Chapter 2
Review of Literature
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In this chapter an attempt has been made to review the literature on the subject critically and comprehensively. Apart from reporting the previous work, the other purpose is to provide insight into the studies of methods and procedures. The available related studies, both Foreign and Indian were screened and have been presented under the following sub headings.

2.1 Carbohydrate Metabolism and Diabetes

2.2 Glycemic Index Theories

2.3 Clinical Implications of Glycemic Index

2.4 Glycemic Index and Management of Diabetes and other chronic disorders

2.5 Association of Diabetes and other chronic disorders

2.1 Carbohydrate Metabolism and Diabetes

Allison M. Hodge (2004), Examined associations between type 2 diabetes and fiber, glycemic load (GL), dietary glycemic index (GI), and fiber-rich foods. This was a prospective study of 36,787 men and women aged 40–69 years without diabetes. For all self-reported cases of diabetes at 4-year follow-up, confirmation of diagnosis was sought from medical practitioners. Case subjects were those who reported diabetes at follow-up and for whom there was no evidence that they did not have type 2 diabetes. Data were analyzed with logistic regression, adjusting for country of birth, physical activity, family history of diabetes, alcohol and energy intake, education, 5-year weight change, sex, and age. 31,641 (86%) participants completed follow-up, and 365 cases were identified. The odds ratio (OR) for the highest quartile of white bread intake compared with the lowest was 1.37 (95% CI 1.04–1.81; P for trend = 0.001).
Intakes of carbohydrate (OR per 200 g/day 0.58, 0.36–0.95), sugars (OR per 100 g/day 0.61, 0.47–0.79), and magnesium (OR per 500 mg/day 0.62, 0.43–0.90) were inversely associated with incidence of diabetes, whereas intake of starch (OR per 100 g/day 1.47, 1.06–2.05) and dietary GI (OR per 10 units 1.32, 1.05–1.66) were positively associated with diabetes. These relationships were attenuated after adjustment for BMI and waist-to-hip ratio. Conclusion of the study was reducing dietary GI while maintaining a high carbohydrate intake may reduce the risk of type 2 diabetes. One way to achieve this would be to substitute white bread with low-GI breads.

Boyd A, Swinburn (2001), aimed there study “Long term Effects of a reduced-Fat Diet Intervention in Individuals with Glucose Intolerance” to determined whether reducing Dietary fat would reduce body weight and improve long term glycemia in people with glucose intolerance. In this study a 5-year follow-up of a 1-year randomized controlled trial of a reduced fat ad libitum diet versus usual diet was conducted. Participants with glucose intolerance (2-hour blood glucose 7.0-11.0 mmol/l) were recruited from a Workforce Diabetes Survey. The group that was randomized to a reduced-fat diet participated in monthly small group education sessions on reduced fat eating for 1 ear. Body weight and glucose tolerance were measured in 136 participants at baseline, 6 months, and 1 year, with follow-up at 2 years (n=104), 3 years (n=99), and 5 years (n=103). Result indicated, compared with control group weight decreased in the reduced fat –diet group (p<0.00001); the greatest difference was noted at 1 year (-3.3kg), diminished at subsequent follow-up (-3.2 kg at 2 years and -1.6 kg at 3 years) and was no longer present by 5 years(1.1 kg). Glucose tolerance also improved in patients on the reduced-fat diet lower proportion had type 2 diabetes or impaired
glucose tolerance at 1 year (47 vs. 67%, \( p < 0.05 \)) but in subsequent years, there were no differences between groups. However, the more compliant 50% of the intervention group maintained lower fasting and 2-hours glucose at 5 years (\( p = 0.041 \) and \( p = 0.026 \), respectively) compared with control subjects. Finally, they concluded that the natural history for people at high risk of developing type 2 diabetes is weight gain and deterioration in glucose tolerance. This process may be ameliorated through adherence to a reduced fat intake.

Bryan W. Wolf, Keith A. Garleb, Yong S. Choe, Phillip M. Humphrey and Kevin C. Maki (2003) stated Pullulan is an extracellular polysaccharide excreted by the fungus Aureobasidium pullulans. To evaluate the glycemic and breath hydrogen responses and gastrointestinal tolerance to Pullulan, non-diabetic healthy adult subjects (\( n = 28 \)) were studied in a randomized, double-masked, crossover design. After an overnight fast, subjects consumed beverages containing 50 g of carbohydrate from either maltodextrin (control) or Pullulan. Capillary blood glucose response was determined for 180 min post-prandially. Breath hydrogen response was determined for 8 h post-prandially. Compared with control, incremental peak blood glucose concentration was reduced (\( P < 0.01 \)) when subjects consumed Pullulan (4.24 ± 0.35 vs. 1.97 ± 0.10 mmol/L). In addition, Pullulan reduced (\( P < 0.01 \)) the positive incremental area under the glucose curve by 50%. When subjects consumed Pullulan, the incremental blood glucose excursions were reduced (\( P < 0.01 \)) at 15, 30, 45, 60 and 90 min, but were maintained above basal glucose concentrations at 150 and 180 min. At 180 min, the blood glucose concentration was higher (\( P < 0.05 \)) when subjects consumed Pullulan compared with control, supporting the hypothesis that Pullulan is digested slowly. Breath hydrogen concentrations were increased (\( P < 0.01 \)) at 3, 4, 5, 6,
7 and 8 h post-prandially when subjects consumed Pullulan. In the first 24-h postprandial period, the frequency and intensity of flatulence was higher (P < 0.05) after subjects consumed Pullulan compared with control. In conclusion, Pullulan attenuated the postprandial glycemic excursion compared with an equivalent maltodextrin challenge. Pullulan also increased breath hydrogen excretion and the incidence of gastrointestinal intolerance symptoms, indicating that a portion of Pullulan was malabsorbed.

Calle-Pascual AL, Gomez V, Leon E, Bordiu E (1988) Twenty-four diabetic patients (12 type 1 and 12 type 2) were studied to determine the influence of using foods rich in carbohydrates with either low or high glycemic indexes on the glycemic control of Diabetes Mellitus. All patients were treated with insulin. During 2 periods of 4 weeks the patients received, at lunch, 2 types of foods rich in carbohydrates as part of their usual diet. Meal A: foods with a low glycemic index and Meal B: foods with a high glycemic index. During the last 7 days of each period the patients determined, at home, their capillary glucose levels before and 1, 2, and 3 hours after lunch by means of a reflectometer. At the end of each period HbA1 levels were also determined. No differences in insulin dose or changes in body weight were found during the two periods of the study for both types of diabetic patients. Capillary glucose levels before lunch were similar on both diets and for both types of diabetic patients. Similarly, postprandial capillary glucose levels 1, 2, and 3 hours later were not different for both died A and diet B. No statistically significant differences were found either in HbA1 values for both periods of the study. These results confirm previous ones obtained in acute studies. The present findings indicate that the glycemic response of foods rich in carbohydrates is modified when included in a mixed meal by the other components of
the meal. From these date it can be inferred that the use in a diet of foods with a low glycemic index does not improve the glycemic control of patients affected of Diabetes

Crapo PA (1977), Carried out a study to see the effect of different type of Carbohydrates on blood glucose level and insulin sensitivity. For the study various groups of diabetes patients selected and each group were given specific type of Carbohydrate food i.e. simple and complex carbohydrate. there post prandial blood sugar level recorded. Result indicated that both blood glucose level and insulin level might respond differently to different kind of Carbohydrates in the diet. The response of simple sugar was thought to be greater than those of complex carbohydrates.

Darwiche G, Ostman EM, Liljeburg HG (2001), Carried out a study aiming to evaluate the use of ultrasonography to determine whether the lowered glycemic and insulinemic responses to bread ingestion after the addition of the sodium propionate are explained by a specific effect of propionate on the GER. The research design comprised, first the effect of sodium propionate in bread was evaluated in 9 healthy volunteers. Barley bread products, with or without added sodium propionate, were ingested as breakfast after an overnight fast. The GER was monitored for 2 hours by ultrasonography; during the period, capillary blood was withdrawn repeatedly for measurement of blood glucose and insulin. The result indicated that the GER of barley bread decreased markedly after the addition of sodium propionate and was accompanied by lowered glycemic and insulinemic response. They concluded this study, the lowered glycemic response to ingestion of bread with added sodium propionate appears to be related to a lower GER.
David JA Jenkins, Cyril WC Kendall (2003), Based on what is known of the components of plant-based diets and their effects from cohort studies, there is reason to believe that vegetarian diets would have advantages in the treatment of type 2 diabetes. At present there are few data on vegetarian diets in diabetes that do not in addition have weight loss or exercise components. Nevertheless, the use of whole-grain or traditionally processed cereals and legumes has been associated with improved glycemic control in both diabetic and insulin-resistant individuals. Long-term cohort studies have indicated that whole-grain consumption reduces the risk of both type 2 diabetes and cardiovascular disease. In addition, nuts (e.g., almonds), viscous fibers (e.g., fibers from oats and barley), soy proteins, and plant sterols, which may be part of the vegetarian diet, reduce serum lipids. In combination, these plant food components may have a very significant impact on cardiovascular disease, one of the major complications of diabetes. Furthermore, substituting soy or other vegetable proteins for animal protein may also decrease renal hyperfiltration, proteinuria, and renal acid load and in the long term reduce the risk of developing renal disease in type 2 diabetes. The vegetarian diet, therefore, contains a portfolio of natural products and food forms of benefit for both the carbohydrate and lipid abnormalities in diabetes. It is anticipated that their combined use in vegetarian diets will produce very significant metabolic advantages for the prevention and treatment of diabetes and its complications.

