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Chapter 4

Qigong for the Management of Type 2 Diabetes Mellitus

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Additional information is available at the end of the chapter

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Abstract

Type 2 diabetes mellitus (T2MD) is a complex, chronic, metabolic disease with hyperglycemia arising from insulin resistance, progressive pancreatic beta cell failure, insufficient insulin secretion and increased hepatic glucose output. In the Chinese medicine theory, T2DM is often referred to as a form of *Xiao Ke* (消渴) or "wasting-thirst disorder." Genetic, dietary, lifestyle and environmental factors play a role in T2DM. People with a family history of diabetes or who are obese are at the highest risk of developing the disease. T2DM is often associated with hypertension, dyslipidemia and atherosclerosis and if not managed can lead to complications including cerebrovascular accident, peripheral vascular disease and nephropathy. T2DM can be well managed with biomedical and Chinese medicine treatment approaches. Lifestyle changes including appropriate diet and exercise are paramount in managing T2DM. Regular Qigong practice can be a beneficial part of one's exercise routine for T2DM self-care. Qigong exercise has shown promising results in clinical experience and in randomized, controlled pilot studies for affecting aspects of T2DM including positive associations between participation in Qigong and blood glucose, triglycerides, total cholesterol, weight, BMI and insulin resistance. This chapter looks at how traditional Chinese medicine (TCM) views diabetes as well as new understandings of how Qigong can support the management of T2DM.

Keywords: medical Qigong, Qigong exercise, type 2 diabetes management, *Xiao Ke*, acupuncture and oriental medicine, traditional Chinese medicine (TCM) nutrition natural medicine, integrative medicine, Yi Ren® Qigong

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1. Introduction

Qigong (pronounced "chee gung") is the authentic cultivation of "Qi" (or "Chi") which means "vital energy of the body." In Chinese, "gong" means the skill and achievement cultivated through regular and disciplined practice. Qigong is an important part of traditional Chinese medicine (TCM) for maintaining wellness, preventing disease and treating disease through self-care practice or by receiving external Qi from a Qigong therapist. In ancient China, the practice of authentic Qi cultivation was associated with the theory of energy flow within the body, described in the *Suwen* (Basic Questions) of the *Huangdi Neijing* (The Inner Classic of the Yellow Emperor) and with the discovery of acupuncture meridians as described in the *Ling Shu* (The Spiritual Pivot). The practice of Qigong combines breathing, movement and meditation and therefore is often classified by Western providers under the category of "mind/body medicine." Qigong is an ancient technology of mind-body management and the refinement of one's vital energy for optimal health and for personal development [1]. Previous studies suggest that Qigong may be a beneficial adjunct treatment for individuals with type 2 diabetes mellitus (T2DM) and have shown consistent and statistically significant positive associations between participation in Qigong and blood glucose, triglycerides and total cholesterol [2]. Qigong has also been associated with trends in weight loss, reduced BMI and improved insulin resistance in people with T2DM [3]. Systematic reviews have found support for a role of Qigong in the management of T2DM [4, 5].

T2DM is a complex, chronic metabolic disease with hyperglycemia arising from insulin resistance, progressive pancreatic beta cell failure and insufficient insulin secretion. According to the International Diabetes Federation (IDF), more than 371 million people worldwide have diabetes and over 550 million people are projected to have diabetes by 2030 [6]. In adults, T2DM accounts for about 90–95% of all diagnosed cases of diabetes [7]. Common symptoms of T2DM include excessive thirst, frequent urination, excessive hunger, fatigue, weight loss, blurry vision, slow-healing sores, frequent infections (bacterial, yeast, or fungal overgrowths thrive on excess sugar in the body) and areas of darkened skin, usually in the armpits and neck which can be a sign of insulin resistance [8]. T2DM is often associated with hypertension, dyslipidemia and atherosclerosis and if not managed can lead to complications including stroke, cardiovascular disease, peripheral vascular disease, neuropathy and kidney failure [9]. Concurrent hypertension with diabetes significantly raises the risk of coronary artery disease, stroke, retinopathy and sexual dysfunction [10]. According to the American Diabetes Association, having diabetes nearly doubles the chance of having a heart attack [9]. Diabetes causes more deaths a year in the United States than AIDS and breast cancer combined [11]. In 2010 in the United States alone, about 73,000 lower-limb amputations were performed on adults with diabetes and peripheral vascular disease [12]. T2DM can substantially diminish quality of life, decrease life expectancy and increase health problems and healthcare costs. A study reported that the estimated total economic cost of diagnosed diabetes in 2012 in the United States was $245 billion. This estimate highlights the substantial burden that diabetes imposes on society [13]. The incidence of T2DM continues to rise by epidemic proportions and has emerged as a global health crisis.

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2. The pathophysiology and etiology of type 2 diabetes mellitus

The exact cause of T2DM is unknown, but researchers tend to agree that genetic, dietary and lifestyle factors play a role in T2DM [14]. People with a family history of diabetes or who are obese are at the highest risk of developing the disease [8, 9]. Genes associated with T2DM have often been linked to pancreatic beta cells and impairments in beta cell mass and in insulin secretion [15]. The risk of developing T2DM increases when a parent or sibling has the disease [8]. Because population-level genetic changes take many generations to occur, the epidemic proportions of T2DM are almost certainly primarily a consequence of recent environmental changes; nonetheless, T2DM does appear to occur preferentially in genetically predisposed populations, which suggests that the effects of preexisting susceptibility genes have been triggered by recent shifts in nongenetic factors [16]. The environment has great biological impact on human health and disease. There is a growing body of literature suggesting a role for epigenetic factors in the complex interplay between genes and the environment, particularly in common complex disorders, like T2DM [16]. Studies have demonstrated that nutrients can reverse or change epigenetic phenomena such as DNA methylation and histone modifications, thereby modifying the expression of critical genes associated with physiologic and pathologic processes [17].

