-up (about 38%) over the three months. The potential impact of loss to follow-up on the estimate in this study cannot be excluded. There are no universally agreed criteria for acceptable follow-up rates in RCTs or cohort studies (Fewtrell et al., 2008). In RCTs, over 20% loss of follow-up poses threats to validity (Fewtrell et al., 2008). It has been suggested that the acceptable follow-up rates in epidemiological cohorts range from 50 to 80%, although their effectiveness has not been tested in most cases (Kristman et al., 2004; Babbie, 1973). In the present study, the bias caused by the loss of follow-up was judged to not be substantial as there was no statistically significant difference in the demographics and health information of those participating the first time and those participating at both time points.

The data in the empirical study consisted of surveys of people with T2DM at two time points. The data at time 1 were collected by a paper version of the questionnaire, collected face to face by the researcher and/or trained research assistants. To make sure of process consistency, the research assistants were trained in explaining the questionnaire questions, coding, and the ethics of data collection and its procedures. This ensured the consistency in the instruction regarding questionnaire responses and the process of data collection. The trained research assistants read and explained the questions in the questionnaires when needed. Thus, the participants could ask when they did not understand a question in the questionnaire. The interaction and conversation between research assistants and participants helped create a harmonious environment.

At time 1 of the survey, 251 volunteers completed valid questionnaires in this study, and 155 participated at time 2. Only information about DRSCA was collected at time 2. Although surveying people by telephone is convenient and people are more likely to be contacted by phone compared to a home visit or travelling by themselves, we noticed the limitation of data collection by phone at time 2: some participants had some questions and felt it was not convenient to ask for an explanation, which may have caused inaccuracy or perfunctory replies. It is suggested that if the time and budget are adequate, data collection at follow-up should be collected by home visits, which may reduce the risk of perfunctory replies.

In the empirical study, the data was first input into an Excel worksheet, and the preliminary calculation was done and then transferred to statistics software. The transfer errors were checked for and removed. Missing data needed to be deduced and filled in by special methods in order to reduce the gap between the data analysis method and practical applications. The missing data amounted to less than 5% in single variable, except for BMI, SBP and DBP (where it was 12%-15%), and was dealt with using the values EM method, which is an iterative method for computing the maximum likelihood or the maximum a posteriori estimates of parameters in statistical models. Regression analysis was conducted to explore the association between DRSCA and outcome information. Compared with the standard regression estimates of associations, the estimates yielded by hierarchical regression had improved precision (Richardson et al., 2015). The data analysis was conducted by the researcher with the consultation of a statistician.

There are some limitations to be considered. First, the association is the premise of causation relationships. However, the cross-sectional design is unable to identify causal relationships (Causation and Experimental Design, 2006). Future intervention design can determine the causal relationships between DRSCA and positive health and negative feelings, as well as the background information. Second, the variance of the dependent variables was not explained by the high percentage. More exploration of other factors that may relate to negative feelings and positive health is needed. Third, previous study have provided information about the association of DRSCA with HbA1c and lipid profiles (Rosal et al., 2011) and this study only examined the association between DRSCA and positive health. An analysis that including HbA1c and lipid profiles would provide more information in future research. Finally, although self-reporting measures are one feasible data collecting method and can provide actionable information (Stirratt et al., 2015), the self-report survey is prone to biased responses (Johnson et al., 2017). Combining both subjective and objective measures in future prospective research is suggested.

6.3 Implications for practice

This study firstly systematically reviewed the theory-based self-management intervention with people with T2DM in RCTs. This systematic review also implied the people with T2DM should participate more in their diabetes self-management. To provide more information in order to promote DRSCA, the empirical study explored the associated factors of self-care from multiple perspectives, including considering background information and outcome information. There are five main implications for future practice.

- Theory-based self-management education should be emphasized in self-management education in practice. In clinical practice, it is suggested that self-care education is conducted using theory-based education in order to enhance the effects. The robust evidence confirmed the suggestion of other researchers (Glanz & Bishop, 2010, p. 399; Craig et al., 2013) that health-promotion interventions based on theories are more likely to produce larger effects than those lacking a theoretical base. Theory-based self-management education was effective on DRSCA. Choosing the proper theories based on the different cultural background, and using the components of the theories to design the educational intervention and outcome is more likely to improve the effects of education in behaviour change of patients. The educational intervention can be conducted in diversified teaching format corresponding with the theory. The teaching format can be a small group education, small group discussion, home visit, skills training and modelling, problem-based learning, self-supervision of daily practice and so on. In addition, the results about the diabetes teaching style in the systematic review showed that educational staff should also be trained in self-management education and that the people with T2DM should be more involved in their DRSCA.

- More information is needed in order to encourage people with T2DM to promote DRSCA. The findings in this study supplement the results of previous studies about the influence of anxiety and depression on DRSCA (Alavi, Molavi & Eslami, 2018; Devarajooh & Chinna, 2017; Pandit et al., 2014). The study implied that DRSCA can be a way of managing negative feelings, such as perceived stress, and improving positive health, such as subjective well-being, in future practice. This information expanded the knowledge of how to develop effective self-care education.

