# CHAPTER 2

## Literature Review

This chapter describes the literature review and conceptual framework of the study. The literature review covered the enlisted topics:

1. Urinary tract stone
    1.1 Definition
    1.2 Pathophysiology
    1.3 Types of urinary tract stone
    1.4 Risk factors
    1.5 Clinical manifestation
    1.6 Complications
    1.7 Management of urinary tract stone
    1.8 Prevention of urinary tract stone recurrence
2. Health Belief Model
3. Dietary behavior of persons undergone urinary tract stone removal
    3.1 Definition dietary behavior
    3.2 Recommended dietary behavior to prevent urinary tract stone recurrence
    3.3 Measurement of dietary behavior
4. Perceived benefits of dietary behavior among persons undergone urinary tract stone removal
    4.1 Definition of perceived benefit
    4.2 Studies related perceived benefits of dietary behavior among patients with urinary tract stone
5. Perceived barriers to dietary behavior among persons undergone urinary tract stone removal
    5.1 Definition of perceived barrier
    5.2 Studies related perceived barriers of dietary behavior among patients with urinary tract stone

6. Factors related to perception to prevent urinary tract stone recurrence
7. Measurement of perceived barrier and benefits to dietary behavior
8. Relationship between dietary behavior, perceived benefits and barriers among persons undergone urinary tract stone removal
9. Conceptual framework

## Urinary Tract Stone

### Definition

Urinary tract stone is the formation of mineral crystals in any part within the urinary tract system (Grace & Borley, 2013). Urinary tract stones can be found in the kidneys, ureter, bladder or urethra. Urinary stones that form in the kidney and become lodged in the ureter are known as upper urinary tract stones (Rippe, 2013). Upper urinary tract formation is a complex process related to the condition when urine becomes concentrated with supersaturation of one or more minerals that crystalized and become stones in the kidney or ureter (Rippe, 2013). Ureteric stones commonly occur when stones from the kidney move down through ureter but becomes retained in the ureter due to its size (Masarani & Dinneen, 2007). Bladder stones develop when urine in the bladder becomes concentrated, causing minerals in urine to crystallize (Rippe, 2013). Concentrated, stagnant urine is often the result of not being able to completely empty the bladder.

In summary, stone can occur in any part of urinary tract system and can be specifically identified based on stone's location. Therefore, urinary tract stone was used as definition as all patients with any type of urinary tract stone were included in this study.



### Pathophysiology

The formation of stones in the urinary tract system involves a complex process that related to: (1) supersaturation of urine; (2) precipitation of salts from a liquid to a solid state called crystal; (3) stone growth through crystallization process; and (4) the of absence of stone inhibitors (Huether & McCance, 2013). The formation of stones begins with the interaction between positive and negative ions in the urine which forms a

variety of salts. Increased salts formation will increase concentration of the urine which leads to crystal formation as a result of supersaturation of the salts. Further crystallization of the salts increase the size of stones from a small nucleus to larger stones and this growing phase is influenced by factors such as urine pH and absence of stone inhibitor agents such as potassium citrate. Small crystal particles will primarily retain at the papillary collecting duct in the kidneys and usually can be flushed out from the kidneys and urinary tract system spontaneously. However, stone size and abnormality of the kidney's anatomy can cause retention of the stones and become larger through crystallization process. Small stones may escape the kidneys and travel to the ureter but larger stones will retain and cause obstruction in the kidneys. Meanwhile, kidney stones from the kidney that are too large to pass through the narrow ureter will become stuck and cause obstruction to the upper urinary tract system which involves the ureter and kidneys or lower urinary tract stone involving the bladder (Huether & McCance, 2013).

**Type of Urinary Tract Stone**

Urinary tract stone were created from several types of insoluble complexes materials such as calcium salts, uric acid and crystine and have been classified into several types depending on its chemical composition. Calcium and uric acid stone with calcium oxalate being the most common compound in the formation of calcium-based stones which diet plays a major role in its pathogenesis (Hall, 2002; Holmes et al., 2001).



**Calcium-based stones.** Calcium is a major component that contributes to 85% of urinary tract stone formation, mostly in the form either calcium oxalate or phosphate (Kok, 2012). Approximately 70%-80% of upper urinary tract stone consist of calcium-based stones which include calcium oxalate monohydrate, calcium oxalate dihydrate and calcium phosphate stones (Kambadakone, Eisner, Catalano, & Sahani, 2010). A metabolic abnormality such as hypercalciuria is the main factor that contributes to the formation of calcium-based stones. Hypercalciura is excessive urinary calcium excretions that occur as a result of excessive sodium intake in diet or other conditions such as vitamin D intoxication (Finkielstein & Goldfarb, 2006).

However, the formation of calcium oxalate stones is much more frequent than calcium phosphate stones (Park & Pearle, 2007). It is mainly related to a metabolic abnormality called hyperoxaluria. Hyperoxaluria may occur when dietary calcium is low or if there is a high intake in oxalate-rich foods (Moe, 2006). Meanwhile, calcium phosphate stones are more common among women and are associated with alkaline urine pH (Finkielstein & Goldfarb, 2006).

**Struvite-based stones.** These stones are caused by urinary tract infections resulting from urease-producing bacteria such as proteus, pseudomonas and klebsiella species and enterococci (Moe, 2006). Struvite-based stone contribute to 5-15% formation of all types of urinary tract stone (Rule, Krambeck, & Lieske, 2011).

**Uric acid-based stones.** Uric acid-based stones account to 5-10% of all urinary tract stone formation (Rule et al., 2011). Uric acid composition seems to be the second most common stone to occur in both genders (Knoll, 2008). Common causes include gout and chronic diarrhea. Patients with a high body mass index (BMI) or diabetes have more acidic urine and a much higher propensity to form uric acid stones (Cheng, Moin, Dunn, Boswell, & Duddalwar, 2012).

**Cystine-based stones.** Cystine-based stone account to approximately 1% of all urinary tract stone (Rule et al., 2011). Formation of cysteine stones is primarily a consequence of cystinuria, a metabolic disorder resulting from genetic defects of the system renal transport (Cheng et al., 2012).



Patient's type of stone only can be identified after it passed on their own or it was removed after surgery. In addition, people who had stone in the past are more likely to develop another same type or different type of stone in the future. The stone recurrence may depend on various factors especially dietary behavior. Thus, in this study, the researcher concerned about general diet to prevent all type of urinary tract stone recurrence.

**Risk Factors**

Risk factors of urinary stone formation maybe divided into two categories; i) non-modifiable which account factors that cannot be controlled or changed and ii) modifiable factors that can be changed or controlled in the pathogenesis of urinary tract stone. Urinary stone formation is influenced by multiple yet complex factors such as genetics, age, gender, lifestyle such dietary habits, metabolic disorders and climate factors (Koyuncu et al., 2010; Lopez & Hoppe, 2010). Lifestyle changes that may contribute to the formation of urinary stones including sedentary habits, stress, unhealthy dietary plan and reduced fluid intake (Abbagani, Gundimeda, Varre, Ponnala, & Mundluru, 2010).

**Non-modifiable factors.** These factors involve family inheritance, genetic factor, age, gender, race, comorbidity and socioeconomic status.

