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Modifying Dietary Behaviors to Manage Body Weight

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Abstract Regardless the amount of energy and macronutrients intake, many behaviors related to diet has healthy impact on body weight. The effect of behaviors related to diet on body weight was discussed in the review as managing these behaviors may help to maintain healthy weight. These behaviors are increase meal frequency, controlling snack, choose good time of meal, eating meals at regular time, eating at home, choose low dense food, decrease portion size, and eating slowly. So, modifying behaviors related to diet is a way to maintain healthy body weight even if the content of the diet is same. These behaviors should be considered in dietary recommendation for obese persons.

Keywords: *nutrition, obesity, dietary behaviors, weight management*

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1. Introduction

Obesity is an epidemic health problem and its prevalence has been increased worldwide nowadays. In 2014, 39% of adults (1.9 billion) are overweight and 13% of them (600 million) are obese. There is a variation in prevalence of obesity between the countries [1].

Dietary management is one option of obesity intervention that includes pharmacology and surgery. Many dietary aspects were related to obesity have been studied by researchers to maintain body weight. These aspects include low calories diet, low fat diet and high protein diet. However, while obesity is developing in a person it may accompanied by some modification in dietary behaviors. In other hand, some change that developed in our life may lead to obesity. Besides, recently much behavior has been changed particularly those related to diet. Dietary behaviors are determined by social and cultural factors. Regardless the controlling of energy intake, modifying dietary behaviors to manage body weight is an important dietary recommendation.

Many researchers tended to study the effects of dietary behaviors on health. Dietary behaviors include meal frequency, snacking, time of meal, meal regularity, eating home and shared meal, food density, portion size, and eating speed. The aim of this review is to discuss the effects of behaviors related to diet on body weight as a strategy for dietary management for obesity regardless the total energy intake and quantity of macronutrients consumed.

2. Meal Frequency

Meal frequency is the total number of meals and snack per day. In 1964, Fabry *et al* studied the effects of meal frequency on overweight, cholesterol and glucose [2]. Since that date, many researchers have studied the effects of meal frequency and many effects of meal frequency on different biomarkers of the human body.

For children, Toschke *et al* [3] studied the relationship between meal frequency and childhood obesity in 4370 children from Germany. As number of meal frequency increases, the children obesity decreases. Four percent of children who eat three meals daily were obese, 2.8% of children who eat 4 meals daily were obese, and 1.7% of children who eat five or more meals daily were obese [3]. Moreover, Toschke *et al* [4] studied the relationship between meal frequency and children obesity. As the daily meal frequency increased, the prevalence of children obesity decreased. Meal frequency was inversely associated with children obesity [4]. Furthermore, in 3668 children aged 6-11 years, body mass index and waist circumference decreased significantly as meal frequency increased. Moreover, blood pressure decreased as meal frequency increased. Central fat deposition and adiposity were inversely associated with meal frequency [5].

For adolescents, Fulkerson *et al* [6] studied the longitudinal and cross-sectional association between family meals frequency and overweight in early adolescents and late adolescents. Family meal frequency was reversely associated with over weight for earl adolescent females. This association was significant in cross-sectional rather than longitudinal study. For late adolescent females and all males, the association was not significant. Late female adolescent may were at risk for overweight when they do not eat meals with family in cross-sectional study. Overweight during young adolescent may not protected by eating family meals during high school [6]. Furthermore, in Mota *et al* [7] study the percentage of adolescent consuming fewer than three meals was significantly higher than normal-weight adolescent. As additional meal in male adolescent and female adolescent reduce the risk of overweight and obesity [7]. Eating frequency was negatively associated with the risk of obesity. Risk of

obesity was 45% lower in subjects eating four or more meals than subjects eating three or fewer meals per day [8].

In addition to effect of meal frequency on weight and obesity, effects of meal frequency on other parameters have been studied by many researchers. Effects of meal frequency on these parameters may explain the mechanisms of reducing weight. The effects of meal frequency on resting energy expenditure and activity-induced energy expenditure were examined by westerterp-plantenga accordance to fat-free mass [9]. No effect of meal frequency on the group of low fat-free mass women. Meal frequency was associated positively with resting energy expenditure and inversely with activity-induced energy expenditure in group of older men with medium fat-free mass. However, in the group of younger men with high fat-free mass, was associated inversely with resting energy expenditure and positively to activity-induced energy expenditure [9].