An improper diet (high in sugar, carbohydrates and fats) and inadequate exercise are contributing factors in the onset of T2DM. The common use of high-fructose corn syrup in foods over the past hundred years has correlated closely with the increasing prevalence of metabolic syndrome, obesity and T2DM, possibly because fructose can alter satiety and lead to the urge to eat more than one ordinarily would [18]. Fructose may also lower metabolism and alter how fat is stored and give rise to the buildup of visceral fat [18]. Fat distribution in the body is important; if fat is stored primarily in the abdomen as opposed to the hips and thighs, there is a higher risk of developing fatty liver, insulin resistance and T2DM [8, 9, 19]. Fatty liver is associated with metabolic syndrome and insulin resistance [9, 19]. One can have fatty liver and not be overweight. If one is overweight and has acquired insulin resistance, losing weight and lowering blood glucose levels through exercise and dietary changes can improve insulin resistance [9, 19]. Exercise is important for regulating one's body weight. Physical activity acts like insulin in that it uses up glucose. Physical activity also makes the body's cells more sensitive to insulin [8].

Obesity is a major risk factor in T2DM because obesity can lead to metabolic disorder and insulin resistance [14]. Many obese people do not develop diabetes, but most people who have T2DM are obese. It is important to point out that people who are not overweight can develop T2DM [11, 15]. Sometimes people who do not appear to have noticeable symptoms may have T2DM and be undiagnosed for many years until complications arise [8]. A high body mass index (BMI) and insulin resistance are primary cofactors in T2DM, but some researchers suggest that the disease could be linked to the pancreatic beta cells themselves, whether due to a reduction in the number of insulin-secreting cells or due to an impairment of beta cell function [15]. In a healthy person, the pancreatic beta cells secrete insulin into the bloodstream and the insulin circulates and enables sugar to enter into the body's cells for the production of

energy [8]. Insulin lowers the amount of sugar in the bloodstream and as the sugar level drops, the pancreas also decreases insulin secretion [8]. In T2DM, this process is impaired because as sugar builds up in the bloodstream the pancreatic beta cells release more insulin but over time the beta cells cannot manage the high levels of blood sugar and they start to lose their function [8].

Excess sugar in the blood can affect nerve conductivity by impairing the tiny blood vessels that nourish the nerves leading to neuropathy or sensations of tingling, numbness, burning or pain, especially in the extremities. Over time it can lead to the loss of blood flow to the extremities and develop into gangrene [8]. One of the early signs of nerve and blood vessel damage from T2DM in men is erectile dysfunction [8, 9, 20]. The damage to tiny blood vessels can also lead to retinopathy, blurry vision, eye damage and even blindness [8, 9]. Similarly, high blood glucose levels can injure the delicate blood vessels that make up the filtration system of the kidneys which can lead to irreversible damage and end-stage kidney failure that requires dialysis or a kidney transplant [8, 9].

3. Traditional Chinese medicine (TCM), etiology and pathogenesis of diabetes

In the view of traditional Chinese medicine, the etiology and pathogenesis of diabetes shares much in common with biomedical perspectives. Both traditions recognize that diabetes can arise from one's inherited constitution, which in biomedical terms is linked to one's DNA and in Chinese medicine is understood as one's prenatal or "preheaven essence." In other words, it is the vital energy and "Qi-information" one inherits from one's parents and ancestors as well as the amount of Qi-energy a person is equipped with before birth which carries with it one's potential for health and longevity. The etiology of diabetes can originate with preheaven kidney essence or kidney yin deficiency and weakness of the five zang organs that predispose a person to further imbalances such as spleen Qi deficiency and dampness [20].

Similar to biomedicine, it is important in TCM for practitioners of acupuncture and oriental medicine to think about the digestive function of the pancreas in the treatment of diabetes mellitus [20]. In the TCM theory, what was translated (or perhaps even mistranslated and perpetuated) long ago as "spleen" is often said to more closely resemble the pancreas [3, 21]. TCM explanations of the function of spleen Qi relate to digestion, namely the transportation and transformation of fluids, whereas the biomedical understanding of the spleen has nothing to do with digestion. The biomedical spleen plays a key role in the body's lymphatic and immune system. The TCM concept of spleen Qi actually more appropriately fits "pancreas Qi" and it is the function of the pancreas that is weakened and leads to diabetes [22]. For the purposes of congruency, the term "spleen Qi" can be taken to mean "pancreas Qi" throughout this chapter.

In biomedical and Chinese medicine perspectives, lifestyle behaviors are also important and can trigger diabetes. From a biomedical standpoint, epigenetics plays a role. Behaviors such as overeating of certain foods, environmental factors, a sedentary lifestyle, or the opposite—overtaxing the body with prolonged stress or overexertion, can turn on genes that lead to

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T2DM. Chinese medicine perspectives are similar in that "postheaven" choices or lifestyle behaviors can influence the onset and progression of T2DM. Improper diet, overeating of certain foods and overtaxing the body can weaken the Qi-energy and disrupt the balance of the zang (organs). Likewise, a sedentary lifestyle can weaken the Qi because not enough Qi is generated to invest in the strengthening of the body [23].