Debra A Schaumburg (2004) Described. Metabolism of many of the most commonly consumed carbohydrates in the United States results in a high plasma glucose response, which can be quantified by the glycemic load. Although hyperglycemia is a risk factor for cataract, there is no information on the potential
effect of a high dietary glycemic load on the incidence of age-related cataract. So their objective was to prospectively examine the association between dietary glycemic load and incident age-related cataract. They studied 2 cohorts—71,919 women and 39,926 men—aged 45 y who had no previous diagnosis of cataract, diabetes mellitus, or cancer and who were followed for 14 and 12 y, respectively, for the occurrence of cataract extraction. We calculated dietary glycemic load from data reported on multiple validated food-frequency questionnaires and used pooled logistic regression models to estimate the association with incident cataract extraction. We performed analyses separately for each cohort and then calculated pooled estimates across cohorts. Results indicated, During 980,683 person-years of follow-up, we confirmed 4865 incident age-related cataract extractions. After adjustment for age, cigarette smoking, body mass index, total caloric intake, dietary intake of lutein and zeaxanthin, and alcohol consumption, there was no significant relation of dietary glycemic load to risk of cataract extraction (P for trend = 0.10). The pooled relative risk between the highest and lowest quintiles of dietary glycemic load was 0.95 (95% CI: 0.81, 1.11; P for heterogeneity by cohort = 0.1). Conclusion of the study shows, These prospective epidemiological data do not support the hypothesis that a high dietary glycemic load, primarily a result of consumption of refined carbohydrates, increases the risk of cataract extraction.

Diane M, Belinda S. O’Connell, Mary L Johnson and Marion Franze (1999). In the study entitled “Glycemic and insulinemic response of subjects with type 2 diabetes after consumption of three energy bars” Seven men and 3 women with type 2 diabetes controlled by medical nutrition therapy alone participated in the study. Age range was 43 to 74 years of age and duration of diabetes ranged from 5 months to 5 years.
Hemoglobin Alc was less than 9.0%, and fasting plasma glucose <11.2mmol/L. Mean body weight was 87kg (range 63–100kg). In a double blind, randomized, 3-way crossover design subjects reported to the center after an overnight fast (10 to 12 hours) on 3 separate occasions (3 to 10 days apart). Subjects consumed approximately 50 grams of carbohydrate from one of three snack bars: the Choice dm® Nutrition Bar (Mead Johnson & Co, Evansville, Ind) which contains resistant starch (resistant starch bar), the Benefit Bar® (Health Management Resources, Boston, Mass) an energy bar with similar macronutrient composition that does not contain resistant starch (traditional energy bar) and the Snickers Bar® (Mars Inc, Hackettstown, NJ) a popular candy bar (candy bar). Bars were presented in a randomized order and all subjects consumed all three bars. Blood glucose and insulin levels were drawn −30, 0, 30, 60, 90, 120, 150, 180, 240, and 300 minutes after initiating the feeding. Plasma glucose was analyzed using the hexokinase method on a Dade Behring Paramax (Deerfield, 111). Plasma insulin levels were determined using an immuno-chemiluminescent method and a polyclonal in house antibody. Data were analyzed using an analysis of variance for a crossover model and included terms for sequence, subject within sequence, treatment, and treatment by period interaction. The model calculated least squared means and standard error. The mean peak blood glucose value for all subjects at each time point was used to determine statistical significance. Mean serum insulin and glucose curves (Figure were calculated using the mean blood glucose or insulin value for all subjects at each time point. The mean) peak blood glucose level at 60 minutes for the resistant starch bar (9.46±0.33mmol/L) was significantly lower than that of the traditional energy bar (11.25±0.32mmol/L), and the candy bar (11.03±0.33mmol/L), P=.003. The mean maximum increase from baseline for the traditional energy bar (3.66±0.24mmol/L) and the candy bar (3.63±0.25mmol/L) were similar and
significantly greater than that of the resistant starch bar (1.89±0.25mmol/L) P<. 001. Mean area under the glucose curve (AUC) adjusted for baseline of both the traditional energy bar (316.65±19.8mmol/L) and the candy bar (306.61±20.05mmol/L) were significantly different from the resistant starch bar (150.37±20.44mmol/L), P<. 001 but did not differ between themselves, P=. 72. There were significant differences in the insulin values at 90 minutes for the traditional energy bar (498±55pmol/L) vs. the resistant starch bar (288±57pmol/L), P=. 008, but not for the resistant starch bar vs. the candy bar (318±58pmol/L), P=. 67. The traditional energy bar led to significantly greater maximum increases from baseline as compared to the resistant starch bar, P=. 016, and the candy bar P=. 011. In vivo and in vitro research indicates that not all starches are equally available for enzymatic digestion. Starches that are incompletely digested and absorbed in the small intestine of healthy people are referred to as “resistant starch”. Because resistant starch is not digested to glucose and absorbed in the small intestine it causes less of an increase in postprandial blood glucose and insulin levels than an equivalent quantity of fully digestible starch. High resistant starch and low glycemic index meals decrease postprandial blood glucose and insulin levels and improve blood glucose control (17–21) in subjects with hyperinsulinemia (9,14), diabetes and in healthy volunteers (6,8,15,16). Resistant starch has also been shown to improve fasting and postprandial blood glucose levels at subsequent meals (10,12, and 13). This study demonstrates that resistant starch consumed in an energy bar lead to significantly lower postprandial blood glucose and insulin levels as compared with bars containing fully digestible starch.

Gary M Shaw, Thu Quach, (2003), determines, Maternal diabetes, pre-pregnancy obesity, hyperinsulinemia, and intakes of sweets have been associated with increased
risks of neural tube defects (NTDs). The interdependence of these factors suggests a common pathogenesis via altered glyemic control and insulin demand. They investigated whether maternal pre-conceptional dietary intakes of sucrose, glucose, fructose, and foods with higher glycemic index values influence the risk of having NTD-affected pregnancies. In a population-based case-control study, all hospitals in 55 of the 58 counties in California participated. In-person interviews were conducted with the mothers of 454 NTD cases (including fetuses and infants who were electively terminated, stillborn, or born alive) and with the mothers of 462 non-malformed controls within an average of 5 months from the term delivery date. The risk of having an NTD-affected pregnancy was the main outcome measure. Risks of having an NTD-affected pregnancy were not substantially elevated in relation to preconceptional intakes of glucose or fructose. Elevated risks of 2-fold were observed for higher intakes of sucrose and foods with higher glycemic index values. Elevated risks were observed for high sucrose intake irrespective of whether adjustment was made for other covariates such as maternal folic acid intake. For higher glycemic index values, adjusted elevated risks were observed in women whose body mass index (in kg/m²) was > 29. Observed associations support observations that potential problems in glucose control are associated with NTD risk even among Nondiabetic women.

Gertrud Schäfer, Ulrike Schenk (2003), stated in their study titled “Comparison of the effects of dried peas with those of potatoes in mixed meals on postprandial glucose and insulin concentrations in patients with type 2 diabetes” Blood glucose response of diabetic patients to mixed meals containing food both rich in fiber and with a low glycemic index, such as dried peas, is scarce. Thus, the extent to which type 2 diabetic patients should take into account low-glycemic, high-fiber foods for
their daily carbohydrate intake is uncertain. They compared the glycemic and insulinemic responses to 3 different meals based on dried peas, potatoes, or both in-patients with type 2 diabetes undergoing dietary treatment. The meals, prepared according to local recipes and consumed at weekly intervals in random order at lunchtime, contained comparable amounts of carbohydrate, fat, protein, and water. The carbohydrate source of the meals differed and was supplied from either dried peas (meal 1), potatoes (meal 3), or a combination thereof (meal 2). Peripheral and venous blood was sampled over 180 min. Results indicated that the increases in postprandial plasma glucose and insulin concentrations were delayed and significantly smaller after the pea meal than after the potato meal. The areas under the glucose curve were 164 ± 40, 257 ± 57, and 381 ± 40 mmol • 180 min/L for meals 1, 2, and 3, respectively (P < 0.01). The areas under the insulin curve were 13.8 ± 4.3, 15.4 ± 3.9, and 31.2 ± 6.9 mmol • 180 min/L, respectively (P = 0.0514). These findings suggest that carbohydrates in dried peas may be largely disregarded in carbohydrate counting and that type 2 diabetic patients should probably increase their consumption of low-glycemic, high-fiber foods at the expense of high-glycemic, low-fiber foods.