- The findings of the study can also be applied in clinical practice. Consider the benefits of DRSCA besides the biological effects constitutes an important part of promoting DRSCA in diabetes education. The

evaluation of positive health and negative feelings, and giving feedback to patients after they have carried out DRSCA can be effective in improving DRSCA.

- The result highlighted the important role of objective support and support utility in facilitating the DRSCA of people with T2DM, which should draw attention to providing the actual supporting resources and encouraging patients to make full use of them. In future practice, health education or a self-management education programme should involve the significant others of people with T2DM in order to promote their awareness, responsibility and cooperation, as well as to gain support from health organizations. To ensure the access to support from a health organization, more efforts should be made on building consultation and guiding services in hospitals and communities. Enabling people with T2DM to receive more support resources and be optimistic can not only grant them have better SWB but also increase the level of DRSCA. This could be an economical way of promoting the DRSCA of people with T2DM and maintaining a harmonious environment for health care.

- Encouraging optimism is also beneficial for the DRSCA of people with T2DM. In clinical practice, the effects of guiding people with T2DM in self-care will be enhanced when considering the different levels of optimism and social support of people with T2DM. An evaluation of the optimism of people with T2DM facilitates providing corresponding help. This finding also implies that people with T2DM have different levels of social support and optimism; therefore, it is necessary for health care professionals to take these individual differences into account in order to improve efficiency when providing self-care education.

6.4 Suggestions for future research

Based on the results, the suggestions for nursing research can be presented as follows:

- The systematic review with the meta-analysis synthesized theory-based diabetes self-management education in a comprehensive way. In future research, it is suggested that theory-based education should be considered when aiming to design interventions to improve the outcomes of education among people with T2DM. In the research which targets the effects of diabetes self-care education, it is suggested that people with T2DM should more actively perform the DRSCA. And for perceived benefits that are associated with DRSCA (Luo et al., 2015), it is helpful

to provide more information that can encourage people with T2DM to increase their involvement in DRSCA. It is suggested that future research should develop a self-management education programme with the adequate involvement of people with T2DM.

- The finding of the empirical study showed that the DRSCA level was not high, which can remind health care staff that both understanding multiple factors associated with DRSCA and promoting DRSCA are still of great importance. The empirical study confirmed the association of DRSCA with reduced perceived stress and improved subjective well-being after controlling for demographic information and health information. This information may be helpful for the further development of diabetes self-care education programmes. In addition to the empirical studies, it is suggested that experimental study is used in future research to confirm these causalities of these findings. Moreover, including SWB and perceived stress as evaluation indicators of DRSCA is suggested. On the other hand, it is also suggested that DRSCA form an important factor in research conducted on reducing perceived stress and increasing SWB.

- In future research about promoting DRSCA, it is suggested that various social supporting resources (e.g. family, the neighbourhood, health care staff, heath organizations and the community) are important and people with T2DM should also be encouraged to utilize these resources to enhance education effects and the level of DRSCA.

- In addition to objective support and support utility, the results of this study indicated the important role of optimism in DRSCA. This is new knowledge added to research aimed at improving DRSCA. Evaluating the level of the dimensions of social support and optimism is helpful in designing programmes for improving DRSCA. People with T2DM are at risk of developing microvascular and macrovascular complications, which can be prevented or reduced by DRSCA. However, compliance with DRSCA is a major challenge for people with T2DM and health care providers, and poor adherence to the required DRSCA has been reported nationally and internationally (Hendrychova et al., 2013; Zhou et al., 2013). Considering that people with diabetes are responsible for daily DRSCA, it is important to explore the internal strength of these people with T2DM. In addition, the study implies that enhancing internal strengths (like optimism) in future research will be beneficial for the DRSCA of people with T2DM. As optimism is not a variable that can be easily changed, measures to promote optimism need to be explored in future studies.

- The topic of the study about the factors associated with the level of DRSCA is of international importance. The demographics vary in different countries worldwide. International research collaboration will provide more of an evidence base for encouraging and improving DRSCA among people with T2DM.

7 Summary

The literature review in the study provides new information for promoting diabetes self-care activities. The study also provides encouraging information with which to promote DRSCA by exploring factors associated DRSCA. The results in the empirical study implied the necessity for considering the role of emphasizing objective support and utility. In addition, as an important inner strength and supporting resource, optimism (which involves higher levels of coping skills) and social support (which facilitates behavioural change and maintenance) directly showed their significance for patients with T2DM in engaging in self-care activities.

These results may contribute to further studies on the factors associated with diabetes self-care, and help health care staff and patients when considering the role of optimism in improving DRSCA. In the outcome information, the results provided the evidence that DRSCA were associated with one component of negative feelings, perceived stress, and one comment of positive health, SWB, which may provide very useful information for motivating people with T2DM to take the initiative to perform and sustain DRSCA. Alternatively, it also may arouse the attention of researchers and health care staff and encourage them to reduce negative feelings and improve positive health. In addition, the results provided the first step and preliminary evidence for future research entering into interventions aimed at testing their causal relationships. The information may provide new knowledge for health policies and for health professionals in diabetes care. It may also arouse the attention of health researchers and staff and encourage them to provide more encouraging information with which to promote the DRSCA of people with T2DM in the health and nursing field. This implication of result for promoting DRSCA may apply to China, as well as to worldwide.