In Chinese medicine, moderation is key. Too much or too little of any one thing can disrupt Qi flow and balance, so just as a sedentary lifestyle weakens the body because it is too yin, a lifestyle that is too yang with a high level of activity that exceeds the body's resources can also weaken the body [23]. In particular, overworking and not balancing one's energy with enough rest or proper nutrition can deplete the vital energy. Chinese medicine also speaks of overindulgence in sexual activity which weakens the energy of the kidneys and depletes the essence. Prolonged stress and emotional imbalance are also factors that weaken the energy of the organs and the Qi, blood, yin and yang and create disharmony in the body that over time leads to disease.

Chinese medicine often refers to diabetes as Xiao Ke (消 渴), which is translated as "wasting-thirst disorder" and encompasses diabetes mellitus along with other endocrine or metabolic disorders that fit particular patterns with symptoms of a strong appetite and strong thirst (for example, Xiao Ke could refer to other biomedical diseases like hyperthyroidism). Xiao Ke can also refer to stages of diabetes including prediabetes and diabetic complications [20]. In other words, Xiao Ke is a general term which is not the equivalent of diabetes mellitus. Diabetes mellitus is now often referred to using the Chinese modern term Tang Niao Bing (糖尿病) which is literally glucosuria [20].

The diagnosis Xiao Ke Bing, or Xiao Ke Disease, is a group of symptoms related to diabetes that can be further differentiated. The traditional, San Jiao or "three burners" differentiation of Xiao Ke has been popular since the Song Dynasty and is still taught in acupuncture schools as a textbook TCM understanding of diabetes. However, the three burners' differentiation may not be complete, practical, or applicable in clinic now because there are additional symptoms and patterns that should be taken into consideration [20, 24]. Upper (burner) Xiao Ke was traditionally characterized as Xiao Ke with predominant thirst. Middle (burner) Xiao Ke was characterized by excessive appetite and heat and lower (burner) Xiao Ke was characterized by excessive and frequent urination [23]. In modern times, it is important to not give a TCM diagnosis and Xiao Ke differentiation only according to the predominance of excessive thirst, hunger, or urination. It is more appropriate to look closely at the whole body's system, symptoms and patterns and to take into account all the contributing factors including preheaven essence (congenital inheritance), postheaven lifestyle (diet, exercise and stress), as well as one's emotions and environmental stressors.

To provide an overview, the following are some common TCM pattern differentiations associated with T2DM from acupuncture and Chinese herbal medicine treatment perspectives.

The kidney is central to the Chinese medicine understanding of the pathogenesis of T2DM. The kidney stores the jing-essence or one's inherited, original reserves of vital energy. If one has constitutional kidney deficiency, one may already be deficient in yin and may be

predisposed to other organ imbalances. This is somewhat similar to saying that one's genes might set them up for epigenetic changes that can be triggered by certain exposures, lifestyle behaviors, or by prolonged stress or emotional imbalances. Overexertion (such as overworking without adequate rest) and overindulgence in sexual activity deplete the kidney yin and jing [25]. A main etiological dynamic in T2DM is kidney yin deficiency at the root which causes dryness heat symptoms as the branch [20, 25]. The relationship between yin deficiency and dryness heat is a circular mechanism because as dryness heat builds, it further consumes the yin fluids [25]. The hyperactive fire resulting from kidney yin deficiency flares upward, resulting in dryness of the lung and heat in the stomach, which combined with kidney yin deficiency, causes diabetes [25].

In addition, chronic kidney yin deficiency can diminish the generation of kidney yang. Combined kidney yin and yang deficiency can in the long run lead to kidney qi failure, making the kidney unable to regulate the exiting of body fluids and manifesting as the need to urinate directly after drinking [26].

In the Chinese medicine theory, the lung is responsible for the descending and distributing of lung Qi and is the upper source of the circulation of water or body fluids [25, 26]. Heat and dryness that consume the yin fluids can injure the lung which then cannot function as well to distribute body fluids and this can present as thirst. Because the lung Qi is responsible for regulating the body's water passages, if lung Qi fails to do this, water and fluid will go directly downward leading to excessive and frequent urination [25, 26].

The liver also plays a central role in the Chinese medicine view of the pathogenesis of T2DM. It is a fairly recent understanding in biomedicine that emotional stress can trigger the onset of T2DM and it is recognized that stress exacerbates high blood glucose levels in people with T2DM [14, 26, 27]. In Chinese medicine theory, the liver is responsible for regulating the smooth flow of Qi throughout the body. Liver Qi stagnation results from stress or excessive emotions and is particularly associated with anger, frustration, irritability, or depression. Constraint and heat from stagnating liver Qi can cause the liver to overact on the middle Jiao which weakens the pancreas Qi and engenders dampness and can also cause too much heat in the stomach, leading to an excessive appetite. Liver Qi stagnation can engender heat in the blood and cause blood stagnation. Blood stagnation impairs fluid distribution and can be accompanied by phlegm stagnation. Heat turns into dryness heat and consumes the yin and can lead to a deficiency of yin in the liver, kidney and stomach [20]. When the yin cannot properly nourish the luo-collaterals, or smaller branches of the body's main meridians, the luo-collaterals can be damaged. In addition, spleen Qi deficiency and the accumulation of dampness or phlegm can lead to the stagnation of phlegm and Blood in the collaterals. Damage of the luo-collaterals manifests as diabetic complications such as hypertension, retinopathy, neuropathy, nephropathy and cardiovascular disease [20].