***Family inheritance and genetic factor.*** The risk of urinary stones formationis associated with a positive family history of stones. The risk incident of stone formation in individuals with positive family history was 2.57 greater compared to those without positive family history of stones (Curhan, Willett, Rimm, & Stampfer, 1997). The higher risk is likely due to a combination of genetic predisposition and environmental factors such as diet (Curhan, 2007). Meanwhile, certain inherited genetic disorders can lead to the formation of urinary stones. Increasing excretion of cystine in urine can be caused by a heredity disorder of the abnormal renal tubule transport called cystinuria (Hanson, 2005). This genetic disorder can lead to the formation of cystine stones in the urinary tract system (Cheng et al., 2012).

***Age.*** The prevalence of urinary stones varies according to age. The peak age of stone formation is 30 years old for men and 35 and 55 years for women (Papadoukakis et al., 2006). In a review of global incidence of urinary tract stones, the peak incidence of urinary tract stone in Iran, Japan and the United States ranged from 40 to 49 years, except for Japanese women for whom the peak incidence occurred between 50 to 59 years (Romero et al., 2010).

***Gender.*** Men are more likely to get urinary stones compared to women with the general ratio being roughly between 1.5 - 2:1 or more (Bartoletti et al., 2007; Goldfarb, Trinchieri & Curhan, 2007). For example, the men and women ratio in incidence of urinary stone is 2.5:1 in Japan to 1.15:1 in Iran (Romero et al., 2010). The fact that men have a higher incidence than female may relate to sex hormones. In a study of risk formation among women, estrogen treatment may decrease the risk of stone recurrence in postmenopausal women by lowering urinary calcium and calcium oxalate saturation (Heller, Sakhaee, Moe, & Pak, 2002).

***Race.*** Prevalence and incidence rates were highest for whites, followed by Hispanics, blacks, and Asians (Romero et al., 2010). White men have the highest kidney stone incidence rate whereas Asian women have the lowest rate (Romero et al., 2010). Meanwhile within individual races, men still have a higher disease burden compared to women from the same race (Romero et al., 2010).

***Comorbidity.*** Comorbidities such diabetes (Daudon, Traxer, Conort, Lacour, & Jungers, 2006; Pak et al., 2003) and hypertension (Borghi et al., 1999; Strazzullo et al., 2001) are found to be associated with the formation of urinary stone. Several risk factors of coronary heart disease including hypertension, hypercholesterolemia, and obesity are also found to be significantly associated with calcium oxalate stone formation (Hamano et al., 2005).

**Modifiable factors.** Modifiable factors related to urinary tract stone formation involve factors such as dietary behavior, BMI and occupation.

***Dietary behavior.*** Diet plays a major role in the pathogenesis of the most widespread forms of urinary tract stone such as calcium and uric acid stone with calcium oxalate being the most common compound in calcium-based stones (Holmes et al., 2001). An unbalanced diet or particular sensitivity to various foods in former stone patients can lead to urinary alterations such as hypercalciuria and hyperoxaluria which can contribute to the formation or recurrence of kidney stones (Meschi et al., 2004). Meanwhile, low fluid intake also result in the production of concentrated urine which causes supersaturation and the formation of stone-forming salts (Dawson, 2012).

***Body Mass Index (BMI).*** BMI is a marker of an imbalance between energy intake and expenditure and is known to have an important role in the pathogenesis of renal stone formation. Even though, the incidence of stone formation found is more likely to occur in men and women with higher BMI, the role of BMI in renal stone pathogenesis remains unclear. A study by Semins et al. (2010) concluded that a high BMI is associated with an increased risk of kidney stone disease. Meanwhile, Hess (2012) found that high BMI is independently associated with an increased risk of renal stone formation.

***Occupation.*** Nature of occupation also found to have association with the formation of urinary tract stone. Person who's occupationally less-active or more sedentary also had a greater predisposition to stone disease (Kalaitzidis, Damigos, & Siamopoulos, 2014). A possible explanation to relate between sedentary occupation and stone formation is insufficient fluids intake which increase supersaturation of stone forming salts (Lewandowski & Rodges, 2004).

In this study, the researcher concerned all of these factors; family inheritance, age, gender, race, comorbidity, BMI and developed personal profile data. The discussion about participants' dietary behavior would be related to all these factors.

**Clinical Manifestation**

The severity of the clinical presentation of this disease depends on the stone's type, rate of formation, size and location. Symptomatic urinary tract stones begin with moderate to severe acute flank pain radiating to the groin, nausea and vomiting (Wolf, Howes, & Craig, 2014). Meanwhile, large and complex urinary tract stones such as staghorn calculi usually manifest with infection such as pyelonephritis, cystitis-like urinary symptoms, persistent flank pain, renal colic and haematuria (Hughes & Arthur, 2013).

**Complications**

Acute complications of urinary tract stones can accelerate from minor flank pain to chronic conditions such as chronic kidney disease, renal failure and life threatening urosepsis (Wolf et al., 2014). The morbidity of upper urinary tract stone is primarily due

to the obstruction that causes dilatation of the ureter (hydroureter), renal pelvis and calyces (hydronephrosis) or both ureter and renal (ureterohydronephrosis) which can lead urosepsis due to the accumulation of urine above the level of blockage (Huether & McCance, 2013). Obstruction in the upper urinary tract system leads to kidney damage due to the blocking of urine urine flow and inability of the kidney in removing body waste products which finally causes renal failure or kidney loss (Muhbes, 2012).

**Management of Urinary Tract Stone**

Management of the upper urinary tract stones depends is depending on the type and severity of the disease. The management of urinary tract stones involve medical and surgical intervention (Downey & Tolley, 2000).

**Medical management.** Drug therapies for urinary tract stone treatment involve stone-specific therapies and general stone-expulsive therapies (Barnela, Soni, Saboo, & Bhansali, 2012). Stone specific therapies are drugs administered to aim specific types of urinary stone formation such as thiazide diuretics which is used to treat calcium oxalate stones and allopurinol for uric acid stones. Meanwhile, general stone-expulsive therapy or medical expulsive therapy (MET) is a combination of several drugs which are used to facilitate the spontaneous passage of upper urinary stones, especially ureteric stones. A combination of tamsulosin and corticosteroid was found to be most effective to induce spontaneous stone passage swiftly (Barnela et al., 2012). A combination of drug therapy such as tamsulosin was also found to be a useful addition to surgical procedures such as ESWL (Gravina et al., 2005).



**Surgical management.** Surgical intervention becomes the main choice to treat urinary tract stones if its size is too big and causes obstruction to the urinary tract system. Besides, failure to comply with medical and lifestyle modifications also result in surgical intervention approach due to urinary tract stones recurrence. There are four type of common surgical intervention to treat urinary tract stone included extracorporeal shockwave lithotripsy (ESWL), uteroscope (URS), percutaneous nephrolithotripsy (PCNL) and open surgery.

***Extracorporeal shockwave lithotripsy (ESWL).*** In ESWL treatment, the urinary tract stones are broken into small, gravel-like fragments by shock waves that generate directly towards the stones' location from outside the body (Rosdahl & Kowalski, 2008). ESWL is typically used to treat renal stones smaller than 2 cm in diameter and ureteric stones (Samplaski, Irwin & Desai, 2009). ESWL is the most commonly used option to treat simple upper urinary tract stone with a high successful rate of stone removal (Samplaski, Irwin, & Desai, 2009).

***Uteroscope (URS).*** The procedure of URS is used to remove ureteral stones with a success rate of 88-97% and a stone-free state can be achieved faster with URS, especially for larger stones (Bartoletti & Cai, 2008). In URS treatment, stones will be removed without crushing the stones by using a special instrument called the stone basket under visual guidance (Rosdahl & Kowalski, 2008). URS is commonly used to remove ureteric stones regardless of their size (Samplaski et al., 2009).