Gilbertson HR, Brand-Miller JC (2001) Undertook a study entitled, “The Effects of flexible low glycemic index dietary advice versus measured carbohydrate exchange diets on glycemic control in children with type one diabetes”. They determined the long term effects of low glycemic index dietary advice on metabolic control and quality of life in children with type 1 diabetes. For this study they recruited children with type 1 diabetes to a prospective, stratified, randomized, parallel study to examine the effects of a measured carbohydrate exchange diet (CHOx) versus a more flexible low glycemic index (GI) dietary regimen on HbA (1c) levels, incidence of hypo-hyperglycemia, insulin dose, dietary intake, and measure of quality of life over 12 months. They found,
at 12 months, children in the low-GI group had significantly better HbA (1c) levels than those in the CHOx group. Rate of excessive hyperglycemia also found significantly less in the low GI group. They concluded this study that the flexible dietary instruction based on the food pyramids with an emphasis on low-GI foods improves HbA (1c) level without increasing the risk of hypoglycemia and enhance the quality of life in children with diabetes.

**Hallfrisch J, Facen and Behall KM (2000)** Carried out a study entitled “Mechanism of the effects of grains on insulin and glucose responses” revealed that consumption of a number of grains extracts control or improve glucose tolerance and reduce insulin resistance. There are number of mechanisms by which the grains may improve glucose metabolism and delay or prevent the progression of impaired glucose tolerance. These mechanisms are related to physical structure of the grains. The composition of grain, particle size, amount and type of fiber, viscosity, amyllose and amylopectin content all effect the metabolism of carbohydrate from grains. They suggested, increasing whole grain intake in the population could result in improved glucose metabolism and delay or reduce the risk of developing type 2 diabetes mellitus. Lingstorm P, Liljeburg H, Bjorck I (2000), carried out a study in which plaque pH was studied during 60 minutes in situ in 10 subjects after eating various breads. The pH response than compared to glycemic index obtained from earlier investigations. The following products were tested: (1) barley kernel bread, (2) sourdough fermented, (3) white wheat bread, (4) syrup sweetened wheat-rye bread. A 5% sucrose solution was served as control. The pH drops with all the breads were considerably smaller than the sucrose solution during first 15-min. From 30 min or onwards the breads gave similar or even lower pH than sucrose. There was great difference in pH response among 4 breads, with most
pronounced pH fall for syrup-sweetened wheat-rye bread followed by white wheat bread. Intensive chewing of barley kernel bread increased, while the addition of fat to syrup-sweetened wheat rye bread reduced the pH fall, in both cases by about 0.2 pH units. A high correlation between plaque pH and GI found, i.e. the more pronounced the pH drop in plaque, the higher the GI in blood. Therefore, both from a carcinogenic and a metabolic point of view, breads with a low GI should be recommended.

Jenkins DJ, Wolever TM (1988) reported that different starchy foods produce different glycemic responses when fed individually, and there is some evidence that this also applies in the context of the mixed meal. A major reason appears to relate to the rate at which the foods are digested and the factors influencing this. A similar ranking in terms of glycemic response to specific foods is seen independent of the carbohydrate tolerance status of the groups tested. Potentially clinically useful starchy foods producing relatively flat glycemic responses have been identified. Many of these are considered ethnic or traditional and include legumes; pasta; grains such as barley, parboiled rice, and bulgur (cracked wheat); and whole-grain breads such as pumpernickel. Specific incorporation of these foods into diets has been associated with reductions in low-density lipoprotein cholesterol and triglyceride levels in hyperlipidemia and with improved blood glucose control in insulin-dependent diabetic patients. To facilitate identification of such foods, it has been suggested that the glycemic response should be indexed to a standard (e.g., white bread) to allow comparisons to be made between the glycemic index of foods tested in different groups of subjects. The scope of application of this principle is subject to further investigation. It may be used to expand the range of possibly useful starchy foods for trial in the diets of diabetic patients.
Kalbag JB, Walter YH (2001), carried out this study to compare the pharmacodynamic effects of single dose of nateglinide (A 4166), repaglinide and placebo on mealtime insulin secretion and glycemic control in healthy subjects. Fifteen healthy volunteers participated in this open label five period crossover study. They received single 10-min preprandial doses of 120-mg nateglinide, 0.5 or 2 mg repalgenide, or placebo or 1 min preprandially of 2-mg repalginide. Subject receive each dose only once, 48 h apart. Pharmacodynamic and pharmacokinetic assessments were performed from 0 to 12 h test date. The result indicated that nateglinide induced insulin secretion more rapidly than 2 or 0.5 mg repaglinide and placebo. The conclusion of this study is, nateglinide provided more rapid and shorter lived stimulation of insulin than repaglinide, resulting in lower meal-related glucose excursion. If similar result is observed in diabetics, nateglinide may produce a more physiological insulin secretory response with the potential for a reduced risk of post absorptive hypoglycemia.

Keihm TG (1976) performed several studies to see the role of high fiber in low glycemic response. In his study “Beneficial Effect of High Carbohydrates, High Fiber Diet in Hyperglycemic men, Author suggested that food rich in carbohydrates specially in the form of fiber is associated with low glycemic response so as to reduced risk of hyperglycemia.

Kirwan JP, Cyr-Campbell D, and Campbell WW (2001), Carried out a study to determine whether pre-exercise ingestion of meals with moderate or high glycemic indexes affects glucose availability during exercise performance time. Six male volunteers (22 +/- 1 year; 80.4 +/- 3.7 kg; VO (2 peak) 54.3 +/- 1.2 ml. Kg (-1), min (-
1) ingested 75 g of carbohydrates in the form of 2 different breakfast cereals, rolled oats (moderate GI, approximately 61; MOD GI) or puffed rice (high GI, Approximately 82; HI GI), combined with 300 ml of water alone (control). The trails were randomized, and the meals were ingested 45 minutes before the subjects performed cycling exercise (60% VO2 peak) to exhaustion. Venous blood samples were drawn to measure glucose, free fatty acids, glycerol, insulin, epinephrine (FPI), Norepinephrine (NE) concentration. A muscle biopsy specimen was obtained from the vastus lateralis before the meal and immediately after the exercise for glycogen determination. Before exercise, both test meals elicited significant (p < .05) hyperglycemia and hyperinsulinemia compared with control. The glycemic response was higher (p < .05) at the start of exercise after the HI GI meal than after control. During exercise, plasma glucose levels were higher (p < .05) at 60 (5.2 +/- 0.1, 4.2 +/- 0.2, and 4.6 +/- 0.1 mmol. L (-1) and 90 (4.8 +/- 0.1, 4.1 +/- 0.1, and 4.3 +/- 0.1 mmol. L (-1) minutes after the Mod GI meal than after either the HI GI or control. Total carbohydrate oxidation was greater (p < .05) during the MOD GI trail than in control and was directly correlated with exercise performance time (r = .95, p < .0001). Pre-exercise plasma FFA levels were suppressed (p < .05) 30 and 45 minutes after ingestion of the HI GI meal and 45 minutes after the ingestion of MOD GI meal compared with control. Finally they concluded that a MOD GI meal provides a significant performance and metabolic advantage when consumed 45 minutes before exercise.

Matthias B Schulze, Simin Liu (2004) Indicated, Increasing evidence suggests an important role of carbohydrate quality in the development of type 2 diabetes. Objective of this study was to prospectively examine the association between glycemic index, glycemic load, and dietary fiber and the risk of type 2 diabetes in a
large cohort of young women. In 1991, 91249 women completed a semiquantitative food-frequency questionnaire that assessed dietary intake. The women were followed for 8 y for the development of incident type 2 diabetes, and dietary information was updated in 1995. They identified 741 incident cases of confirmed type 2 diabetes during 8 y (716 300 person-years) of follow-up. After adjustment for age, body mass index, family history of diabetes, and other potential confounders, glycemic index was significantly associated with an increased risk of diabetes (multivariate relative risks for quintiles 1–5, respectively: 1, 1.15, 1.07, 1.27, and 1.59; 95% CI: 1.21, 2.10; P for trend = 0.001). Conversely, cereal fiber intake was associated with a decreased risk of diabetes (multivariate relative risks for quintiles 1–5, respectively: 1, 0.85, 0.87, 0.82, and 0.64; 95% CI: 0.48, 0.86; P for trend = 0.004). Glycemic load was not significantly associated with risk in the overall cohort (multivariate relative risks for quintiles 1–5, respectively: 1, 1.31, 1.20, 1.14, and 1.33; 95% CI: 0.92, 1.91; P for trend = 0.21). Conclusion of the study was, A diet high in rapidly absorbed carbohydrates and low in cereal fiber is associated with an increased risk of type 2 diabetes.