From a medical Qigong perspective the main causes of T2DM are associated with an imbalanced autonomic nervous system, weakened pancreas energy, low kidney energy and excess energy of the liver. This is based on clinical observation with internal Qi diagnostics, a process in which a trained Qigong practitioner uses medical Qigong techniques to perceive and assess a person's internal Qi-energy flow through the organs and associated meridians.

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During a randomized controlled pilot study conducted at Bastyr University in 2010, a particularly striking and common pattern found in patients with T2DM was a disharmony of Qi flow between the liver and pancreas [3]. With medical Qigong subtle energy-based observation, it was very clear to the evaluating medical Qigong practitioner in the 2010 study that the biomedical spleen is not a key player in organ patterns associated with T2DM, but the pancreas and its energy and function are a focal point of the disease. According to five element theory, the phenomenon of the liver (wood element) overpowering or overacting on the pancreas (earth element) [3] was the main dynamic. In addition, an underlying factor observed was a weak kidney or water element. These observations are in alignment with TCM theories about the role of the kidney and yin deficiency affecting the energetic function of other organs. Furthermore, the observation that in many cases of T2DM the role of the liver and its effect on the energetic function of the pancreas emphasizes the impact of stress in modern-day society on the liver energy, whether stress comes from inappropriate diet, lifestyle, the environment, or overwork.

This internal Qi-subtle energy-based observation may provide additional perspectives for TCM therapies for treating T2DM [3]. We have found that Qigong has synergistic effects with other modalities of TCM for treating T2DM. Qigong exercises that focus on boosting kidney and pancreas energy and relieving stress from the liver and autonomic nervous system can be particularly beneficial in managing T2DM [3, 27, 22]. In addition, the self-realization that arises through Qigong self-care practice can help people with T2DM become more aware of the underlying stressors and contributing factors in their condition and to make proactive lifestyle changes.

4. Medical Qigong

Medical Qigong is defined as the system of authentic Qi (vital energy) practice, which empowers the body to heal itself and to facilitate the healing process of others. It involves appropriate management and regulation of all energetic and informational communications and interactions within and without the body in the process of self-healing and healing others. Medical Qigong is another branch of traditional Chinese medicine.

Medical Qigong consists of two aspects of authentic Qi practices, namely internal medical Qigong and external medical Qigong. Internal medical Qigong refers to self-healing and self-care Qigong practice, or Qigong exercises practiced by oneself. Internal medical Qigong exercises include unique breathing methods, movements for specific health conditions, meditations with unique mudras and internal observations with specific energetic codes and images for healing health conditions. External medical Qigong refers to when a medical Qigong practitioner is facilitating the healing process of others. In external Qigong, the medical Qigong practitioner works with his or her client by cleansing and clearing unhealthy Qi, removing blockages or Qi stagnation from the client's energy field to promote healthy internal Qi circulation, or by projecting specific healing Qi into the energy field of the client and directing it to specific areas and systems of the body for restoring internal balance and harmony. The medical Qigong practitioner may also transmit universal healing energy and energetic intelligence to his or her client for improving health conditions and restoring well-being.

4.1. The history and development of medical Qigong

The term "medical Qigong" was made popular by Guizhen Liu in the 1950s and became part of Chinese mainstream culture. Mr. Liu was famous for teaching *nieyang-gong* (innernourishing *qigong*) and at that time medical Qigong became the standard term for healing and improving health conditions with authentic Qi cultivation, regulation and management.

According to historical documents, Qigong has been practiced and studied for about five thousand years in China. The following statement was recorded in the Yellow Emperor's Classic of Internal Medicine, *Suwen* Chapter one: "If your mind is calm and peaceful and able to reach a state of emptiness and you hold your spirit within and your authentic Qi flows easily and freely, how could illness arise?" (The reign of the Yellow emperor was 2690–2590 B.C.). An important part of the Yellow Emperor's Classic of Internal Medicine is the *Ling Shu*–Spiritual Pivot, which contains detailed information about the acupuncture meridians. The acupuncture meridians were discovered by Qigong practitioners in ancient times and can be identified with internal visual and experiential perception.

Lao Zi (601–531 B.C.), the founder or "father" of Daoism mentioned authentic Qi cultivation in his classic *Dao De Jing* (Classic on the Dao of Virtues). He emphasized that the way to obtain health was to "concentrate on authentic Qi cultivation and become more flexible." The famous philosopher Zhuang Zi, in his book *Nan Hua Jing* (third century B.C.), stated that "the immortals' breathing reaches down to their heels and the normal person's breathing to the throat." He emphasized the importance of breathing in the internal cultivation. Up to now, one of the commonly accepted definitions of Qigong is breathing exercise. *Xing Qi* refers to "moving the Qi." An early description of this type of Qigong practice, entitled "The Jade Pendant Inscription on *Xing Qi*" (sixth century B.C.), is shown here in **Figure 1**.