***Percutaneous nephrolithotripsy (PCNL).*** Meanwhile, PCNL is a procedure where the stones are  and removed by a special needle that is inserted through a small incision on the skin (Rosdahl & Kowalski, 2008). PCNL is conducted to remove renal or ureteral stones more than 2 cm in diameter,  staghorn calculi or stones that failed to be removed by ESWL and URS procedures (Samplaski et al., 2009).

***Open surgery.*** Open surgeries such as pyelolithotomy and nephrolithotomy have become less favourable options in surgical management in light of advances in ESWL and endourological surgery such as URS and PCNL. Open surgery is only conducted in situation of complex stones that cannot be treated with ESWL, URS and PCNL (Bartoletti & Cai, 2008).



Even the latter surgical intervention is less invasive but the prevention strategy is preferable compared to repeated surgical intervention as the long term treatment goal is to prevent recurrence and growth of existing stones (Goel, 2012).  Hence, the recurrence of urinary tract stone after surgery can be prevented by lifestyle modification especially by practising good dietary behavior.

**Prevention of Urinary Tract Stone Recurrence**

Urinary tract stone that are less than 5 mm in diameter is commonly able to pass spontaneously but lifestyle modification is required to ensure no recurrences happening in the future (Parmar, 2004). Engagement in lifelong medication and/or recommended dietary behavior is often necessary in order to prevent stone recurrence (Barnela et al., 2012; Pearle et al., 2014). Patients may experience stone formation every year or even more frequently due to high of recurrence rate especially if they are practicing unhealthy lifestyle such as unhealthy diet (Johri, Jaeger, Robertson, Choong, & Unwin, 2011). Therefore, lifestyle and dietary behavior modification should be the first preventive treatment for urinary tract stones before considering medical or surgical treatment approaches in urinary stone management (Johri et al., 2011). An Association of Urology (Turk et al., 2014) has highlighted three major measurements for general prevention of urinary tract stone: fluids intake; nutritional advice for a balanced diet and lifestyle advice including BMI; and adequate physical activity as general preventions for recurrent urinary stones. However, the prevention management of this disease through dietary behavior was found to be more beneficial and cost effective in the prevention of urinary tract stone recurrence (Borghi et al., 2002; Roy, 2006).

Dietary changes including fluid intake are important measures in preventing the recurrence of kidney stones (Barnela et al., 2012). Dietary intake is a major focus in the prevention of urinary tract stone as it is basically determines the type of stone formation. Numerous studies conducted in the past indicate the important role of dietary behavior in new stone formation and its recurrence (Borghi et al, 2002; Dennison, Mayo, & Abraham, 2011; Taylor, Stampfer, & Curhan, 2004). Following the findings from all these epidemiology studies, the general diet to prevent urinary stone and its recurrence is recommended as follows: limited animal proteins, limit sugar intake, limit fat intake, normal calcium intake, limited oxalate intake, reduced sodium chloride intake, increased alkaline potassium intake, increased vegetable fiber intake and increased water intake (Finch & Irving, 2007; Pearle et al., 2014).

## Health Belief Model

Health Belief Model (HBM) was developed in 1950 by social psychologists in reasoning individuals' participation in health programmes such as immunization (Rosenstock, 1974) and it considers that people will act to protect their health if they perceive that they are at risk and that a particular action will enable them to deal with such a risk, without triggering excessive personal sacrifice. According to the HBM, health behavior is influenced by personal beliefs about the disease (Rosenstock, 1974). The HBM predicts that beliefs about specific illnesses and their preventive health behaviors impact the likehood of performing these behaviors (Rosenstock, 1974; Strecher & Rosenstock, 1997). These beliefs include: perceived threat (a function of perceived susceptibility to and perceived severity of the health condition); relative cost of the behavior (difference between perceived benefit of and perceived barrier to perform the health behavior); and modifying factors (such as demographic, psychosocial and structural variables) (Rosenstock, 1974; Strecher & Rosenstock, 1997). Self-efficacy has been added to the original model as it is related to personal beliefs in one's ability to do something (Rosenstock, Stretcher, & Becker, 1988). Ultimately, an person's course of action often depends on the person's perceptions of the benefits and barriers related to health behavior (Rosenstock, 1974; Rosenstock et al., 1988).

The HBM has been applied in many health behavior studies to predict and explain engagements in preventive health behavior (Strecher & Rosenstock, 1997). In application of the HBM Rosenstock (1974) followed the definition of preventive health behaviour originally suggested by Kasl and Cobb (1966). Preventive health behavior has been defined as "any activity undertaken by a person who believes himself to be healthy for the purpose of preventing disease in an asymptomatic stage" (Kasl & Cobb 1966). Meanwhile, specific illness is the patient's experience of ill health related to specific disease (Boyd, 2000). The same definition is followed in the present study. Furthermore, dietary behavior to prevent a recurrence of urinary tract stone requires patients to change their health behavior and take better care of themselves (Kok, 2012).

The applicability of the HBM has been reported in predicting preventive dietary behavior in many populations with perceived benefits and barriers becoming a central

constructs that promote behavioral changes (Kloeblen & Batish, 1999; Pires & Mussi, 2012; Salashoori, Sharifirad, Hassanzadeh, & Mostafavi, 2014). Moreover, a person is likely to change their behavior if perceived benefits outweigh perceived barriers (Rosenstock, 1974; Strecher & Rosenstock, 1997). Meanwhile, perceived benefits and barriers were found to influence fluid intake behavior among former stone patients in order to prevent a recurrence of urinary tract stone compared to other construct such as perceived severity and perceived susceptibility (McCauley et al., 2012). Thus, in the current study, perceived benefits and perceived barriers to prevent a recurrence of urinary tract stone after their removal were investigated to determine the factors that can influence dietary behavior among this population.

## Dietary Behavior of Persons Undergone Urinary Tract Stone Removal

### Definition of Dietary Behavior

Dietary intake is defined as the ingestion of solids foods and fluid (Furman, 2012). Meanwhile, dietary behavior refers to the eating patterns of people as well as behaviors related to the consumption of foods such as selection and preference (Karen & Jay, 2002). In this study, dietary behavior is defined as eating patterns involving food and fluid intake of the persons who have undergone urinary tract stone removal to prevent a recurrence of urinary tract stone.

### Recommended Dietary behavior to Prevent Recurrence of Urinary Tract Stone

Dietary habit becomes the main concern in dealing with the high incidence in formation of urinary tract stone. Dietary patterns related to food choice play an important role in the recurrence of urinary tract stone among affected population. Unhealthy dietary patterns are considered the most important risk factor in the formation of urinary tract stone (Awasthi, Malhotra, & Modgil, 2011; Borghi et al., 2002; Pak et al., 2005; Taylor et al., 2004). Recommended guidelines for dietary changes in prevention of urinary tract stone recurrence include: increased water intake, reduced dietary oxalate, reducing dietary animal protein and other purines, normal dietary calcium and balanced diet with adequate intake of fruits and vegetables (Pak, 2004; Qaseem, Dallas, Forciea, Starkey, & Denberg, 2014; Turk et al., 2014). In this

study, recommended fluid intake also cover particular beverages such as tea, coffee and juice intake to prevent urinary tract stone recurrence.