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Meyer KA, Kushi LH, Jacobs DR and Folsom AR (2000) examined the relation of baseline intake of carbohydrate, dietary fiber, dietary magnesium and carbohydrate rich food and the glycemic index with incidence of diabetes. It was a prospective cohort study of 35988 older women initially free of diabetes. During 6-years of follow-up, 1141 incident cases of diabetes were reported. Total grain, whole grain, total dietary fiber, cereal fiber and dietary magnesium intake showed strong inverse association with incidence of diabetes after the adjustment for potential non-dietary confounding variables. These data support a protective role for the grains (particularly whole grains), cereals fiber, and dietary magnesium in the development of diabetes mellitus in older women. They concluded dietary carbohydrate might influence the development of type 2 diabetes mellitus.
Michael SD, Agues (1989) aimed a study titled "Dietary composition and physiological adaptation to Energy restriction" to examine whether Dietary composition affects hormonal and metabolic adaptation to energy restriction. In this study a randomized design was used to compare the effects of a high Glycemic and Low Glycemic index energy restricted diet. The macronutrient composition of high Glycemic was 67% Carbohydrates, 15% protein, and 18% fat. Low Glycemic diet was 43% Carbohydrates, 27% Protein and 30% fat. The Diet has similar total energy density and fiber content. The subjects, 10 moderately overweight young men were studied for nine days on two separate occasion. On day 0-1 they consumed self selected food ad libitum, on day 1-6 they received energy restricted high or low Glycemic Index diet, on 7-8 day the high or low GI diet were consumed ad libitum. Result indicated decreased serum leptin to a lesser extent from 0-10 days with high GI diet than with low GI diet. Resting energy expenditure declined by 10.5% during high GI food but only 4-6% during low GI diet. They concluded that diet with identical energy content could have different effect on leptin concentration and energy expenditure.

Nancy F. Sheard, Nathaniel G., Brand-Miller (2004), Diabetes has long been viewed as a disorder of carbohydrate metabolism due to its hallmark feature of hyperglycemia. Indeed, hyperglycemia is the cause of the acute symptoms associated with diabetes such as polydypsia, polyuria, and polyphagia. The long-term complications (retinopathy, nephropathy, and neuropathy) associated with diabetes are also believed to result from chronically elevated blood glucose levels (2–6). In addition, hyperglycemia may contribute to the development of macrovascular disease, which is associated with the development of coronary artery disease, the leading cause of death in individuals with diabetes (7–9). Thus, a primary goal in the management
of diabetes is the regulation of blood glucose to achieve near-normal blood glucose. The rate of appearance of glucose into the blood stream (absorption) and its clearance/disappearance from the circulation determine blood glucose concentration following a meal. Insulin secretion and its action on target tissues largely influence the rate of disappearance of glucose. The component of the diet that has the greatest influence on blood glucose is carbohydrate. Other macronutrients in the diet, i.e., fat and protein can influence the postprandial blood glucose level, however. For example, dietary fat slows glucose absorption, delaying the peak glycemic response to the ingestion of a food that contains glucose. In addition, although glucose is the primary stimulus for insulin release, protein/amino acids augment insulin release when ingested with carbohydrate, thereby increasing the clearance of glucose from the blood. Both the quantity and the type or source of carbohydrate found in foods influence postprandial glucose level.

Ostman EM, Liljeborg HG (2001), aimed their study to characterize the glycemic index and insulinemic response after intake of regular fermented milk products. In addition, the acute metabolic effects of fermented milk (curd) and pickled cucumber as supplement to a traditional breakfast based on a high glycemic index bread was evaluated. The research demonstrated ten healthy volunteers served different breakfast meals after an overnight fast. Capillary blood samples were collected before and during 2 or 3 hours after the meal. White bread was used as reference meal in both studies. The results drawn shows, the lactic acid in the fermented milk products did not lower the glycemic and insulinemic indexes. Despite low glycemic index of 15-30, all of the milk products produced high insulinemic indexes of 90-98, which were not significantly different from the insulinemic response of reference bread. Addition of
curd and pickled cucumber to a breakfast with high glycemic index significantly reduced postprandial hyperglycemia and insulinemic compared with reference meal. In contrast regular milk and cucumber had no favorable effect on the metabolic responses. The final conclusion of the study drawn is, Milk products appear insulinotheic as judged from 3-fold to 6-fold higher insulinemic indexes than expected from the corresponding glycemic indexes. The presence of organic acid may counteract the insulinotheic effect of milk in mixed meals.

Pathak P, Shrivastava S, Grover S (2000), Carried out a study entitled “Development of food products based on mellitus, Legumes, and fenugreek seeds and their suitability in the diabetic diet”. A multitude of investigations have demonstrated the beneficial hypoglycemic effects of millets, fenugreek seeds, legumes in diabetic diet. However the bitter taste of fenugreek and course nature of millets have been limitations in using them in daily dietaries. In this study the millets, fenugreek seeds and legumes in judicious combination, after suitable processing, were used to formulate three nutritious food Products dhokla, uppuma, and laddu. Evaluation of these food products for glycemic response in five normal and five diabetic subjects showed hypoglycemic effects in terms of glycemic index. The highest GI was observed for dhokla (34.96) followed by laddu (23.52) and uppuma (17.60) in normal subjects. The comparison of GI of all three products in normal subjects with diabetics did not show significant differences (p<0.05). The food products were well accepted to the subjects.

Revilge A (1976) Conducted a study titled “Effect of Dietary fiber on Carbohydrate metabolism in type 2 Diabetes Mellitus on NIDDM Subjects. For the study different Carbohydrate rich food especially rich in dietary fiber (soluble fiber) i.e. Legumes,
Lentils, oats, and some fruits were used, then there post prandial blood glucose assessed. Result indicated reduced postprandial blood glucose level. They concluded that severe Carbohydrate restriction is not necessary to control blood sugar but higher amount of Carbohydrates in the form of soluble fiber, i.e. Legumes etc should be increased in diabetic diet.

Romon M, Nuttens MC (2001) aimed this review to study the influence of energy and micronutrients intake on infant birthweight in women with gestational diabetes mellitus undergoing intensive management. This prospective study evaluated the impact of intensive management of gestational diabetes on maternal and fetal morbidity, and addressed the relationship between food intake and infants birthweight. In the study setting 15 maternity hospital in France were chosen. Ninety-nine women with gestational diabetes or gestational hyperglycemia diagnosed between 24 and 34 weeks of gestation were surveyed. After 1 was excluded because of premature birth and 18 were excluded as underreports, 80 women were included in the final analysis. Diet intake was assessed by dietary history at the first interview, and by 2,3 day diet records at the 3rd and 7th week after diagnosis. Result in a forward stepwise regression analysis (controlling for maternal age; smoking; parity; pregnancy BMI; pregnancy wt gain; gestational duration; infant sex; fasting and 2 hour postprandial serum glucose; insulin therapy; energy, fat, carbohydrate and protein intake during treatment) infant weight was positively associated with gestational duration (beta +0.34, p<.002), and negatively with smoking (beta -0.24, p<.03). There were no large for gestational age infants among women whose carbohydrate intake exceeded 210 g/day. The conclusion of the study drawn is that for women with gestational diabetes undergoing intensive care, higher carbohydrate intake is associated with decreased incidence of macrosomia.
These findings suggest that nutrition counseling in gestational diabetes must be directed to maintain a sufficient carbohydrate intake (at least 250 g/day), which implies a low fat diet to limit energy intake. A careful distribution of carbohydrate throughout the day and the use of low glycemic index food may help to lower postprandial hyperglycemia.

Sawaya AL, Fuss PJ, Dallal GE, Tsay R, Roberts SB, McCrory MA, Young V (2001), Investigated the effect of food palatability on the thermic effects of feeding (TEF), Substrate oxidation and circulating glucose and insulin. The result suggested that over 6 hours postprandial consumption of palatable foods does not increase TEF, but was instead associated with increased glycemic response and increased carbohydrate oxidation. These changes, combined with previous work on glycemic index, predicted an accelerated return of hunger and increased energy intake at subsequent meals following consumption of palatable vs. control foods. They suggested the need of further study to examine the possible mechanism for this study.

Simin and coworkers (2000) in their study titled "A prospective study of dietary Glycemic Load, Carbohydrate intake, and risk of CHD in US women" revealed that high dietary Glycemic Load from refined Carbohydrates increases the risk of CHD, independent of Known coronary disease risk factors. He aimed this study to prospectively evaluate the Relation of the amount and type of Carbohydrates with risk of CHD. His study designed a Cohort of 75521 women aged 38-63 years with no previous diagnosis of Diabetes Mellitus, MI, Angina, and stroke or other cardiovascular diseases in 1984 was followed For 10 years. In the study each participants Dietary Glycemic Load was calculated as a Function of Glycemic Index, Carbohydrate content and frequency of intake of individual Food reported on a validated food frequency
questionnaire at baseline. They updated all Dietary variables in 1986 and 1990. The result during 10 years of follow-up indicated 761 cases of CHD in which 208 were fatal and 553 nonfatal. Dietary Glycemic load was found to be directly associated with risk of CHD after adjustment of smoking, Total Energy and coronary heart disease risk factors. The association between dietary Glycemic Load and CHD risk was most evident among women with body weight above Average.