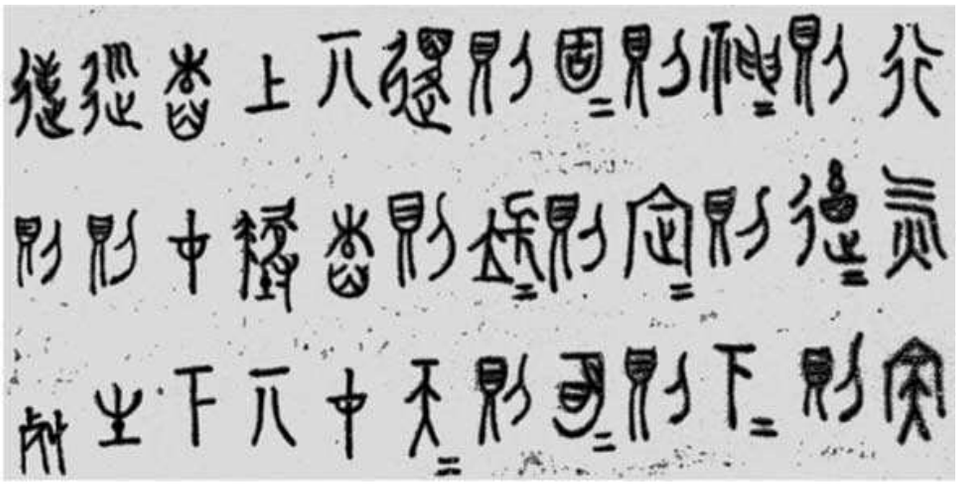


Figure 1. The Jade Pendant Inscription on *Xing Qi* (sixth century B.C.) [28].

The Jade Pendant Inscription on *Xing Qi* could be the earliest monograph on Qigong in Chinese history. It reads as follows:"In moving Qi, one breathes deeply and cultivates the authentic Qi within. If the authentic Qi is stored, it expands. When the authentic Qi expands, it descends down to the Dantian. When the authentic Qi becomes stable in the Dantian, it

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will solidify. When the authentic Qi is solidified, it will begin to sprout and move to the root of the Du meridian. After the authentic Qi has moved to the root of the Du meridian it will grow and rise up along the Du meridian. When it rises up to the top of the head, it will flow down along the Ren Meridian to the bottom of the torso. When the authentic Qi rises up to the top of the head, it reaches heaven. Heavenly, Qi functions from above and earthly Qi functions from below. Moving the authentic Qi around the Du and Ren meridians freely leads to vitality and longevity while adverseness to this leads to aging and death." *Jing Zuo* literally means"quiet sitting"or"sitting in silence"and refers to a meditation practice to achieve a peaceful and tranquil mind for internal observation, cultivation and realization. Medical Qigong has been practiced with documented results in China. For example, 156 different Qigong therapy methods for healing specific illnesses were described in an ancient book, entitled "Treatise on the Causes and Manifestations of Diseases" (610 A.D.) by Yuan-Fang Chao. In this book, Dr. Chao summarized 1729 cases of diseases from clinical experiences and pathologic observations and explained the symptoms of diseases and their causes as they relate to internal subtle energy flow. For treating diseases, the unique method of Yuan-Fang Chao was to give patients specific Qigong exercises for their self-healing and self-care.

It was during the Jin dynasty (265–420 A.D.) and the northern and southern dynasties (420–589 A.D.) that Qigong developed as a practice to prevent or correct disease through the transmission of healing Qi [29]. A medical Qigong therapist can emit his/her healing Qi to assist another person. This transmitted Qi has healing intelligence that can communicate with another person's Qi for the purpose of addressing specific health conditions [30].

5. The effects of medical Qigong on people with type 2 diabetes

A randomized controlled pilot study was conducted at Bastyr University in 2010 on the effects of Qigong on glucose control in type 2 diabetes [3, 27, 31]. In this study, a three-armed, 12-week randomized, controlled clinical trial compared the biological and psychological responses of Yi Ren Medical Qigong (YRMQ) with progressive resistance training (PRT) or standard care in patients with T2DM. The results on blood glucose control [31], perceived stress [27], body weight and insulin resistance [3] in people with T2DM were interesting and intriguing. Fasting plasma glucose, body weight, body mass index (BMI), insulin and perceived stress levels were recorded before and after the 12-week intervention. As shown in **Figure 2**, the plasma glucose levels indicated significant reductions in the Qigong group. In contrast, the plasma glucose levels showed an increase in both the PRT group and the control group, respectively [31].

The results of the preliminary study showed a very interesting phenomenon as shown in **Figure 3**: the PRT group participants demonstrated significant body weight loss and BMI decrease, but their insulin resistance increased; in contrast, the YRMQ group showed a smaller loss in body weight and BMI, but their insulin resistance decreased [3]. These results suggested that medical Qigong works with a different mechanism for the management of type 2 diabetes compared with PRT [3].