**Normal intake of calcium-rich food.** Calcium is present in more stones compared to other elements with calcium oxalate being the most common compound in the formation of calcium-based stones (Hall, 2002; Holmes et al., 2001). Previously, restriction of calcium intake in diet therapy has been practiced for many years to prevent stone recurrence as this restriction is believed to decrease hypercalciuria (Al Zahrani, Norman, Thompson, & Weerasinghe, 2000). Hypecalciuria is a metabolic abnormality which is believed to be an important risk factor for the crystallization of calcium oxalate and the formation of kidney stones (Nouvenne et al, 2010). Absorptive hypercalciuria is due to intestinal over-absorption of calcium after oral calcium load (> 0.2 mg/mg creatinine) and subsequent increase of renal calcium excretion leading to formation of the stones which can be classified; 1) Type I when it is unresponsive to diet; and 2) Type II when urinary calcium is normalized with dietary calcium restriction (Al Zahrani et al., 2000).

A diet with high in calcium intake leads to increase in urinary excretion and promotes stone formation while very low intake of calcium may also contribute to stone formation (Dennison et al., 2011; Hong et al., 2012). In a prospective study by Sorenson et al (2012), 1,950 (2.5%) women from the total 78,293 women studied developed the urinary tract stones due to consumption of an unhealthy diet during the 8 years of follow-up, with approximately 80% of them consuming less than the required daily dietary calcium intake of 1,000 to 1,200 mg as recommended by the Institute of Medicine. In this study, the average daily dietary calcium intake was 39 mg lower in women who developed kidney stones than in those who did not develop them (Sorenson et al., 2012).

Restriction of calcium intake is found to be insignificant as concluded in many large prospective studies conducted among this population. In a large prospective study on the risk of symptomatic stone formation in 45,619 men, the mean score (SD) of daily dietary calcium intake among men who developed stones for the following 4 years in follow-up is 797± 280 mg which is relatively low when compared to 851± 307 mg in men who do not have stones (Curhan et al., 1993). Following the previous study, a

prospective cohort study with 12-year follow-up among 91, 731 healthy women and found that the relative risk for women with the highest dietary calcium intake (more than 1,098 mg per day) was 0.65 compared to women with the lowest dietary calcium intake of less than 488 mg per day and there were 864 cases of stones formation documented in the duration of this study (Curhan, Willett, Speizer, Spiegelman, & Stampfer, 1997). These two studies concluded that high dietary calcium intake daily increases the risk of stone formation in both genders.

The protective effect of increased calcium intake diet to prevent stone recurrence later was investigated among 120 hypercalciuric men with recurrent calcium oxalate stones which were divided into two groups: (1) 60 men with a diet containing 1200 mg of calcium per day (30 mmol/day) but reduced amounts of animal protein (52 g/day) and salt (50 mmol/day) and; (2) 60 men with traditional lower calcium diet intake (400 mg/day) (Borghi et al., 2002). In this study, both groups were also advised the men to avoid consuming large amounts of oxalate-rich foods such as; walnuts, spinach, rhubarb, parsley and chocolate. The findings from this study showed that 12 of the 60 men on the normal calcium, low animal protein and low salt diet (group 1) and 23 of the 60 men on the low-calcium diet (group 2) had stones relapses within 5 years of the study's completion. Thus, the findings from this study recommend a normal calcium intake containing 1200 mg of calcium per day (30 mmol/day) with reduced salt and animal protein intake would provide greater protection from the recurrence of urinary tract stone.

Maintaining a normal calcium intake with low salt intake can prevent hypercalciuria, especially among former stone patients, which can cause a recurrence of stones (Kok, 2012) and normal calcium intake should be tailored based on patients' dietary calcium needs (Pearle et al., 2014). A moderate increase in calcium intake (800-1200 mg) with approximately 3-4 servings of dairy per day by people with low calcium intake appears appropriate whereas those with moderate calcium intake can continue with their intake instead of restricting their calcium intake in order to prevent stones recurrence (Heilberg & Goldfarb, 2013).

Thus, to prevent urinary tract stone and its recurrence, the total calcium intake should not exceed 1,000-1,200 mg daily (Paterson, Fernandez, Razvi, & Sutton, 2010;

Pearle et al., 2014; Skolarikos et al., 2015), with approximately 3-4 servings per day of dairy milk product with low calcium (Heilberg &Goldfarb, 2013) or equivalent to four 8-oz glasses of low calcium milk. In addition, patients should be aware of some of the more healthy sources of dietary calcium such as milk, cheese, yogurt, broccoli and sardines (International Osteoporosis Foundation, 2015).

**Limited intake of oxalate-rich food.** An oxalate-rich diet intake plays an important role in the formation of calcium oxalate stones as this type of stones is the major component of all urinary stones (Hesse & Siener, 1997). Oxalate is present in urine in much smaller quantities than calcium and changes in oxalate levels in the urine have a much greater impact on stone formation than changes in calcium concentration (Morton, Iliescu, & Wilson, 2002). Urinary excretion of oxalate exceeding of 45 mg per day is regarded as hyperoxaluria (Flagg, 2007). Hyperoxaluria may result from increased dietary intake and increased intestinal absorption of oxalate from the gut, or by increased endogenous production of oxalate caused by the metabolic breakdown of ingested precursors (Siener, Ebert, Nicolay, & Hesse, 2003). Nevertheless, about 10-20% of the urinary oxalate is derived from diet intake (Morton et al., 2002).

An increased intake of vegetables in daily diet is recommended for stone patients but the intake of vegetables rich in oxalate should be avoided in order to prevent a recurrence of urinary tract stones. Vegetables rich in oxalate mostly comes from green leafy vegetables such as spinach can increase the risk of stone formation (Norris, 2013). However, most of the patients who ate vegetables preferred green leafy vegetables such as spinach because it was readily available everywhere and part of their diet culture (Awasthi et al, 2011).



Hence, to prevent recurrences of urinary tract stone, stone former patients with hyperoxaluria should limit their intake of high-oxalate foods such as certain nuts (including almonds, peanuts, cashews, walnuts and pecans), certain vegetables (including beets and spinach), wheat bran, rice bran and chocolate (Meschi et al., 2004; Paterson et al., 2010; Pearle et al., 2014).

**Limited intake of protein-rich food (animal protein).** The role of limited protein diet intake is important in the prevention of urinary tract recurrence as excessive

protein intake increases the excretion of potentially lithogenic substances such as calcium and uric acid which increases the risk of stone formation (Reddy, Wan, Sakhaee, Brinkley, & Pak, 2002). Many studies found that a high protein intake, especially animal protein, can increase the formation of stones. Excessive animal protein such as meat intake is associated with uric acid stone formation due to the increase of purine product (Ngo & Assimos, 2007). Uric acid is an end product of purine metabolism and excessive uric acid in urine increase urine supersaturation which may lead to the formation of stones (Flinch & Irving, 2007). Decreasing the consumption of meat, chicken and seafood will decrease the intake of purine; therefore, decreasing the production of uric acid could prevent urine crystallization (Saxena & Sharma, 2010).