In a study conducted to examine the difference between metabolic marker and substrate partitioning in high frequency meals and low frequency meals. Low frequency meals showed more variation and low area under curve (AUC) of glucose, fat and carbohydrate oxidation were the same in the frequency meals. However, protein oxidation and basal metabolic rate (BMR) were increased significantly in low frequency meals. Moreover, satiety increased and hunger rating reduced in low frequency meals more than in high frequency meals. Despite the higher variation of glucose in low frequency meals, fat oxidation was not high. These finding prove the benefits of low frequency meals for weight management for long term [10].

In obese subjects, Kanaley *et al* [11] examined the difference between 3 meals and 6 meals. There were no differences between three meals and six meals in glucose total area under the curve (tAUC). Moreover, there was no difference between three meals and six meals in glucose:insulin ratio and glucose-dependent insulinotropic polypeptide (GIP). However, insulin, total area under the curve (tAUC) and peak insulin were higher in the three meals comparing to six meals [11].

When Smeets *et al* [12] examined the effects of one meal difference on metabolism and appetite, No differences between three meals and two meals on 24-hour energy expenditure, diet induced thermogenesis, activity-induced energy expenditure and sleeping metabolic rate. However, there was an increased fat oxidation in three meals comparing to two meals but the quantity of oxidized fat from breakfast was decreased. Moreover, over 24-hour, satiety feeling was increased in their meals more than two meals. So, satiety in particular during the day and fat oxidation in particular during the night can be sustained by decreasing intervals between meals [12].

Stote *et al* [13] conducted a controlled trial study to examine the effects of meal frequency on some health indicators. Meal frequency has no significant effects on heart rate, body temperature, or measured blood variables. However, there were significant effects of consuming one meal per day as increase in hunger, decrease in fat mass, increase in blood pressure, and increase in levels of LDL and HDL and decrease in cortisol level [13].

The differences between high meal frequency and low meal frequency in a condition of restricted energy diet were examined in a sample of 16 subjects (8 men and 8 women) in Canada. There were no significant difference between low meal frequency and high frequency diet before or after energy restriction diets. Moreover, there were no difference between high meal frequency and low meal frequency in the adiposity and appetite [14].

When ohkawara *et al* [15] studied the difference between consuming three meals and six meals daily on 24-hour fat oxidation and hunger, they found that increasing meal frequency from 3 to 6 meals has no significant effect on 24-hour fat oxidation, however, it probably increase hunger and desire to eat. They also found that no significant effect of fat oxidation, 24-hour energy expenditure and 24-hour respiratory quotient when meals increased from three to six per day. Moreover, hunger area under curve (AUC) and desire to eat were higher when six meals consumed, but there was no difference between consuming 3 meals or 6 meals in fullness 24-hour area under curve (AUC) [15].

3. Snacking

Bellisle *et al* [16] observed some differences between snack and meal. Snack is about a half of meal in weight and energy content. However, meal is consumed daily. Snack contains more carbohydrate and satiety ratio is higher after snack more than meal. Time of snack during the day is different than meal [16]. Despite the composition and the time of the snack, snacks have slight effect on satiety and the energy macronutrients were not compensated to the next meal. Insulin induced by snacks restrains the late increase in plasma free fatty acids that may inhibit satiety [17].

Obese people consuming snacks significantly more frequent than non-obese people. When number of snacks increased, energy intake increased. This association was high in sweet and fatty snacks [18].

Marmonier *et al* [19] studied the effect of composition of consumed snacks in satiety on the next meal. Consuming snacks has different effect on the meal depending on macronutrient contents of the snack. Dinner has requested after 60, 25, and 34 minutes after consuming high protein, high fat and high carbohydrate snacks respectively [19]. Mazlan *et al* [20] studied the effect of consuming high fat high sugar snack on energy intake and macronutrients selection while Increase in fat content does not replace sugar from the diet and increase in sugar content does not replace fat from the diet. High fat snack increases energy intake and fat intake. High sugar snacks increase energy intake and carbohydrate intake [20]. In eight lean young men, dinner request was delayed by high protein snack more than no snack; however, this is not the case in high carbohydrate snack. For high protein snack, concentrations of plasma fatty acids were lower, while, there were no change in glucose and insulin comparing to no snack. However, for high carbohydrate snack, concentrations of plasma fatty acids were lower, while, concentrations of plasma glucose and insulin were higher comparing to no snack [21].