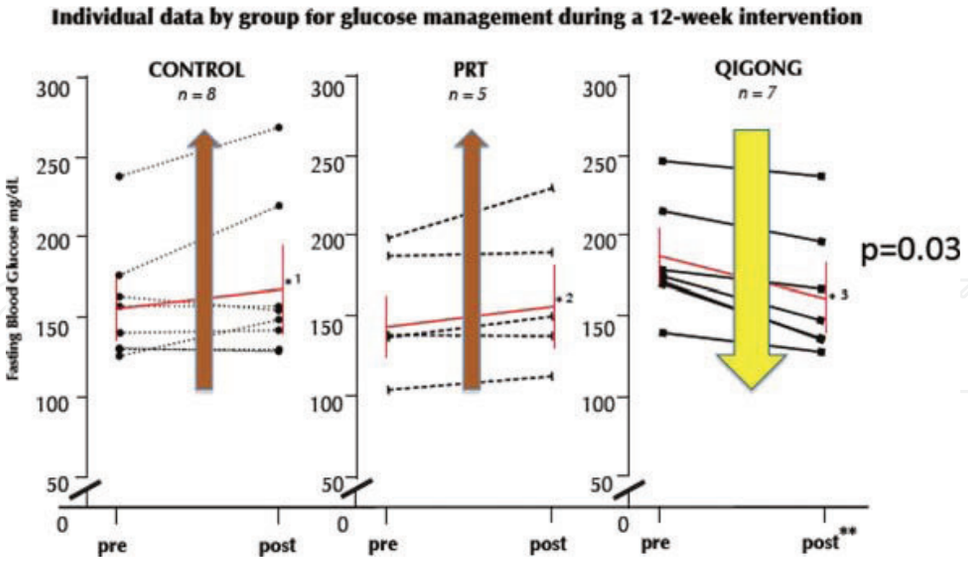


Figure 2. Changes in fasting blood glucose during a 12-week intervention [3, 31].

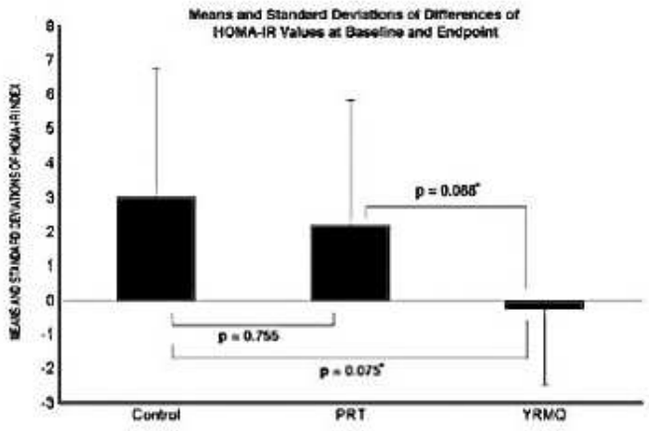


Figure 3. Changes in insulin resistance during a 12-week intervention [3, 31].

Insulin resistance plays a major role in the pathogenesis of metabolic syndrome and T2DM and yet the mechanisms responsible for it remain poorly understood. Current studies have shown that mitochondria may be a major factor in the development of T2DM [32–34]. Mitochondria are known as the powerhouses of the cell. They convert energy from the food that we eat into an energy substance called adenosine triphosphate (ATP) through the process of oxidative respiration. A potential mechanism linking mitochondrial dysfunction to insulin resistance is seen when decreases in substrate oxidation affect electron flow through the electron transport chain (ETC) and lead to the formation of superoxide which damages mitochondria [35]. Mitochondrial superoxide shows evidence of a being a cellular reaction to nutrient excess, leading to insulin resistance with body tissues [36]. Exercise is also known to have a major impact on both mitochondrial function and insulin sensitivity in skeletal muscle [37–40]. Exercise increases energy expenditure and insulin sensitivity. Studies suggest that aerobic exercise may be useful in reversing insulin resistance in prediabetic individuals, possibly preventing the development of type 2 diabetes [34].

One possible explanation for the outcome in the abovementioned study [3] of the YRMQ participants who experienced a reduction in insulin resistance is that in medical Qigong practice, specific Qi-energy breathing exercises that are uniquely recharging might enhance the mitochondrial oxidative respiration process and provide energetic support to mitochondria for preventing ETC electron leakage thereby restoring the functions of the mitochondria for reversing insulin resistance. This possible relationship needs further study.

In addition, it is widely accepted that the etiology of T2DM involves pancreatic β-cell dysfunction and insulin resistance [41]. In molecular genetics studies, the most common mutation leading to mitochondrial diabetes is the A3243G mutation in the mitochondrial encoded tRNA (Leu, UUR) gene [42, 43]. Researchers have found that the A3243G form of mitochondrial diabetes is related to decrease glucose-induced insulin release but is not characterized by insulin resistance, indicating that the major pathology occurs within mitochondria of pancreatic β cells [41]. In the abovementioned study [3], YRMQ group participants practiced, among other Qigong exercises, a specific medical Qigong exercise for empowering the pancreas, which might be beneficial for restoring the functions of the mitochondria of pancreatic β cells. Further studies are needed to investigate these possible benefits.

5.1. Mechanisms of managing type 2 diabetes with medical Qigong

From a medical Qigong perspective, the main cause of T2DM is the imbalance of yin and yang. Another way to look at this is excess sugar intake is too yin and a lack of exercise leads to deficiency of yang. T2DM is largely preventable and many cases could be avoided by lifestyle changes such as eating less and getting appropriate exercise such as walking for 40–60 min/day.

6. Synergistic effects of medical Qigong with acupuncture on type 2 diabetes

Acupuncture and medical Qigong therapy work on the same energetic/Qi "map" of the body, using energy/Qi meridians and points to enhance the body's function in very specific ways. Receiving acupuncture treatments from an experienced Chinese medical practitioner supports the management of T2DM by improving the energetic function of the internal organs.

It must be noted that each individual may present differently and shift presentations over time and the acupuncture and Qigong protocols should be adjusted accordingly for best results. For example, a patient with T2DM and presenting with extreme fatigue, low back and knee pain, excess weight and low motivation may need much more focus on supporting their pancreas and kidneys and less focus on calming down excess energy of the liver. As the patient starts to feel higher energy levels and reduced pain, the acupuncturist might find that the hyperactive liver becomes much more prominent in the patient's presentation and would require an adjustment in the acupuncture treatment and medical Qigong exercises to address the shifting pattern differentiation and to make further progress.