In Taiwan, changes in personal dietary habits from local diet to Western diet has led to a high incidence of urinary tract stones, especially calcium oxalate stones between 1957 and 1999 (Hsu, Chen, Huang, & Wang, 2002). In this study, a high intake of animal protein was the main factor that contributed to a high incidence of urinary tract stones. In an early study on the relationship between protein intake and formation of stone, a direct correlation was found where a daily intake of 77 grams or more animal protein showed a relative risk of stone formation compared with the lowest protein intake of 50 grams or less daily (Curhan et al., 1993). However, restricting dietary protein to below RDA levels (0.8g/kg per day) is unsafe and should also be avoided as individuals who undertake low-protein diets risked the elevation of parathyroid hormone, inducing bone loss (Martini & Wood, 2000).



Thus, a limited intake of animal protein to 80g per day is recommended as a general prevention of urinary stones (Flinch & Irving, 2007). The European Urology Guidelines also recommended a limited intake of animal protein content to between 0.8-1.0 g/kg/ daily (Skolarikos et al., 2015) to prevent urinary tract stone formation and its recurrence.

**Limited sodium intake.** Sodium is a common preservative in all foods. High sodium diets are associated with greater calcium excretion in the urine which may facilitate the formation of stones (Timio, Ferry, Anson, Eastwood, & Cappucio, 2003). The latest randomized control study found that an intake of low-salt diet, accomplished

by eliminating added salt and reducing foods with a high salt content, corrected idiopathic hypercalciuria in approximately 30% of all cases (Nouvenne et al., 2010). This study demonstrated that approximately 30% of patients achieved normal calciuria with the reduction of 100 mmol urinary Na (corresponding to a reduction in intake of 5.8 g/d) accompanied by a reduction in urinary calcium of about 64 mg/d in men and women. Furthermore, in this study, urinary calcium reached normal range in 61.9% of the patients who were on the low salt diet to 34.0% patients who were on a control diet (water therapy alone). This study concluded that a low-salt diet can reduce calcium excretion and prevent the formation of calcium-oxalate stones among hypercalciuric former stone patients. Thus in general, patients should limit their salt intake to 2g per day or less to prevent urinary tract stone recurrence (Finch & Irving, 2007; Paterson et al., 2010; Pearle et al., 2014).

**Increased intake of fruits and vegetables.** An increased intake of fruits and vegetables is important to prevent recurrence of urinary tract stone. Most dietary potassium is derived from meat, fruits and vegetables mostly contribute to an alkali that increases urinary citrate (Meschi et al., 2004). Fruits such as orange contain high level of potassium citrate which is an important inhibitor to protect against urinary tract stone formation as it increases urinary citrate and reduces calciuria (Pak, 1994). A higher intake of fruits and vegetables may raise urinary pH and reduce the risk of uric acid crystal formation (Saxena & Sharma, 2010).

A higher intake of fruits, vegetables and fiber is also found to have a protective effect in the prevention of urinary tract stone recurrence. A study to evaluate the association between total fiber, fruits and vegetable intake with incidence of urinary tract stone formation among women (N= 83,922) found that women with the highest intake of fiber, fruits and vegetables were 22%, 15% and 22% less likely to experience incidence of urinary tract stone respectively compared to women with the lowest intake (Sorenson et al., 2014). In this study, most of the women were found to consume a daily moderate intake of fruits, vegetable and fiber and after an 8 year follow-up found that 2,937 women developed urinary tract stone with 547 of them experiencing its recurrence. A study by Sorenson et al. (2014) also demonstrated that an intake of about two portions of fruits and vegetables per day or an increase of 12 grams of fiber intake

per day showed a significant difference in the risk of urinary tract stone formation between the groups with the highest and lowest intake of fruits, vegetables and fiber. This study concluded that a higher intake of fruits, vegetables and fiber is associated with a decreased risk of urinary tract stone formation and its recurrence.

In general, stone patients are generally advised to increase their consumption of fruits and vegetables regularly to prevent a recurrence of urinary tract stone (Borghi et al., 2002; Pearle et al., 2014; Skolarikos et al., 2015).

**Increased fluid intake.** An increased fluid intake has proven to be an effective strategy in the prevention of urinary tract recurrence (Borghi et al., 1996; Borghi et al., 1999; Sarica, Inal, Erturhan, & Yagci, 2006). Theoretically, the formation of urinary stones is related to the supersaturation of urine. Inadequate fluids intake can result in low urine volume which increases the urinary concentration of lithogenous salts, thereby increasing the saturation of stone-forming salts (Pak, 2004). Thus, increased fluid intake could inhibit stone formation by lowering the urinary concentration of stone-forming constituents (Siener & Hesse, 2003). A high urinary volume generates a series of positive effects that are useful in the prevention of stone recurrences.

The protective volume of fluid intake in the prevention of recurrence stones is still becomes debatable. In a RCT that compared the risk of stone recurrence, subjects with increased fluid intake and without dietary changes to achieve a urine output more than 2 L per day had a 12.1% recurrence rate compared to 27% recurrence rate in subjects without increased fluid intake with a urine output of less than 1.3 L per day (Borghi et al., 1996). During the 5 years of this study, a high intake of fluids also lowered the recurrence rate of stones among intervention group. There was no specific fluid intake amount given to the intervention group instead of high fluids intake to achieved urine output more than 2 L per day. Meanwhile, another clinical trial in surgical treatment found that stone-free patients who increased their fluids intake and with a urine production target of more than 2.5 L per day had a lower risk of recurrence (8.3%) compared to 40%  of patients who were given drug therapy (Dai, Zhao, Liu, You, & Wang, 2013).

A systemic review of five studies on fluid intake concluded that an increased fluid intake of more than 2.5 l per day showed protective effects to prevent stone recurrence (Prasetyo, Birowo, & Rasyid, 2013). This result is concurrent with the general recommendation of urolithiasis prevention from the European Association of Urology which recommend a fluid intake of 2.5-3 L per day with a minimal urine production target of 2 l per day (Skolarikos et al., 2015; Turk et al., 2014). Meanwhile, the American College Physician also recommend increasing fluid intake to achieve at least 2 L urine output per day in order to prevent stone recurrence (Qaseem et al., 2014). Thus, to prevent a recurrence of urinary tract stone, patients should modify their fluid intake and ensure a urine output of at least 2 L per day according to the current guideline.

Particular beverages such as tea, coffee, citrate product (grape juice, orange juice) may also contribute to decrease or increase formation of urinary tract formation. Consumption of 240 ml (8 oz) grape juice daily was associated with increased risk of urinary tract stone (Curhan, Willet, Rimm, Spielgelman & Stampfer, 1996; Curhan, Willet, Speizer & Stampfer, 1998). The mechanism of grapefruit juice to increase risk of urinary tract formation remains unclear as it may associate with certain drug metabolism (Goldfarb & Coe, 1999). Meanwhile, consumption of 240-ml (8-oz) coffee and tea daily showed preventive effect in stone formation (Curhan, Willett, Rimm, Spiegelman & Stampfer, 1996; Curhan, Willett, Spiezer, & Stampfer, 1998; Ferraro, Taylor, Gambaro, & Curhan, 2013) by increase diuresis moderately together with the excretion of magnesium and potassium as well as calcium and sodium (Massey & Wise, 1992).