Tsilihas EB, Gibbs AL, McBurney MI and Wolever TM (2000), Stated that the result of 6 studies suggest that high carbohydrate diets are deleterious for people with type 2 diabetes. The objective of this study was to see whether the long-term replacement of dietary monounsaturated fatty acids with carbohydrate from breakfast cereals with either high or low GI affected blood glucose and lipids in the subjects with type 2 diabetes mellitus. The subjects with type 2 diabetes mellitus were randomly assigned to receive approximately 10% of energy from a low glycemic index breakfast cereals, a high GI cereals, or oil or margarine containing MUFA group. The result indicated that the subjects who received cereals consume 10% more energy from carbohydrate than did the subjects in MUFA group. The changes in Glycated hemoglobin, body weight, fasting cholesterol and triglycerol did not differ significantly among groups. The HDL-cholesterol increased by 10% in MUFA group. The ratio of total to HDL cholesterol was higher in subjects with high-GI cereals. During 8 hours metabolic profile, mean plasma insulin was higher and mean free fatty acids were lower in the 2 cereal group than MUFA group. The conclusion of the study drawn was, a 10% increase in carbohydrate intake associated with breakfast cereal consumption had no deleterious effects on glycemic control or blood lipid over 6 months in subject with type 2 diabetes.
Walker (1984) Carried out a study “Glycemic Index of South African Food” to see the glycemic response of some vegetables. Vegetables like carrot, potato, sugar is evident that contrary to conventional belief, ingestion of simple sugar like fructose results in glycemic response that is 20-29 % to that of Glucose intake. Whereas ingestion of equal amount of complex polysaccharides in carrots and potato results in blood glucose response that is 80-90 % of glucose.

2.2 Glycemic Index Theories

Granfieldt Y, Eliaassan AC and Bjoreck I (2000) carried out a study entitled “An examination of the possibility of lowering the glycemic index of oat and barley flakes by minimal processing”. In this study they studied the importance of the degree of gelatinization and the product thickness for postprandial glycemic and insulineemic response to rolled oat and barley flakes in healthy subjects. Thick rolled oats were made from raw or preheated kernels. In addition thin rolled oats were made from roasted kernels. Finally steamed rolled barley kernel were prepared. All thin flakes elicited high glucose and insulin response (GI, 88-118), insulinemic index (II, 84-102) were not significantly different from white bread. In contrast all varieties of thick flakes gave significantly lower metabolic response (GI, 70-78, II, 58-77) than the reference bread. Thick barley flakes however, gave high glucose and insulin response (GI, 94, II, 84), probably because the botanical structure underwent more destruction than oats flakes. They finally concluded this study that the minimal processing of oat and barley flakes had a relatively minor effect on GI features compared with more commercial processing. One exception was thick oat flakes, which on contrast to the corresponding barley flakes had low GI.
HollenbeckCB and Coulston AM (1991) demonstrate, a classification of carbohydrate-containing foods based on their glycemic response to 50-g carbohydrate portions has recently been developed. The relative glycemic potency of many of these carbohydrate-containing foods has been compared, and these data have been published in the form of a glycemic index. It has been suggested that meals containing low glycemic index foods will result in a lower postprandial glucose response than meals with a higher glycemic index. However, whether or not these data will lead to a clinically useful reduction in postprandial hyperglycemia in individuals with carbohydrate intolerance remains controversial. In this review, we will try to delineate why we believe that the glycemic index, as currently developed, may be a spurious tissue.

Jenkins (1981) in his Study “Glycemic Index of Food: A Physiological Basis of Carbohydrate Exchange” suggested that the response of different carbohydrate Food Articles to raise the blood sugar could be expressed as “Glycemic Index “. They predicted that different carbohydrates sources raise Blood Sugar to a variable extent and simple Carbohydrates exchange based on chemical analysis are not sufficient to predict physiological response as a measure of Glycemic Response. They have suggested to use Glycemic Index” to classify Carbohydrates containing food into low/high Glycemic substances. Glycemic Index is based on the blood glucose response to food in comparison with equal amount of glucose.

M. Batra, S. Sharma and V. Seth (1994), A study was conducted to estimate the glycemic index (GI) of four isocaloric and equicarbohydrate variations of the snack food 'cheela' (a savoury pancake) made from powdered whole legumes Phaseolus
 aureus (green gram) and Cicer arietinum (sengai gram) and their respective fermented batters. Fifteen healthy, normal weight females aged 18-23 years comprised the sample. Glucose was used as a reference food. The test meals were given within 4 weeks of reference food administration, with at least 2 days interval between the test meals. The meals and reference food were served at a fixed time in the morning, after a 12-h overnight fast. Blood glucose was estimated at 0, 30, 60 and 120 min after eating using an Ames glucometer II. The GI for the test meals ranged from 36% to 45%. The green gram cheela (unfermented) had the lowest GI (36 ± 0.6%), peak blood sugar value (111.6± 1.5 mg%) and AUC (2319 ± 72) as compared to the other three products. There was no significant difference between the fermented and the corresponding unfermented preparations.

Raghuram TC, Pasricha Swarn, Krishnaswami Kamla (1987), carried out a study entitled “Glycemic index of Indian foods” to evaluate the glycemic index of various Indian foods. Oral GTT with 50 g of carbohydrate was done in 10 individual after an overnight fast. Test foods than given separately on a second occasion. Blood samples were than collected at half an hour intervals from 0-2 hours. Plasma glucose was estimated and area under curve was calculated using trapezoidal rule. The result indicated that Pongal and pasarattu (south Indian preparation containing green gram) have low glycemic index as compared with other. Though sundal and chole have high protein content, the glycemic index was not low. It indicated that the level of protein in the preparation might have no influence on glycemic index. Study also revealed the same glycemic index of orange and orange juice, although there is considerable difference in fiber content. They admitted, our knowledge of glycemic index of
different carbohydrate is inadequate to predict consistently and accurately the glycemic response.

Simon Schenk, Christopher J Davidson (2003), The glycemic index (GI) of a food is thought to directly reflect the rate of digestion and entry of glucose into the systemic circulation. The blood glucose concentration, however, represents a balance of both the entry and the removal of glucose into and from the blood, respectively. Such direct quantification of the postprandial glucose curve with respect to interpreting the GI is lacking in the literature. They compared the plasma glucose kinetics of low- and high-GI breakfast cereals. Design On 2 occasions, plasma insulin concentrations and plasma glucose kinetics (by constant-rate infusion of [6,6-2H2] glucose) were measured in 6 healthy males for 180 min after they fasted overnight and then consumed an amount of corn flakes (CF) or bran cereal (BC) containing 50 g available carbohydrate. Results: The GI of CF was more than twice that of BC (131.5 ± 33.0 compared with 54.5 ± 7.2; P < 0.05), despite no significant differences in the rate of appearance of glucose into the plasma during the 180-min period. Postprandial hyperinsulinemia occurred earlier with BC than with CF, resulting in a 76% higher plasma insulin concentration at 20 min (20.4 ± 4.5 compared with 11.6 ± 2.1 μU/ml; P < 0.05). This was associated with a 31% higher rate of disappearance of glucose with BC than with CF during the 30–60-min period (28.7 ± 3.1 compared with 21.9 ± 3.1 μmol·kg⁻¹·min⁻¹; P < 0.05). Conclusion: The lower GI of BC than of CF was not due to a lower rate of appearance of glucose but instead to an earlier postprandial hyperinsulinemia and an earlier increase in the rate of disappearance of glucose, which attenuated the increase in the plasma glucose concentration.
They concluded, liquid Meal Replacement are safe and effective tool for obese subjects with type 2 diabetes Mellitus patients and can result in improvement, in body weight, glucose, Glycosylated Hemoglobin and blood lipid levels.

Vladimir Vuksan, John L Sievenpiper, Julia Wong, Zheng Xu, Uljana Beljan-Zdravkovic, John T Arnason, Valeria Assinewe, Mark P Stavro, Alexandra L Jenkins, Lawrence A Leiter and Thomas Francis (1995). A study entitled “American ginseng (Panax quinquefolius L.) Attenuates postprandial glycemia in a time-dependent but not dose-dependent manner in healthy individuals” showed that 3 g American ginseng administered 40 min before an oral glucose challenge significantly reduces postprandial glycemia in subjects without diabetes. Whether this effect can be replicated with doses <3 g and administration times closer to the oral glucose challenge is unclear. Objective was to study the dosing and timing effects of American ginseng on postprandial glycemia. In a random crossover design, 12 healthy individuals [± SEM age: 42 ± 7 y; body mass index (BMI; in kg/m2): 24.1 ± 1.1] received 16 treatments: 0 (placebo), 1, 2, or 3 g American ginseng at 40, 20, 10, or 0 min before a 25-g oral glucose challenge. Capillary blood was collected before administration and at 0, 15, 30, 45, 60, and 90 min after the start of the glucose challenge. Two-way analysis of variance showed that the main effects of treatment and administration time were significant (P < 0.05). Glycemia was lower over the last 45 min of the test after doses of 1, 2, or 3 g ginseng than after placebo (P < 0.05); there were no significant differences between doses. The reductions in the areas under the curve for these 3 doses were 14.4 ± 6.5%, 10.6 ± 4.0% and 9.1 ± 6%, respectively. Glycemia in the last hour of the test and area under the curve were significantly lower when ginseng was administered 40 min before the challenge than when it was administered 20, 10, or 0
min before the challenge (P < 0.05). They concluded this study that American ginseng reduced postprandial glycemia in subjects without diabetes. These reductions were time dependent but not dose dependent: an effect was seen only when the ginseng was administered 40 min before the challenge. Doses within the range of 1–3 g were equally effective.