When treating T2DM with acupuncture, practitioners of Chinese medicine may wish to consider two categories of points. The first category consists of points that harmonize and support the zang fu/organ imbalances within the body that are causing the condition. The second group consists of points that help shift unhealthy habits, behaviors and emotions that lead to unhealthy gene expression and diabetes.

From internal Qi-subtle energy-based observation, there are four common areas of zang fu/organ disharmony and dysfunction in the body that must be shifted in order to manage T2DM. These four areas are: (1) excess energy in the liver, (2) low pancreas energy, (3) kidney energy deficiency and (4) an imbalanced autonomic nervous system (represented by the Ren and Du meridians). Although it is important to address all of these imbalances, the key to supporting the successful management of T2DM lies in addressing them at the correct time with each patient:

1. Excess liver (wood element) energy must be released and drained to prevent it from overacting on and damaging the functions of the pancreas (earth element) and affecting the kidneys (water element). Each organ has specific connections with other organs in the body and has the ability to benefit or hinder these relationships. In T2DM, by bringing the liver energy into balance, it sets up the potential for the pancreas and kidneys to recharge and regain normal function. Also, by calming down the liver and creating balance between the liver and the pancreas, the biomedical liver can reduce the amount of glucose it is sending into the bloodstream.

    a. Important points for regulating the Qi and soothing a hyperactive liver: Liver 3, Liver 14, Liver 13, Large Intestine 4 and Large Intestine 10 [23, 44, 45].

2. Low pancreas energy leads to low insulin production and poor blood sugar management. By increasing the energy of the pancreas, its energetic function can improve and play an important part of managing T2DM. By improving the energy of the pancreas, other symptoms can also improve including a reduction in dampness and body weight, reduced fatigue, improved digestive function and less worry and anxiety. This is very important because by improving the pancreas Qi one is working on many different levels including the physiological level (insulin production), the emotional level (decreased worry and anxiety) and the physical level (weight and dampness). In addition, a stronger pancreas will have the energy to keep a potentially hyperactive liver in greater balance.

    a. Important points for increasing the energy of the pancreas: Pancreas 3 (Spleen 3), Pancreas 4 (Spleen 4), Pancreas 6 (Spleen 6), Bladder 20, Bladder 49, Pancreas 9 (Spleen 9), Stomach 36 and Stomach 40 [23, 44, 45].

3. Low kidney energy creates an overall low energetic state in the body and may contribute to insulin resistance. In Chinese medicine, the kidneys are said to be the root of Qi and the foundation of yin and yang in the body [38]. If the foundation of all yin and yang is weak then the rest of the zang fu network can become weak as well. If the root of all the body's energy is increased, the body can return toward its normal function.

   a. Important points for increasing the energy of the kidneys: Kidney 3, Kidney 6, Kidney 7, Bladder 23, Bladder 52 and Pancreas 6 (Spleen 6) [23, 44, 45].

4. An imbalanced autonomic nervous system, from an energetic point of view, is concerned with excess energy expenditure through the sympathetic nervous system without adequate restoration and conservation of energy through the parasympathetic nervous system [46]. In our modern, overstimulated world, many people find it hard to find time to relax and generally operate with an overactivated sympathetic nervous system and constant energy expenditure. This tells the body to send more and more sugar into the bloodstream to bring energy to the cells, causing the pancreas to overwork and the body to become tired. Not only does this affect the body as a whole but it specifically leads to a weakened parasympathetic nervous system that must be restored in order to bring in energy and restore normal functions of the organs.

   a. Important points for balancing the autonomic nervous system: Du 17: stimulates the upper parasympathetic nervous system; Du 2: stimulates the lower parasympathetic nervous system; Lung 7: confluent point of the Ren Meridian; Small Intestine 3: confluent point of the Du Meridian [44].

The second group of points to consider is points that help shift unhealthy habits, emotions and behaviors that contribute to diabetes. These include increased appetite and overeating, emotional and mental health (particularly overthinking, anxiety and worry) and a sedentary lifestyle.

One of the risk factors in T2DM is overeating. An important contribution of acupuncture is to reduce appetite and prevent overeating. Points to reduce appetite and overeating include: Stomach 44, Ren 12, appetite/hunger-control point on the ear.

Points to transform and decrease dampness are very important because dampness by nature makes one feel heavy, tired and stagnant [47]. By transforming dampness, one can feel lighter with increased energy and the desire to be less sedentary. Points include: Pancreas 9 and Stomach 40.

Points for reducing anxiety, worry and overthinking: Du 17, Heart 7 and Ren 17.

7. Western and Chinese medicine nutrition and food restrictions for diabetes

Maintaining healthy target blood glucose levels is key in managing T2DM. Integrative health care, along with self-care through wise food choices, appropriate physical exercise and medical Qigong is a synergistic approach to managing T2DM that can lead to better quality of health and better quality of life.

It is important to work with one's primary care physician to monitor one's A1c and to determine one's target blood glucose levels [48]. Working with a nutritionist to select an appropriate

diet and with a Chinese medicine practitioner for support with specific Chinese medicine nutritional recommendations, acupuncture and Chinese herbal medicine that fits one's pattern differentiation, is a holistic approach that can bring more balance to the body. Qi cultivation through the practice of medical Qigong self-care exercises can increase one's vitality and internal, energetic awareness to help a person make dietary and lifestyle changes toward better health.