**Measurement of Dietary Behavior**

In general, there are several instruments that can be used to measure dietary behavior, such as:

**Food Behavior Checklist (FBC).** The FBC was developed to examine dietary behavior among low income participants (Murphy, Kaiser, Townsend, & Allen, 2001). The development of the FBS was based on literature review, previous short food frequency questionnaire and food behavior checklists. This questionnaire is composed

of 22 items as follows: fruits and vegetables (9 items), Dairy items (2 items), fat and cholesterol (5 items), diet quality (4 items) and food security (2 items). The responds was designed in several forms according to the statement of the items as follows: 4-point Likert scale (1 = Always, 2 = Often, 3 = Sometimes, 4 = Never), open-ended questions and dichotomous questions (1 = No, 2 = Yes). Criterion validity was tested with a biological measure (serum carotenoid level) and convergent validity with dietary instrument (nutrient intake from 24-hour recalls). 10 responses of food behavior items were significantly correlated with serum carotenoid level (r = > 0.45) and an additional 12 items showed associations with the 24-hour recalls data (maximum r = 0.50). Cronbach's coefficient α ranged from 0.28 (fat and cholesterol items) to 0.79 (fruits and vegetable items) (Murphy et al., 2001).

**Rapid Eating and Activity Assessment for Patients (REAP).** The REAP was developed for quick assessment on a patient's dietary patterns and physical activity (Gans et al., 2006). The REAP, which was developed based on a food frequency questionnaire is composed of 27 items on multiple factors related to diet categories as follows: meals (2 items); meat (5 items); whole grains (1 item); calcium-rich foods (3 items); fruits and vegetables (2 items); saturated fat and cholesterol (3 items); sugary foods (3 items); sodium (2 items); soft drink (1 item); alcoholic beverage (1 item) and; others (2 items). Physical activity (2 items) is an additional subscale in the REAP. The responses are designed as follows: 1= Usually/Often, 2= Sometimes, 3= Rarely/Never and Not Applicable.



The REAP instrument underwent a series of evaluations, including: 1 = feasibility test with medical students and physicians; 2 = validation test; 3 = cognitive assessment testing with consumers and; 4 = reliability test and additional validation test of revised tools with consumers. The feasibility study revealed a moderately high ranking of usefulness that is practical in the assessment of dietary behavior. This instrument showed excellent test-retest reliability (r = 0.86) and correlated with the Healthy Eating Index score (r = 0.49). This instrument is also associated with the intake of most nutrients studied (Gans et al., 2006).

However, the FBC and REAP are not suitable for this study for several reasons. Certain domains of the FBC such as 'food security' and 'diet quality' are not related to

this study objective. Furthermore, the FBC does not measure important categories related to dietary behavior to prevent recurrence of urinary tract stone such as fluid intake behavior and salt intake. Other reason is the FBC having multiple methods of responses which makes it difficult to score and summarize the behaviors of participants in this study.

Even though the REAP has adequate reliability and validity to be used for the dietary behavior assessment, this instrument will not able to provide enough information regarding dietary intake to prevent recurrence of urinary tract stone. The development of this instrument is more suitable to adopt in a general population but not for a population with a specific disease such as urinary tract stone. Furthermore, the component of fluid intake in the REAP is not enough to provide information regarding fluid intake behavior among persons who have undergone urinary tract stone removal in this study. Thus, the instrument used to measure dietary behavior in this study was developed by the researcher in order to investigate dietary behavior on specific foods and fluid related to urinary tract stone.

## Perceived Benefits of Dietary Behavior among Persons Undergone Urinary Tract Stone Removal

### Definition of Perceived Benefit

Perceived benefits is an important concept in determining or predicting an individual's intention to perform and adopt health behavior in the HBM. Perceived benefit is defined as a person's belief about the value or usefulness of a new behavior to reduce a threat or illness (Janz & Becker, 1984). In general, perceived benefit is about the positive beliefs of an individual towards a particular health behavior that can give them an advantage in decreasing the risk of an illness or disease. In this study, perceived benefit is operationalized as the perception of a person who have undergone urinary tract stone removal regarding the positive outcomes of their dietary behavior, including food and fluid intake to prevent further disease complication.

**Studies Related to Perceived Benefits of Dietary Behavior among Patients with Urinary Tract Stone**

Identifying perceived benefits is crucial as high benefit that perceived by the patients may motivate and promote patients to change their behavior in order to prevent the complication of the disease. There is very limited data available regarding how patients with urinary tract stone or stone formers perceived the benefit from recommended dietary behavior to prevent recurrence of urinary tract stone. However, stones formers perceived that benefit of increased fluid intake can prevent them from stone recurrence, pain and surgery (McCauley et al., 2012). Increase perceived benefit of recommended dietary behavior in prevention of urinary tract stone recurrence can promote and motivate patients to change their health behavior. Finding from the study by McCauley et al. (2012) showed that stone formers are highly motivated to prevent recurrence of urinary tract stone but unfortunately refused to comply with dietary behavior unless they were assured the stones will totally not recur at the future.

Benefits of dietary behavior should be emphasized continuously as stone formers become less motivated to continue the health behaviour related prevention of recurrence of stones as time passed after the stones episode (McCauley et al., 2012). Strong positive beliefs regarding the advantages of the health behavior outcomes will contribute to the behavioral change among the target population. For instance, in a study of patients with risk of coronary heart disease (CHD) found that patients tend to eat more healthy diet as they strongly perceived the benefits of healthy eating can help them to reduce chance of getting disease complication, being more fit, feeling much better and help them to control their weight (Baldwin, 2014). Meanwhile, in another study on dietary intake among renal failure patients found that high benefits of restriction salt intake that perceived by the patients help them to engage in healthy dietary habit effectively (Agondhi et al., 2011).

Perceived benefits have also been reported as an important factor to adhere a healthy diet in diabetes population. In a study of behavioral determinant of cardiovascular disease risk factors among diabetes patients by Sabzmakan et al (2014), findings showed that most patients believed having a healthy diet will result in CVD prevention, less need to take medication, weight reduction, and morbidity reduction

associated with disease, increasing life and reducing health costs. This study also revealed that the benefits of adhering to healthy diet such as losing or maintaining weight, preventing disease complications and feeling healthier were perceived more than other benefits statements that were consistent with those reported by other studies in healthy population (Lopez-Azpiazu, Martinez-Gonzalez, Kearney, Gibney, & Martinez, 1999; Pawlak & Colby, 2009). These findings showed that patients tend to engage in good health preventive behavior if they believe the specific health behavior such as good dietary habit would benefit them.

## Perceived Barriers to Dietary Behavior among Persons Undergone Urinary Tract Stone Removal

### Definition of Perceived Barrier

Perceived barrier is an important construct in the HBM. Perceived barriers have been established in previous health promotion and disease prevention literature as important predictors of behavioral change in many populations (Baheiraei, Mirghafourvand, Charandabi, & Mohammadi, 2013; McGuire & Anderson, 2012; Timmerman, 2007). Perceived barrier is defined as the potential negative aspects of a particular health action that may act as an obstacle to adopt a recommended health behavior (Janz & Becker, 1984). In other words, perceived barrier concerns the negative aspects which potential acts as obstacles for performing a particular health behavior. In this study, perceived barrier is defined as the perception that persons who have undergone urinary tract stone removal regard as difficulties or obstacles that inhibit them from engaging in dietary behavior changes in future prevention of urinary tract stone recurrence.



### Studies related to Perceived Barriers to Dietary Behavior to Prevent Urinary Tract Stone Recurrence

The information related to the barriers that prevent stone recurrence among former patients is very limited as there is only one available study that specifically addressed the barriers to dietary behavior among patients with urinary tract stones. Patel and Mehta (2014) identified three stages of the barriers to recommended dietary

behavior among study samples which are primary, secondary and tertiary stages. In this study, the two major factors in primary barriers that patients claimed they were not clearly informed about the benefits of the diet (25%) and eventually forget about the diet regime (19%). The secondary barriers in this study are factors such as financial problems (16%), time constraint (15%), the taste of the recommended food (12%) and restrictions of the diet by family members (6%) that cause low positive engagement to diet modifications. The tertiary barrier is related to motivation when 7% of patients failed to engage in diet modification as time passes after their first stone removal without clear reason. In other words, patients' motivation towards recommended dietary behavior to prevent stone recurrence tends to fade away after some period of time.