Wolever TM, Csima A, and Jenkins DJ (1989) In their study titled “The glycemic index: variation between subjects and predictive difference mentioned, it is not known whether the variability of the glycemic index (GI) in different subjects is due to within- or between-individual variation. In addition, it is not known how large a difference in GI between different meals is clinically important for individuals with diabetes. Therefore, insulin-dependent (IDDM) and non-insulin-dependent (NIDDM) diabetic subjects tested four foods, with each food taken by each subject on two separate occasions. For each food, most of the variation of absolute glycemic responses was due to difference between the subjects. However, when the results were expressed as the GI, there were no significant differences between the subjects, and most of the variation was due to within-individual variation. Using the within-individual variance, we estimated the so-called "predictive difference" of GI values. Its reliability was assessed by consideration of published data from eight studies where the same group of subjects took different mixed meals. There were 37 cases where the difference between the GI of any two meals was greater than the predictive difference. Of these 37 pairs of meals, the GI correctly ranked the glycemic responses in 36 (97%). We conclude that GI values for the same food do not vary significantly between different individuals. For a subject with NIDDM a difference in GI of 34 will predict the ranking of glycemic
responses of two meals with 95% probability. The corresponding value for a subject with IDDM is 50.

Wolever TM, Jenkins DJ (1990) Studied 12 subjects with diabetes to determine how well the glycemic index (GI) predicted the ranking of glycemic responses of different foods in individuals. All subjects ate three mixed meals (bread, rice, or spaghetti with GIs of 100, 79, and 61, respectively) four times in a randomized complete block design. The mean glycemic response areas of the different meals ranked according to the predicted GI in every individual. The observed mean +/- SD GI values of the meals were significantly different from each other (bread 100 +/- 7, rice 75 +/- 9, and spaghetti 54 +/- 9), with no significant difference in response between subjects. It is concluded that individuals share common mean GI values for different foods. Within confidence limits determined by the variability of glycemic responses, the number of repeated tests conducted, and the expected GI difference, the GI can be used to predict the ranking of the mean glycemic responses of mixed meals taken by individuals.

Wolever TM, Jenkins DJ (1991) in their study titled “the glycemic index: methodology and clinical implications” indicated there is controversy regarding the clinical utility of classifying foods according to their glycemic responses by using the glycemic index (GI). Part of the controversy is due to methodologic variables that can markedly affect the interpretation of glycemic responses and the GI values obtained. Recent studies support the clinical utility of the GI. Within limits determined by the expected GI difference and by the day-to-day variation of glycemic responses, the GI predicts the ranking of the glycemic potential of different meals in individual subjects. In long-term trials, low-GI diets result in modest improvements in overall blood
glucose control in-patients with insulin-dependent and non-insulin-dependent diabetes. Of perhaps greater therapeutic importance is the ability of low-GI diets to reduce insulin secretion and lower blood lipid concentration in-patients with hypertriglyceridemia.

Yip I (2001) Carried out a study on “Liquid Meal Replacement and Glycemic control in Obese type 2 Diabetes patients. This Study included a program to see the effect of Meal Replacements for weight management. For the study Subjects were randomized into groups. The results indicated that in-patient Having Meal Replacement, significant weight loss, blood sugar reduction, reduced total serum Cholesterol, LDL was seen. They concluded, Liquid Meal Replacement are safe and effective weight loss tool for Obese subject with type 2 Diabetes mellitus patients and can result in improvement in body Weight, Glucose, Glycosylated Hemoglobin and Blood Lipid level.

2.3 Clinical Implications of Glycemic Index

Berrino F, Bellati C and Kaaks R (2001), Hypothesized that an ad libitum diet low in animal fat and refined carbohydrate and rich in low glycemic index foods, monounsaturated and n-3 polyunsaturated fatty acids and phytoestrogens might favorably modify the hormonal profile of postmenopausal women. They conducted the study and selected 104 postmenopausal women on the basis of high testosterone levels and randomized for dietary intervention or control. The intervention included intensive dietary counseling and specially prepared group meals twice a week over 4-5 months. Changes in serum levels of testosterone, estradiol, sex hormone-binding globulin were measured. In the intervention group testosterone were found to be decreased, sex hormone-binding globulin increased significantly compared with the control group.
Serum estradiol also decreased but not significantly. Intervention group also decreased body weight, waist hip ratio, total cholesterol, and fasting glucose levels. They concluded this study that a radical modification in diet designed to reduce insulin resistance and also increased phytoestrogens intake. It decreased the bioavailability of serum sex hormone in hyperandrogenic postmenopausal women, which may reduce the risk of developing breast cancer.

Cyr-Campbell D, Campbell WW, Kirwan JP, J. Scheiber, W. J Evans (1995). Stated in a study entitled “The effects of glycemic index on submaximal exercise performance” that the total amount of carbohydrate and the rate of appearance of plasma glucose and insulin affect the metabolic responses to carbohydrate intake prior to exercise. Exercise performance can be enhanced when muscle glycogen use is decreased or when blood glucose levels are maintained. Recently a number of studies have suggested that exercise time to exhaustion may be prolonged by carbohydrate feedings that prevent a hypoglycemic response and increase the availability of glucose to the working muscles. The purpose of this study was to examine the effects of 4 different cereals (Oats, Oats with sugar, puffed rice, and puffed rice with sugar) with varying glycemic indices on exercise time to exhaustion. Six young, healthy, moderately well trained men (age, 22.3 ± 0.8; % fat, 15.6 ± 1.2; VO2max, 54.3 ± 1.2ml•kg⁻¹•min⁻¹) were recruited for this study. Each subject resided in the Clinical Research Center for three days prior to each trial to ensure dietary control. On the morning of the trial each subject consumed 75g of available carbohydrate. A venous catheter was placed for blood draws and 30minutes after completion of the test meal, the subject began cycling at 60% of a previously determined VO2max-Subjects were told that they would be rewarded ($1/min) for every minute they continued exercising.
Ford ES and Liu S (2001), Examined the relationship between glycemic index and glycemic load, which were determined from a food frequency questionnaire and HDL_C concentration. They stated, the age adjusted mean HDL_C concentration for increasing quintiles of glycemic index distribution were 1.38, 1.32, 1.30, 1.26 and 1.27 mmol/l (p<.001 for trend). After additional adjustment for sex, ethnicity, education, smoking status, body mass index, alcohol intake, physical activity, energy fraction from carbohydrate and fat and total energy intake, the mean HDL_C concentration for ascending quintiles for glycemic were 1.36, 1.31, 1.30, and 1.28 mmol/l (p<.001). Adjusting for the same covariates and considering glycemic index as a continuous variable, they found a change in HDL_C concentration of −0.06 mmol/l per 15-units increase in glycemic index (p<.001). These findings from a nationally representative samples of US adults suggested that high glycemic index and high glycemic load are associated with lower concentration of plasma HDL_C.

Giacco R, Parillo M, Revellese AA and Riccardi G (2000), Carried out a study entitled “Long term dietary treatment with increased amount of fiber-rich low glycemic index natural foods improves blood glucose control and reduces the number of hypoglycemic events in type 1 diabetic patients”. The study was randomized with parallel groups. A total 63 type 1 diabetes patients, after a 4-week run-in period on their habitual diet, were randomized to either an high fiber (n=32) or a low-fiber diet (n=31) for 24 weeks. At the end of the run-in period and dietary treatment, fasting blood sample for the measurement of plasma cholesterol, HDL cholesterol, triglyceride, and
HbA1c were collected. The high fiber diet after the period of 24 weeks decreased both mean daily blood glucose concentration and the number of hypoglycemic events.

Heather R Gilbertson, Anne W Thorburn, Jennie C Brand-Miller (2003) carried out a study titled “Effect of low-glycemic-index dietary advice on dietary quality and food choice in children with type 1 diabetes”. The objective was to determine the effect of low-GI dietary advice on dietary quality and food choice in children with diabetes. Children aged 8–13 y with type 1 diabetes (n = 104) were recruited to a prospective, randomized study comparing the effects of traditional carbohydrate-exchange dietary advice (CHOx) with those of more flexible low-GI dietary advice (Low GI). We determined the effect on long-term macronutrient intake and food choice with the use of 3-d food diaries. There were no differences in reported macronutrient intakes during any of the recording periods. After 12 month, intakes of dietary fat (33.5 ± 5.6% and 34.2 ± 6.7% of energy, P = 0.65), carbohydrate (48.8 ± 5.4% and 48.6 ± 6.5% of energy, P = 0.86), protein (17.6 ± 2.5% and 17.3 ± 3.7% of energy, P = 0.61), total sugars, and fiber did not differ significantly between the CHOx and Low GI groups, respectively. The average number of different carbohydrate food choices per day also did not differ significantly. Subjects in the lowest-GI quartile consumed less carbohydrate as potato and white bread, but more carbohydrate as dairy-based foods and whole-grain breads than did subjects in the highest-GI quartile. Children with diabetes who receive low-GI dietary advice do not report more limited food choices or a diet with worse macronutrient composition than do children who consume a traditional carbohydrate-exchange diet.
Holt SH, Brand Miller JC, Stitt PA (2002) The effects of equal energy portion of different bread on blood glucose level, feeling of fullness and subsequent food intake. Holt SH, Brand Miller JC (2001) carried out a study to compare the effects of equal energy portion of 7 different breads on feeling of fullness and subsequent ad libitum food intake. A satiety index score (SI) was calculated for each breads. Ten healthy subjects participated in the study. Subjects fasted for 10 hours overnight and then reed to the research center the next morning, where they first completed baseline satiety ratings, gave a fasting blood sample, and then consumed the test bread. Additional finger prick blood sample and satiety rating were collected at 15-minute intervals over 120 minutes, after which the subjects’ ad libitum intake of food was recorded. A satiety index (SI) score was calculated for each test food by dividing the area under the 120 minutes satiety response curve (AUC) for the test bread by the satiety AUC for the reference bread (regular white bread) and multiplying by 100. Result indicated, the mean SI score for the bread ranged from 100% to 561% with regular white bread having the lowest SI score. Mean SI scores were negatively correlated with energy intake at a test meal after 120 minutes (r = -0.88, p < .01, n = 7) and total day energy intakes (r = -0.72, p < .05, n = 7). The strongest predictor of the breads SI score was their portion size and the energy density. The breads glycemic index was not found to be significantly associated with the fullness response. They concluded SI scores would be useful addition to food labels to indicate which foods are less likely to be overeaten and could be used for weight control plans to help reduce energy intakes without increased hunger.