Generally in both western nutrition and in Chinese medicine nutrition, recommendations for healthy eating for people with T2DM include eating a variety of healthy foods in regular meals while being mindful of portion sizes [49]. Eating small meals at regular times helps to regulate blood sugar and to avoid high spikes in glucose levels after a big meal followed by a drop in blood sugar if a meal is skipped.

The U.S. Department of Health and Human Services and the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) offer helpful guidelines entitled "Diabetes Diet and Eating" with suggestions about what to eat, how much to eat and when to eat and they also recommend to those with T2DM to take any necessary medications prescribed by their primary care physicians in order to keep diabetes in check and to prevent diabetic complications [48].

An approach currently being studied by researchers is the very low-calorie diet (VLCD) and its potential to reverse T2DM [50]. A prospective, longitudinal, single-center study published in 2016 showed that people with T2DM who followed a VLCD with total energy intake at 624–700 kcal/day for 8 weeks achieved fasting blood glucose of <7 mmol/L and continuing remission of diabetes for at least 6 months [50]. Data suggests a potential for the reversal of T2DM; however, questions remain about the possibility of long-term, sustained recovery from diabetes [19, 50].

From a Chinese medicine perspective, in addition to moderating portion sizes in order to not overeat, moderation in diet also involves the careful harmonization of the five tastes (sweet, salty, sour, bitter and pungent) and the selection of as much balanced variety as possible in one's daily diet [23]. The more colors one sees on one's plate, the more likely it is that the meal is meeting the nutritional needs of all the organs. It is generally advisable to avoid eating the same foods over and over again because one can miss out on important nutritional benefits that come with eating a diverse range of foods. In addition, the overeating of certain foods leads to imbalances. Eating too many sweet foods damages the spleen (pancreas). Overeating salty foods damages the kidneys and the heart. Eating too many pungent or acrid and spicy foods leads to internal heat which consumes the yin and can worsen diabetes [23].

Food prohibitions in Chinese medicine are focused on not exacerbating a person's specific pattern differentiation [23]. For example, someone with spleen (pancreas) Qi deficiency and dampness would be encouraged to limit or avoid sugar, fatty foods, dairy, raw foods, cold foods and cold drinks in general (e.g., cold salads, smoothies) and instead to have cooked foods like whole grains such as Job's tears, barley, brown rice, millet, quinoa and teff, proteins that are lean, cooked vegetables rather than cold salads and to drink warm liquids in order to aid digestion.

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If a person has too much heat in the stomach, foods that are hot in nature should be avoided such as chillies, lamb, alcohol, coffee, garlic and onions [25]. When there is yin deficiency, one should also take care to not eat foods that are overly hot or overly cold or overly drying [25]. If a person has Qi and blood stagnation, foods that are overly cloying, heavy, or difficult to digest should be avoided because they can worsen stagnation. Overeating and emotional eating can also cause stagnation, so a relaxed and positive frame of mind is important while eating [47]. One should avoid eating when feeling irritable or angry, eating while working or multitasking, eating on the run, or eating heavy meals late in the day, or eating too late at night in order to prevent stagnation [47]. It is helpful to eat the main meal earlier in the day to allow adequate time for optimal digestion and to make mealtime a peaceful time for the benefit of all the organs [47]. In the evening, the body's organs naturally start to transition into a rest and restore mode and eating late at night disrupts this process and weakens organ function. If one is hungry late at night, a light, low-carbohydrate, sugar-free and protein-rich snack such as a handful of seeds and a warm glass of water or hot herbal tea can curb hunger and prevent a glucose spike [20].

7.1. TCM food for diabetes management

Chinese medicine food therapy for managing T2DM includes a very special food that doubles as a Chinese herb: *Ku Gua*, known as bitter melon or bitter gourd (Fructus Momordicae Charantiae). It has been used since ancient times in China, India and other parts of the world in the management of what we now call diabetes. Bitter melon contains antidiabetic substances: charantin which reduces blood glucose levels and polypeptide-p which is an insulin-like compound [51]. In Chinese medicine nutrition theory, bitter melon is considered to be bitter and cold and enters the spleen (pancreas), stomach and heart channels. Since bitter melon is thermally cold, people with pancreas Qi deficiency should be mindful to not overeat it since overeating cold foods can further diminish pancreas Qi. However, by adding warming ingredients (e.g., curry seasoning, chili powder and mustard seeds), savory dishes can be prepared that are less cold for the pancreas. For people with excess stomach heat, bitter melon clears stomach heat and by doing so also reduces excessive appetite and can aid in weight loss. Bitter melon can be consumed daily (250–300 g/day) as a juice or by boiling slices of it for several minutes and drinking the water as a tea [20]. People who are taking insulin should use caution when consuming bitter melon because of its additional effect on lowering blood glucose levels.

8. Conclusion

Qigong exercise has shown promising results in clinical experience and in randomized, controlled pilot studies for affecting aspects of T2DM including positive associations between participation in Qigong and blood glucose, triglycerides, total cholesterol, weight, BMI and insulin resistance. Lifestyle changes with appropriate diet and exercise are paramount in managing T2DM. Regular Qigong practice as part of one's exercise routine can have a positive influence on one's awareness of behaviors that either contribute to or

improve one's condition and can lead to helpful lifestyle changes, an overall sense of well-being and better health. Qigong exercises can play an important, synergistic role in integrative care with biomedical approaches and with acupuncture, Chinese herbal medicine and nutrition for managing T2DM.

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