A study conducted to compare between consuming three snacks: yogurt as high protein (25g CHO, 14g protein, and 0g fat), high fat crackers (19g CHO, 0g protein, and 9g fat), and high fat chocolate (19g CHO, 2g protein, and 9g fat). Afternoon hunger was reduced greatly

in the yogurt snack group. Eating was delayed in yogurt snack group by 30 minutes comparing to chocolate snack group and 20 minutes comparing to crackers snacks group. In addition to, energy intake in dinner was decreased in yogurt snack group by 100 kcal comparing to crackers and chocolate snack group. So, comparing to high fat snack, consuming high protein snack with low energy density as yogurt reduce food intake overall the day and improve satiety and appetite control [22]. Moreover, effects of dairy snacks on appetite were examined by dougkas *et al* [23]. Yogurt has the most negative effect on appetite. Comparing with water, hunger rating was lower after having yogurt, cheese and milk by 8, 10, and 24% respectively. Moreover, energy intake was lower after having yogurt, cheese and milk by 11, 9, and 12% respectively [23].

Almiron-Roig *et al* [24] compared between the effect of time of consumption and physical form of equal energy contents snacks intake. Authors found that no differences between cola and cookies in suppressing hunger rating and satiety. Rating of thirst was reduced by cola but not by cookies. Energy intake was reduced by consumption of cola or cookies 20 minutes before lunch but it was not affected by physical form of snack. It was concluded that time of consumption is more important than form of food [24].

4. Time of Eating

De Castro [25] studied the association between the time of the day of food intake and overall food intake in the day. High density of food in any time of the day was associated positively with increased overall food intake. The intake of food in the morning was associated negatively with overall food intake. The intake of food in the late evening was associated positively with overall food intake [25].

High energy content of breakfast was associated with higher overall energy intake. However, higher ratio of breakfast energy to overall energy was significantly associated with reduction in overall food intake where ratio of breakfast energy to overall energy intake depends on food consumed post breakfast. Moreover, breakfast energy was the strongest effect on daily energy intake. Schusdziarra *et al* [26] recommend that reduction of breakfast energy should be considered as one strategy for obesity management [26]. Night fasting was associated with decrease in blood glucose, energy expenditure, insulin, glucagon, and triglyceride comparing to night eating. There was slight alteration in the secretion of thyroid hormones and cortisol in the night fasting [27].

A study conducted to examine the differences between night fasting and night eating (24-hour awake). When the percentage of carbohydrates content of the morning meal was high, total energy and carbohydrate intake during the day were lower. When the percentage of fat content of the morning meal was high, then, total energy, carbohydrate and fat intake during the day were lower. When the percentage of protein content of the morning meal was high, protein intake was lower during the day. In another hand, the intake over all the day was high when the intake of total energy, carbohydrates and fat high in the evening [28]. Many recent studies suggested that consuming low density food in the morning and avoiding high density food at night may reduce overall intake and is one of the dietary intervention for obesity [25,28,29]. There was no statistical association between time out of the bed and first eating meal, the time between last eating and bed, time of eating from wake-up [8]. Reid *et al* [30] reported that time of meal was associated with overall intake but not with BMI. Authors also reported that eating close to sleep was associated with high total energy intake and, thus, it may increase body weight [30]. When Almiron-Roig *et al* [24] compared between the effect of time of consumption and physical form of equal energy contents snacks intake, they found that time of snack consumption had more effect than physical form of food on energy intake [24].