Motivation plays an important role in encouraging patients to change and comply with their dietary intervention in order to prevent future recurrence of urinary tract stones. However, the existence of multiple barriers causes most of them to not engage in their prevention behavior effectively. In a study on fluid intake behavior, multiple barriers from three progressive stages were identified and divided into three levels: 1) primary barriers such as lack of knowledge and forgetting to consume fluids; 2) secondary barriers such as distaste for water, availability of water and lacking thirsty; 3) tertiary barriers complication such as passing urine frequently and workplace-related issues (McCauley et al., 2012). According to this study, the primary barriers are commonly perceived by first time former stone patients who were aware of the therapy needed or unmotivated to modify their diet accordingly. Meanwhile, secondary barriers are typically perceived by patients who were aware and tried to change but were unsuccessful in implementing fluid intake therapy. Tertiary barriers are commonly perceived by patients who had the awareness and high motivation to prevent the recurrence of urinary tract stones.



**Factors Related to Perception to Prevent Urinary Tract Stone Recurrence**

There are many factors that can be potential influence persons' perception when engaging in recommended dietary behavior to prevent urinary tract stone as educational background, food preferences, complexity of diet regimes, socioeconomic status and interpersonal relationships. These factors may affect persons' perceived benefits and perceived barriers to engage in recommended dietary behavior.

**Education**

Poor educational background becomes a major barrier that causes patients with urinary stones to not understand the implementation of diet therapy regime (Patel & Mehta (2014). Besides this, the lack of knowledge regarding recommended dietary behavior to prevent the recurrence of urinary tract stone becomes the most common barrier that causes patients to fail to engage in their dietary habit effectively (Hiatt et al., 1996; Salmeh, Yaghoubi, Zakizadeh, Yaghoubian, & Shahmohammadi, 2012). In another study, patients developed stone recurrence in multiple location of the urinary tract system as they were unaware of the warning symptoms and a lack of pain had become the primary reason of why they neglected the treatment, including their diet intervention (Zargooshi, 2001). Thus, continuous education regarding lifestyle, including recommended dietary behavior and individual risks related to urinary stone prevention, is important to improve patients' understanding and knowledge in order to ensure their engagement in prevention activities effectively (Fritsche & Dotzer, 2012).

**Food Preference**

On the other hand, unhealthy food selection and preference habit among urinary tract stone patients also account for stone recurrence. Most of the patients also do not favor vegetables and instead prefer animal-based protein diets which also contribute to the recurrence of urinary tract stone. An evaluation on dietary habit among 130 urinary stone patients in north India found that 60% of the samples consumed vegetables and totally preferred diet based animal protein and 40% of the patients were consuming salted foods (Awasthi et al., 2011). The researchers concluded that this population practiced unhealthy dietary habits due to their preference for unhealthy food which contribute to high incidence, prevalence and recurrence of stone formation. Besides this, most patients with urinary tract stone do not understand how to tailor their diet correctly and often choose to modify their diet according to their preference such as lower calcium intake in their daily diet regime compared to the recommended amount (Salmeh et al., 2012). Practicing this unhealthy diet behavior may result in future stone formation or deterioration of the current stone disease into chronic urinary stone.

Some population may experience difficulties in changing their diet habits as some of high risk foods and fluid that can induces the formation of urinary tract stones and its recurrence are part of their food culture or used to be their main dish in their daily life. Regarding the context Malaysian, unhealthy dietary habits such as frequent intake of oxalate-rich foods or drinks, such as "ulam" (dark green, leafy vegetable), Chinese tea and "teh tarik" (milk tea), increased the incidence of calcium stone formation as well as expose patients to the risk of stone recurrence (Hong et al., 2012).

**Complexity of Diet Regime**

Even though patients have adequate knowledge and diet resources, the complexity of the diet regime always becomes a barrier to their engagement in dietary behavior (Fritsche & Dotzer, 2012). This is proven by findings in a study conducted by Hiatt et al. (1996) to evaluate the dietary behavior among urinary stone patients for more than 4 years where the intervention group who provided with a diet regime consisting of low animal protein, high fiber and dairy products that contained an adequate calcium intake or calcium supplement and fluid intake of more than 8 glasses daily. The result showed a high recurrence of urinary tract stone formation episode compared to the control group who only instructed to maintain fluid and adequate calcium intake. During the study's completion, 12 out of 50 patients in the intervention group experienced stone recurrence compared to only 2 out of 54 patients in the control group who suffer stone relapse. The researchers concluded that a complex diet regime may cause inconvenience among the patients to engage in good dietary behavior as recommended while high awareness among the control group prevented them from recurrence of stone formation.



**Socioeconomic Status**

Socioeconomic status was found to have an impact on dietary habit and may strongly be associated with urinary stone formation and its recurrence (Saint-Elie et al., 2010). Patients who have low economic background may not access information related to disease prevention and are unaware of the symptoms of stone recurrence which results in late treatment seeking (Zargooshi, 2001). In a study by Zargooshi (2001), the researcher singled out poverty and awareness as the main barriers in the early presentation for treatment among 310 patients with urinary stones. Poverty has also

caused patients to experience chronic complications of the disease where 19 patients suffered from pyonephritis and another 23 patients suffered from obstructive renal athrophy.

**Interpersonal Relationship**

Interpersonal relationship as a barrier in promoting health behavior changes is a challenging issue to overcome due to its complex structure which involves family, peers and healthcare professionals. Poor interpersonal relationship between patients and healthcare professionals in term of lack of communication and trust issues become major barriers for patients with urinary tract stones to comply with preventive behaviors such as diet modification (Fritsche & Dotzer, 2012). Patients will be motivated to be involved in disease management if healthcare professionals are able to maintain a good relationship with their patients during their primary visits and followup but patients refused to cooperate when they experiences bad relationship with healthcare professional (Culhane-Pare & Lee, 2006).

Moreover, patients should actively participate in decision-making regarding disease management such as treatment choices and lifestyle counselling with their healthcare provider. However, factors such as fears also become a barrier and the main reason urinary tract stone patients choose to delay their treatment until their condition worsens. The sources of these fears include fear of healthcare professional, treatment procedures and anesthesia (Culhane-Pare & Lee, 2006). The researcher also found that rather than involving in direct discussion, most patients also depend on their family members to voice out concerns and get information related to prevention of stones rather do it by themselves. Thus, building good interpersonal relationships during their visit sessions play an important role in encouraging patients to cooperate in disease management.

**Measurement of Perceived Benefit and Barriers of Dietary Behavior**

There are several instruments have that been used to measure perceived benefits of and perceived barriers to dietary behavior such as;

**Healthy Eating Benefits/Barriers Scale (HEBBS)**

The HEBBS was developed by Walker, Pullen, Hertzog, Boeckner, and Hageman (2006) based on the Health Promotion Model (HPM). The HPM categorizes the factors influencing behaviors such the cognitive-perceptual factor which include items; perceived benefits of and barriers to health promoting behavior similar to the HBM.