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8 Appendices

Appendix1: Demographic information and health information questionnaires

1.   Age (in years).
2.   Gender (1) Male (2) female,
3.   Education (less than college education/associate degree or above),
4.   Family history of diabetes (yes/no),
5.   Have you had symptoms before diagnosis? (yes/no),
6.   Duration of diabetes since diagnosis (in years)
7.   Have you received standard diabetes education before the survey? (yes/no)
8.   Living alone (yes/no)
9.   Smoking (yes/no)
10.   Drinking alcohol habit (yes/no)
11.   Complication (yes/no)
12.   Hight ( ) cm, weight ( ) kg.
13.   Systolic blood pressure ( ) MmHg
14.   Distolic blood pressure ( ) MmHg

Appendix 2: The association of covariates with negative feelings and positive health.

	Negative feelings (n=248)			Positive health (n=246)		
	Perceived stress Mean (SD) t	Anxiety Mean (SD) t	Fatigue Mean(SD) t	Resilience Mean(SD) t	SWB Mean(SD) t	DRQoL Mean(SD) t
Gender						
Male	13.17(6.72) -2.34*	38.98(8.66) **-3.96***	7.15(3.88) -0.14	31.28(5.83) 1.93	75.40(15.34) **2.50***	-1.88(1.62) -0.38
Female	15.18(6.58)	43.16(7.69)	7.22(3.85)	29.84(5.73)	70.24(16.94)	-1.81(1.31)
Age in years						
<65	14.67(6.84) 1.84	40.65(8.38) -0.40	7.07±3.79 -0.60	30.92(5.74) 0.89	74.42(16.00) 1.52	-2.02(1.59) **-2.38***
≥65	13.06(6.42)	41.09(8.70)	7.37±3.99	30.24(5.94)	71.22(16.47)	-1.59(1.28)
Education						
< College level	14.38(6.64) 1.34	40.89(8.34) 0.23	7.39±3.84 1.46	29.95(5.91) -3.37**	72.04(16.98) -1.88	-1.74(1.45) **2.04***
≥College education	13.07(6.93)	40.61(8.99)	6.57±3.90	32.79(4.99)	76.52(13.24)	-2.19(1.56)
Living alone						
Yes	14.23(6.03) 0.23	41.29(8.19) 0.48	7.27(3.69) 0.19	30.02(5.85) -0.93	73.21(14.65) 0.03	-1.79(1.41) 0.33
No	14.00(6.92)	40.68(8.59)	7.14(3.92)	30.84(5.81)	73.14(16.70)	-1.87(1.52)
Disease duration						
5years	14.42(6.71) 0.59	39.13(8.12) **-2.16**	6.84(4.03) -0.93	31.41(4.74) 1.39	75.39(14.14) 1.50	-1.70(1.57) 1.14
≥5years	13.88(6.74)	41.61(8.57)	7.34(3.78)	30.30(6.24)	72.10(17.07)	-1.93(1.44)
Have symptoms prior to diagnosis						
Yes	14.06±6.74 0.32	40.57(8.14) -0.53	7.09(3.53) -0.44	30.81(6.23) 0.49	72.09(16.07) -1.20	-1.80(1.55) 0.63
No	14.04±6.73	41.14(8.9)	7.31(4.27)	30.44(5.23)	74.60(16.41)	-1.92(1.41)
Family history of diabetes						
Yes	13.98±6.89 -0.10	40.96(8.54) 0.16	7.82(3.82) 1.5	30.75(5.81) 0.16	73.42(15.45) 0.15	-1.87(1.54) -0.86
No	14.08±6.68	40.77(8.49)	6.95(3.86)	30.62(5.84)	73.06(16.54)	-1.84(1.48)
Have received SSCE						
No	14.03(7.48) -0.07	41.03(9.24) 0.45	7.52(3.87) 1.61	30.35(5.90) -0.95	74.82(16.43) 1.89	-1.88±1.44 -0.40
Yes	14.09(5.58)	40.54(7.40)	6.73(3.82)	31.06(5.70)	70.88(15.74)	-1.81±1.56
Social support						
Low	14.07(6.49) 0.04	41.13(8.90) 0.61	7.21(3.97) 0.12	29.38(5.88) **-3.64***	69.98(16.43) **-3.23****	-1.62(1.42) **2.60***
High	14.03(6.99)	40.48(8.04)	7.14(3.76)	32.02(5.45)	76.54(15.30)	-2.10(1.52)

Note. SD = standard deviation. SWB = subjective well-being. DRQoL = disease related quality of life. *P<0.05; **P<0.01; ***P<0.001; SSCE = standardized self-care education. DRSCA = diabetes-related self-care activities. Modified from Original Publications II- III.

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