5. Meal Regularity

Meal regularity refers to eating meals at same time every day. This is, moreover, has positive impact on body weight. When Farshchi *et al* [31] examined the effect of meal regularity in nine healthy lean women; there was no association between meal regularity and energy intake. However, regular meal was associated with high postprandial energy expenditure and thermal effect of food. Thus, this may enhance gaining of weight in long term [31]. Moreover, Farshchi *et al* [32] examined the effects of meal regularity on dietary thermogenesis, insulin sensitivity and fasting lipid profiles. Eating regular meals was associated with reduced energy intake, increased postprandial thermogenesis, reduced fasting cholesterol, and LDL. No effect observed of meal regularity on fasting glucose and insulin. However, the insulin concentration peak was lower in eating regular meals more than eating irregular meals [32]. In addition to, the effects of meal regularity on lipids, insulin, glucose and uric acid were examined by Farshchi *et al* [33]. Meal regularity has no effect on fasting blood glucose and insulin. However, AUC and peak of insulin were higher for the irregular meals. Meals irregularity was associated with higher total and LDL cholesterol [33]. Although, in a cross-sectional study conducted on 3,607 aged 60 years subjects in Sweden, irregular meals were associated with metabolic syndrome and insulin resistance [34]. In another study, Obesity was significantly associated with skipping breakfast and skipping lunch [35].

6. Eating Home and Shared Meal

Subjects who eat breakfast out of home are twofold higher risk of obesity. Moreover, subjects, who eat dinner away from home are two-fold higher risk of obesity, however, this association was not significant. In contrast, eating lunch away from home was associated with risk of obesity more than eating lunch at home. Comparing with eating breakfast and dinner at home, eating breakfast and dinner away of home were significantly higher in calories, calories from fat, calories from saturated fat, and low calories from protein, calories from carbohydrate and fiber. Lunch eating away was significantly higher in calories, calories from fat, low calories from protein [8]. Although, among more than 34, 000 subjects from Ten European countries, eating away of home was associated with energy intake positively [36].

As discussed in meal frequency that as meal frequency increase as weight decrease, Chan *et al* [37] found that

increase in frequency of family meals at home was negatively associated with body mass index (BMI) [37]. In Schroder *et al* [38] cross-sectional study that conducted on more than 3000 Spanish people, fast food consumption was associated with obesity, higher BMI, energy intake, poor diet quality, and more likely not to meet recommended dietary allowance (DRI) [38]. Family meals was associated positively with intake of fruits, vegetables, grains, energy, protein, fiber, calcium, iron, and many vitamins [39].

In another study conducted on young adult, eating with others was associated with increased intake of fruit and vegetables significantly. However, eating on the run was associated with increased intake of fast food, soft drink, and total fat significantly [40]. Parents who reported eating six to seven family meals per week during childhood are significantly positively associated with more eating family meals currently comparing to those eating less family meals per week. Although, parents who reported eating family meals during childhood, are positively significantly associated with regular family meals currently [41]. High frequency of family meal during adolescence was associated with high intake of fruit, vegetable, and low intake of soft drink. Although, it was associated with more breakfasts meals for women and more dinners for women and men in adulthood [42].

Diet quality was significantly better in families with regular meals. Affable environment around family meals was associated with regular meals. Home-made meals were positively associated with regular family meals. In contrast, fast-foods were negatively associated with regular family meals. As more as parents work part time and stayed at home is positively associated with regular meals. To enhance family meals, is not enough to mention its benefits, but also to support skills of parents to prepare food at home [43]. So, Promoting family meals with children may have long-term benefits over generations.

7. Food Density

Low dietary energy density is higher in proportion of food and higher micronutrients and water and low in fat. Persons who eat low dense food are consuming more food comparing to those eating high dense food according to the weight of the food. However, persons who eat low dense food are consuming low energy intake comparing to those consuming high dense foods. When normal weight persons compared to obese persons, normal weight persons were consuming low dense food more than obese persons. Subjects with low dietary energy density consume fewer beverages such as caloric carbonated beverage. They also consume less fat and had higher intake of micronutrients [44,45].

The lowest energy density value is found with those consuming high fruit and vegetables. Low dense food is high in micronutrients and water and low in fat. Persons with low dense food are consuming fewer caloric beverages comparing to those with high dense food. To consume low dense food, persons should be encouraged to have more fruit, vegetable and grains and to reduce fat [45]. In addition to, From Mendoza *et al* [46] cross-sectional study that conducted from 1999-2002 National Health and Nutrition Examination Survey, the dietary energy density was associated with higher BMI in women and higher waist circumferences in women and men. In addition to, dietary energy density was independently associated with the metabolic syndrome and higher fasting insulin [46].