Perceived benefits of healthy eating can be measured by a nine items by using the HEBBS. The 9 benefit items are staying healthy, having more energy, being fit, losing weight, becoming more attractive and reducing the risks of cancer, heart disease and breast cancer.

Meanwhile, the perceived barriers of healthy eating can be measured by 9 items by using this scale. The barrier items include: inconvenience, unappetizing, expensive, influence from family members, time consuming and limitation to buy and prepare the food.

The responses of this instrument was designed in a 4-point Likert scale: Strongly Agree, Agree, disagree and Strongly Disagree. The construct validity of the HEBBS was evaluated using data from 220 rural women aged between 50-69 years old. The principle axis factor analysis resulted in a single benefits factor that explained 33% of the variance. The Cronbach's coefficient alpha was found to be .80, indicating an acceptable internal consistency (Walker et al., 2006).



However, the HEBSS was not be suitable to be adopted in this study as this questionnaire is more generalized towards a healthy population and not aimed at a population with a disease such as urinary tract stone. Furthermore, this scale does not cover certain categories such as the benefits and barriers of fluid intake in the prevention of urinary tract stone recurrence.

**Decisional Balance Questionnaire (DBQ)**

This survey instrument was developed to examine the perceived benefits and perceived barriers of eating healthy food among African Americans in prevention of diseases related to their lifestyle such as obesity, diabetes and hypertension (Pawlak & Colby, 2009). The subscale of perceived benefits was developed based on literature reviews related to the statements that measured the perceived benefits of eating behavior (Pawlak & Colby, 2009). This subscale consist of 11 items which measured benefits such as: feeling better, help to taking care of oneself, weight loss, get more nutrients, be healthier, gain more energy, look younger and avoid constipation.

This subscale consist of 12 items which measured barriers such as healthy foods are too expensive, do not taste good, take too long to prepare, not sweet enough, not salty enough, too low in fat, do not satisfy my cravings, do not know how to find healthy foods, do not know how to prepare healthy foods, family and friends don't like to eat healthy foods.

All the statements of perceived benefits and barriers were rated on five-point Likert scale; 1 = Strongly Disagree, 2 = Disagree, 3 = Neither Agree/Disagree, 4 = Agree, and 5 = Strongly Agree. The Cronbach's alpha reliability scores for the perceived benefits and perceived barriers subscale were 0.956 and 0.904, respectively. The content validity was done by an African American dietitian who had an extensive experience in faith-based nutrition interventions to review the content of the survey (Pawlak & Colby, 2009). Three African American church members participated in the cognitive testing of the survey to assess the understanding and readability of the instrument. This scale has a good reliability but requires more exploration on its psychometric properties in order to establish its validity before it can be adopted for general use.

For this study, the items of perceived benefits and barriers subscale in the DBQ is unable to provide further information related to perceived benefits of recommended dietary behavior to prevent specific diseases such as urinary tract stone. Furthermore, this scale also does not cover certain categories such as the benefits and barriers to fluid intake in the prevention of urinary tract stone recurrence.

**Perceived Barriers to Healthy Eating**

This structured questionnaire was developed to capture the importance of perceived barriers to healthy eating among the Malaysian adults (Ismawati, Zainalabidin, & Golnaz, 2014). This instrument was developed based on literature review. This scale consists 13 items which divided under 4 main factor related to barriers; factor 1 = physical (6 items; price of healthy food, lengthy preparation, unappealing food, health food is more perishable, not enough to satisfy hunger, strange/unusual food), factor 2 = knowledge and social (3 items; experts keep changing their minds, not knowing enough about healthy eating, feeling conspicipous amongst others), factor 3 = lack of time (2 items; irregular working hours, busy lifestyle) and factor 4 = Unavailable healthy choice (2 items; healthy options not available in restaurants, limited choice when I eat out).

This scale was using a 7-point scale and the response ranging from 1 = strongly disagree to 7 = strongly agree. The Cronbach's alpha reliability for this scale was 0.96 which indicated good internal consistency. Exploratory analysis (EFA), principal component analysis (PCA) with Varimax rotation was done for validity. The four-factored scale was checked individually to examine overall internal consistency of each factor using Cronbach's alpha. The Cronbach's alpha for the four factors ranged from 0.80 to 0.91.

For this study, the barrier items of this scale is unable to provide specific information related to perceived barriers of recommended dietary behavior to prevent specific diseases such as urinary tract stone. Furthermore, this scale also does not cover certain categories such as barriers to fluid intake in the prevention of urinary tract stone recurrence.

As conclusion, all instruments reviewed in this study were not covered all aspect of perceived benefits of and perceived barriers to recommended dietary behavior among persons undergone urinary tract stone removal. However, certain items in these instruments can be used to measure perceived benefits and barriers in this study. Thus, the researcher developed instrument that measured specific benefits and barriers to

recommended dietary behavior perceived by persons undergone urinary tract removal based on these instruments.

**Relationship Between Dietary Behavior, Perceived Benefits and Barriers Among Persons Undergone Urinary Tract Stone Removal**

There is no study was found to examine the relationship between dietary behavior, perceived benefits and perceived barriers among persons who have urinary tract stone removal. A study conducted by McCauley et al. (2012) among stone former patients by using the HBM as framework, did not examined the correlation between dietary behavior, perceived benefits and barriers. However, this study found that high perceived benefits by patients have increased their motivation and engagement in fluid intake to prevent a recurrence of urinary tract stone, while the existence of barriers prevent patients from further maintaining good fluid intake behavior. Besides, patients in this study are only motivated and willing to change once they believe the recommended preventive health behavior would benefit them more in the future.

Another study conducted on patients with recurrent kidney stone found an inverse significant relationship between preventive behavior and perceived barriers ($r = -.31$, $p = .000$) ( Morowati Sharifabad, Pirouzeh, Hemayati & Askarshahi, 2015). Result from this study reflected the higher perceived barrier, the less good dietary behavior performed by patients which is concurrent with the HBM assumption. However, study by Morowati Sharifabad et al. (2015) only examined relationship between preventive behavior and perceived barriers, where the preventive behavior in this study aimed several prevention strategies such as dietary behavior, exercise, medication intake and seeking consultation from health care professional.



Meanwhile, other specific population also showed consistent correlation between dietary behavior with HBM constructs; perceived benefits and perceived barriers. For example, a study on high folate diet intake behavior among pregnant women found that folate dietary behavior were correlated with perceived benefits ($r = 0.25$, $P < 0.01$) and perceived barriers ($r = -0.41$, $P < 0.01$) (Kloeblen & Batish, 1999).

Thus, relationship between dietary behavior, perceived benefits and barriers among persons undergone urinary tract stone need be investigated as findings from previous studies showed the existence relationship between these three variables.

## Conceptual Framework

The conceptual framework study of dietary behavior, perceived benefits and barriers among persons undergone urinary tract stone removal was based on the Health Belief Model (HBM). The HBM recommended that health behavior is influenced by a person's beliefs about the disease (Rosenstock, 1974; Strecher & Rosenstock, 1997). These beliefs include perceived perceived benefit of and perceived barrier to perform the health behavior (Rosenstock, 1974; Strecher & Rosenstock, 1997). The recurrence of urinary tract stone is associated with the dietary behavior of patients. After urinary tract stone removal, a person is likely to perform or engage in dietary preventive behavior if they perceived the benefits to be more than the barriers and would benefit them in the prevention of urinary tract stone recurrence.