intake and higher glycemic indexes (GI s) raise fasting triglycerol concentration. Dietary glycemic load is positively associated with risk of coronary artery disease and type 2 diabetes. In this study they examines both the physiological relevance of GI and
K. Silliman, JR Mahoney (2004), Carried out a study titled “Effect of dietary glycemic index on postprandial glucose, insulin, and free fatty acid response in obese and normal weight premenopausal women”’ August 2004, Supplement • Volume 104 • Number 8

Abdominal obesity is highly associated with type 2 diabetes and dyslipidemia. The objective of this study was to determine if the type of carbohydrate [low versus high glycemic index (GI)] influences the postprandial glucose, insulin, free fatty acid (FFA) response in women with abdominal obesity. Subjects (27±9 years) were 15 normal weight (lean) and 26 abdominally obese healthy premenopausal women. Using a randomized crossover design, subjects consumed two breakfast meals, high (66) and low (45) GI, after fasting for 12 hours on two occasions, separated by no more than 14 days. Blood samples were collected prior to each meal and then 1, 3, and 5 h after the meal and analyzed for glucose, insulin and FFA. Obese subjects had significantly (p<0.03) higher 1 h blood glucose (102±43 mg/dl vs. 92±40) and FFA levels (0.29±0.16 mm vs. 0.25±0.11) after consuming the high GI meal. The blood glucose response area under the curve (AUC) was also higher (p=0.06) in obese subjects after the high GI meal. The insulin AUC after the high GI meal was significantly (p<0.04) greater for both obese (184±123 μIU/ml•5 h vs. 120±105) and lean subjects (94±83 vs. 46±11). Low glycemic index meals containing whole grain breads and cereals, similar to the meal consumed in this study, may produce a more beneficial postprandial response, particularly in women with abdominal obesity.
Kirwan JP, O Gorman (2001) carried out a study to determine whether eating a breakfast cereal with a moderate glycemic index could alter substrate utilization and improve exercise duration. For the study 6 active women (age, 24 +/- 2 years; weight, 62.2 +/- 2.6 kg; vo (2 peak), 46.6 +/- 3.8ml x kg (-1) x min (-1) ate 75 g of available carbohydrate in the form of regular whole grain rolled oats mixed with 300 ml of water or water alone. The trail were performed in random order and the meal or water was ingested 45 min before performing cycling exercise to exhaustion (60% of VO (2 peak)). Blood samples were drawn for glucose, glucose kinetics, free fatty acid, glycerol, insulin, and epinephrine and norepinephrine determination. A muscle biopsy was obtained from the vastus lateralis muscle before the trail and immediately after exercise for glycogen determination. Glucose Kinetics were determined using a [6,6-(2 H) glucose tracer. The result indicated that plasma free fatty acids and glycerol level were suppressed (p<0.05) during the first 120 min of exercise for the rolled oats trail. Respiratory exchange ratio were also higher (p<0.05) for first 120 min of exercise for the rolled oatmeal trail. At exhaustion, glucose, insulin, FFA, glycerol, epinephrine, nor epinephrine and muscle glycogen were different between trails. The conclusion drawn was that, increased hepatic glucose output before fatigue provides some evidence of glucose sparing effects after the breakfast cereal trail. However, exercise duration was not significantly altered, possibly because of the sustained suppression of lipid metabolism and increased carbohydrate utilization throughout much of the exercise period.

Liu S, Manson JE (2001) reviewed that in metabolic studies, greater carbohydrate intake and higher glycemic indexes (GI s) raise fasting triglycerol concentration. Dietary glycemic load is positively associated with risk of coronary artery disease and
type 2 diabetes. In this study they examines both the physiological relevance of GI and GL and the ability of dietary questionnaire to measure these variables. The result drawn supported the physiological relevance of the GL as a potential risk factor for coronary artery disease in free living women, particularly those prone to insulin resistance. Findings also documented the ability of a semiquantitative food-frequency questionnaire to assess dietary GI s and GLs.

Liu S, Manson JE (2002), examined whether a high glycemic load was associated with elevated hs-CRP concentration and whether this association was modified by body mass index. In 244 apparently healthy women they measured plasma hs-CRP concentration and determined average dietary glycemic loads with a validated semiquantitative food-frequency questionnaire. Using multiple regression models, they evaluated the association between dietary glycemic load and plasma hs-CRP after adjusting for age; treatment status; smoking status; BMI; physical activity level; parental history of myocardial infraction; history of diabetes, hypertension and high cholesterol; menopausal hormone use; alcohol intake; and other dietary variables. The result indicated a strong and statistically significant positive association between dietary glycemic load and plasma hs-CRP.

Spieth LE, Harnish JD, Lenders CM and Ludwig DS (2000), In their study entitled “A low glycemic index diet in the treatment of pediatric obesity”, stated that the conventional dietary approaches for the treatment of obesity have generally yielded disappointing results. Therefore they aimed this study to examine the effects of low glycemic diet (GI) compared with reduced fat diet in the management of pediatric obesity. In 107 obese otherwise healthy children selected for the study attending
outpatient clinic. Among them 64 patients given low GI diet and 43 received low fat diet for 4 months. They measured changes in body mass index and body weight from first to last clinic visit. The results revealed more significant decrease in BMI with low GI diet than reduced fat diet. They concluded this study that a low GI diet seems to be a promising alternative to standard dietary management for obesity in children.

Stannard SR, Constantini NW and Miller JC (2000), stated in the study entitled “The effects of glycemic index on plasma glucose and lactate levels during incremental exercise” that consumption of low GI foods before submaximal endurance exercise may be beneficial to performance. To test whether this may also be true for high intensity exercise, 10 trained cyclists began an incremental exercise test to exhaustion 65 min after consuming equal carbohydrate portion of glucose (high GI), pasta (low GI) and a noncarbohydrate control (PL). The time to fatigue did not differ significantly between treatments. Plasma glucose was significantly lower after LGI vs. HGI from 15 min to 45 min of rest postprandial. During exercise, plasma glucose concentration lowers after HGI vs. LGI from 200 w until exhaustion. Plasma lactate concentration following HGI was significantly higher than PL from 30 min of rest postprandial through to the end of the 200-w workload. At higher exercise intensities, there was no significant difference in plasma lactate levels between treatments. These findings suggest that a high GI carbohydrate meal 65 min prior to exercise decrease plasma glucose and increase plasma lactate levels compared to a low GI meal, but not enough to detrimental to incremental exercise performance.

Theresa O. Scholl, Xinhua Chen (2004), Carried out a study titled “The Dietary Glycemic Index during Pregnancy: Influence on Infant Birth Weight, Fetal Growth,
and Biomarkers of Carbohydrate Metabolism” and stated. During pregnancy, lower levels of maternal glucose before and during a glucose load have been associated with reduced infant birth weight and an increased risk of small-for-gestational-age births. A lower incremental area under the glucose response curve defines a low glycemic diet. Thus, during pregnancy the maternal diet, as measured by the glycemic index, may influence fetal growth and infant birth weight. A total of 1,082 gravidas who enrolled in the Camden Study between August 1996 and October 2002 were followed prospectively during pregnancy. The dietary glycemic index was computed from three 24-hour recalls in the course of pregnancy. Samples for plasma glucose and for glycosylated hemoglobin were obtained at 24–28 weeks’ gestation. The glycemic index was positively and significantly related to maternal glycosylated hemoglobin and plasma glucose. There were as well significant linear trends for dietary fat intake to decrease and for intakes of carbohydrate, sucrose, fiber, and folate to increase as the glycemic index declined. Gravidas with a low dietary glycemic index had reduced infant birth weight and approximately a twofold increased risk of a small-for-gestational-age birth. Consistent with data on maternal plasma glucose, data in this study show that the type of carbohydrate in the diet of urban, low-income women influences fetal growth and infant birth weight.