Energy density, in addition, was associated with significant increase in waist circumference but not with weight change in about 90000 subjects from five European countries during mean of 6.5 years. The annual weight change for 1 kcal/g energy density was -42 g/year, 0.09 cm /year for waist circumferences. Energy density of 1 kg/g was associated with change in waist circumferences by 0.17 cm/year for subjects with <25 baseline BMI [47]. When Ledikwe *et al* [48] studied the impact of changing food density on weight changes over 18 months. The results were that changing dietary density was associated with lower BMI and the greatest loss was in the first six months [48]. Drewnowski *et al* [49] reported that low density food is more expensive than high density food. That may make high density food more preferable in low-economic people. So, authors are suggesting that in addition to behavioral intervention, to improve diet quality, economic support may be required [49].

8. Portion Size

It is reported that when large portion size offered comparing to small portion size, person have more 30% of energy. The increase in portion size was not influenced by person or person characteristics as body weight and sex [50]. In addition to that, the weight of consumed beverage was significantly increased when portion size of the beverage increased. Increasing portion size of beverage by 50%, intake of beverage increased by 26% for men and 10% for women. So, when portion size of caloric beverage increased that increase intake of energy. To reduce caloric intake, non-caloric beverage or low caloric beverage should be considered as an alternative to high caloric beverage [50]. In another study, there was 13% increase in obesity risk when portion size increase by one size among nine sizes [35].

In a restaurant setting, energy intake increased as portion size increased, however, there was no difference between group who consume small restaurant portion (248g) and group who consume large restaurant portion (377g) in the appropriate of the portion size [51]. Young &nestle 2002 determined sample of marketplace food to compare them with federal standards and determine change in portion size through the history. Findings show that there is an increase in marketplace food portion and exceeds federal standards. This increase in portion size is began in the 1970s and it continued parallel with the increase in obesity [52].

The impact of increasing portion size of a sandwich on energy intake was examined by Rolls *et al* [53]. When portion size of the sandwich increased from 8-inch to 12-inch, energy intake increased by 23% for men and 12% for women. In addition to, there were no significant difference in rating of hunger between 8-inch and 12-inch sandwiches [53]. Consumption of beverage is significantly increased when portion size increased. When portion size increased by 50%, energy intake from caloric beverage increased by 10% for women and 26% for men. No effect was observed of increased portion size of beverage on

food intake. So, when portion size of caloric beverages increased, the total energy intake will be increased [54].

9. Eating Speed

Recently, many researchers confirmed that eating speed influence energy intake. Eating slowly is associated with decrease in energy intake significantly. Moreover, it increase water intake significantly. In addition to, satiety was higher with slow rate eating and it show higher satiety efficiency index [55]. In another study by Andrade *et al* [56] there was no difference between appetite rating and energy intake in slow or fast rate eating. However, subjects with slow rate eating, has less hunger at 1 hour post slow eating. Authors, assume that the lack of association between tow eating speed is may be because water intake affects appetite regulation [56]. Furthermore, in another study by Shah *et al* [57], the effect of eating speed on energy intake between normal weight and overweight subjects was examined. In slow eating rate, energy intake was lower in normal weight but not in overweight subjects comparing to fast eating rate. Normal weight and overweight subjects had lower energy density and eating rate during the slow eating comparing to fast eating rate. At 60 minutes after the beginning of meal, both normal weight and overweight reported less hunger and more fullness for normal weight group during slow eating [57].

10. Conclusion

Obesity is world-wide common health problem that leads to many health complications. Developing obesity in a person may be accompanied with some change in dietary behaviors. So, Modification of behaviours related to diet may help to obtain optimal body weight.

In other hand, regardless restriction of energy and macronutrients intake, controlling these behaviors may maintain healthy body weight. These behaviors are: meal frequency, snacking, time of meal, meal regularity, eating home and shared meal, food density, portion size, and eating speed. Optimal body weight was associated with high meal frequency, high food intake in morning and low food intake in overnight, more regular meals, more eating at home and shared meals, low density food, low portion size food, low eating speed. These behaviors should be considered in dietary recommendations for obesity intervention.

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