2.4 Glycemic Index and Management of Diabetes and other chronic disorders

Brigitte Sloth, Inger Krog-Mikkelsen (2004) investigated the long-term effects of a low-fat, high-carbohydrate diet with either low glycemic index (LGI) or high glycemic index (HGI) on ad libitum energy intake, body weight, and composition, as well as on risk factors for type 2 diabetes and ischemic heart disease in overweight healthy subjects. The study was a 10-wk parallel, randomized, intervention trial with 2
matched groups. The LGI or HGI test foods, given, as replacements for the subjects' usual carbohydrate-rich foods, were equal in total energy, energy density, dietary fiber, and macronutrient composition. Subjects were healthy overweight women aged 20–40 y. Results indicated energy intake, mean (± SEM) body weight and fat mass decreased over time, but the differences between groups were not significant. No significant differences were observed between groups in fasting serum insulin, homeostasis model assessment for relative insulin resistance, homeostasis model assessment for β cell function, triacylglycerol, nonesterified fatty acids, or HDL cholesterol. However, a 10% decrease in LDL cholesterol (P < 0.05) and a tendency to a larger decrease in total cholesterol (P = 0.06) were observed with consumption of the LGI diet as compared with the HGI diet. They concluded, This study does not support the contention that low-fat LGI diets are more beneficial than HGI diets with regard to appetite or body-weight regulation as evaluated over 10 wk. However, it confirms previous findings of a beneficial effect of LGI diets on risk factors for ischemic heart disease.

**Chew I and Brand JC (1988)** The study titled “Applications of glycemic index to mixed meals” Plasma glucose and insulin responses to six different meals were determined and compared with values predicted by published glycemic indices of the component foods. The test meals were of different ethnic origins: Indian (lentil curry with rice), Italian (spaghetti bolognese), Chinese (stir-fried vegetables and chicken with rice), Greek (lentil stew), Western (sirloin chop and vegetables); and Lebanese (sandwich with unleavened bread and hummus). Eight healthy volunteers were given 50-g carbohydrate portions of the above meals after an overnight fast. The glycemic and insulin indices were highest for the Lebanese meal and lowest for the Greek with
significant differences among the meals (ANOVA, p less than 0.05). The observed
glycemic indices correlated well with the predicted glycemic indices (r = 0.88, p less
than 0.05). suggest that the glycemic index approach will be useful in planning diets for
diabetic people.

David S. Ludwig (2001) stated that obesity is among the most important medical
problems in America today. Currently 1 in 4 children and 1 in 2 adult are Overweight,
prevalence rate have been increased by 50% since 1960's. In an attempt to combat this
problem, the federal government and various official medical agencies have advocated
decreased intake of total fat and sugar while increasing intake of complex
carbohydrates. Despite the current reduction in fat consumption to near the
recommended 30% of total energy, rates of Obesity have continued to rise, suggesting
that other dietary factors may play critical role in the body weight regulation. One such
factor may be Glycemic Index. This review examine the physiological effects of
Glycemic Index and argues for the need for controlled clinical trial of a low Glycemic
Index Diet in the treatment of obesity.

Franceschi S, Dal Maso L, and Negri E (2001) conducted a study entitled “Dietary
glycemic load and colorectal cancer risk” to test the insulin/colon cancer hypothesis.
They determined whether the dietary glycemic index and the glycemic load are
associated with colorectal cancer. Research design consisted a case control study on
colorectal cancer. Cases included 1125 men and 828 women with histologically
confirmed incident cancer of the colon or rectum. Controls were 2073 men and 2081
women hospitalized for acute condition. They calculated average daily dietary
glycemic index and glycemic load and fiber intake from validated food frequency
questionnaire. Result indicated direct association with colorectal cancer risk emerged for glycemic index and glycemic load. They concluded this study that the positive association of glycemic index and load with colorectal cancer suggest a detrimental role of refined carbohydrate in the etiology of the disease.

Liu S, Willett WC and Manson JE (2000) carried out a study to prospectively evaluate the relationship and amount of carbohydrates with risk of CHD. A cohort of 75521 women aged 38-63 years with no previous diagnosis of diabetes mellitus, myocardial infraction, angina, stroke or other cardiovascular diseases. The followed by 10 years. Each participant’s dietary glycemic load was calculated as a function of glycemic index, carbohydrate content and frequency of intake of individual foods reported on a validated food-frequency questionnaire at baseline. They updated all dietary variables in twice at 3 years interval. During 10 years of follow-up the result documented 761 patients of CHD. Dietary glycemic load was directly associated with risk of CHD after adjustment of age, sex, smoking status, total energy intake. These epidemiological data suggest that high dietary glycemic load from refined carbohydrates increases the risk of CHD that is independent of known coronary risk factors.

Simin Liu and coworkers (2001) stated in their epidemiological study that Glycemic load is positively associated with risk of coronary heart disease and type 2 Diabetes. The Objective of their study was to examine both the physiological relevance of GI and the Ability of dietary Questionnaire to measure these variables. In the research Design they Measured plasma triglycerol concentration in fasting blood samples from 185 healthy Postmenopausal women and HDL-Cholesterol concentration in an additional
95 non-Fasting samples. Dietary carbohydrate, GI, and GL were assessed by the use of
Semiquantitative Food frequency questionnaire. The result indicated that for the lowest
And the highest quintiles of GL, the multivariate adjusted geometric mean
triacylglycerol concentration were 0.98 and 1.75 mmol/l. (87 and 155 mg/dl,p for
trend =<0.001). Both overall GI (p for trend = <0.03) and carbohydrate (P for trend = <
0.01) contributed independently to the strong positive association with HDL
Cholesterol concentration. These data support the physiological relevance of the GL as
the potential risk factors for coronary artery disease in free living women particularly
those prone to insulin resistance, these findings also document the ability of a
semiquantitative food frequency questionnaire to assess dietary GI and GLs.

Wolever.TM, Jenkins (1987) was studied the effects of the glycemic index (GI) of
carbohydrate eaten the previous night on the glycemic response to a standard test meal
eaten subsequently in the morning (breakfast). On separate evenings normal subjects
ate low- or high-GI test meals of the same nutrient composition. The dinners consisted
of single foods in two experiments and mixed meals containing several foods in the
third. Their GIs predicted the differences between the observed glycemic responses to
low- and high-GI dinners. The glycemic responses to breakfast were significantly lower
on mornings after low-GI dinners than after high-GI dinners. Eating, at dinner, foods
with different fiber contents but the same GI had no effect on postbreakfast glycemia.
We conclude that the GI predicts the difference between glycemic responses of mixed
dinner meals; breakfast carbohydrate tolerance is improved when low-GI foods are
eaten the previous evening.
2.5 Association of Diabetes and other chronic disorders

DeMarco HM, Sucher KP and Cisar GE (1997) stated the lowering of plasma glucose could contribute to fatigue in subjects performing strenuous endurance exercise. Plasma glucose may be maintained by pre-exercise carbohydrate meals. A low glycemic index meal (LGI) may offer an advantage by providing a source of glucose to the blood for a long period of time accompanied by a minimal insulin surge.

The purpose of this study was to compare postprandial metabolic, physiologic, and performance responses to a LGI and a moderately high GI meal (HGI), each providing three foods totaling 1.5g carbohydrate per kg body weight. After an overnight fast, 10 male endurance trained cyclists consumed one of the test meals or water 30min prior to cycling 2h at 70% of maximum oxygen uptake (VO2 max) followed by cycling to exhaustion at 100% of VO2 max. Data were analyzed using two-way ANOVA for repeated measures (P < 0.05). Plasma insulin levels were significantly lower after LGI than after HGI from 15min after ingestion through 20min of exercise. Significantly higher respiratory exchange ratios (RERs) were observed after HGI than after LGI until 2h of exercise, at which time there was a significant decline in the RER after HGI. At 2h of exercise, plasma glucose levels were significantly higher and ratings of perceived exertion lower after LGI as compared to after HGI. Time to exhaustion was 59% longer after LGI (206.5 ± 43.5s) than after HGI (129.5 ± 22.8s). These results suggest that maximal performance following endurance exercise may be affected by the glycemic index of pre-exercise meals. The LGI induced a lower rise in plasma insulin after ingestion and then maintained plasma glucose at higher levels at the end of a period of strenuous exercise, which may have better supported subsequent maximal effort.
Edward Giovannucci (1997) stated in his study entitled "Insulin, Insulin-Like Growth Factors and Colon Cancer: A Review of the Evidence" that insulin and insulin-like growth factor (IGF) axes are major determinants of proliferation and apoptosis and thus may influence carcinogenesis. In various animal models, modulation of insulin and IGF-1 levels through various means, including direct infusion, energy excess or restriction, genetically induced obesity, dietary quality including fatty acid and sucrose content, inhibition of normal insulin secretion and pharmacologic inhibition of IGF-1, influences colonic carcinogenesis. Human evidence also associates high levels of insulin and IGF-1 with increased risk of colon cancer. Clinical conditions associated with high levels of insulin (noninsulin-dependent diabetes mellitus and hypertriglyceridemia) and IGF-1 (acromegaly) are related to increased risk of colon cancer, and increased circulating concentrations of insulin and IGF-1 are related to a higher risk of colonic neoplasia. Determinants and markers of hyperinsulinemia (physical inactivity, high body mass index, central adiposity) and high IGF-1 levels (tall stature) are also related to higher risk. Many studies indicate that dietary patterns that stimulate insulin resistance or secretion, including high consumption of sucrose, various sources of starch, and a high glycemic index and high saturated fatty acid intake are associated with a higher risk of colon cancer. Although additional environmental and genetic factors affect colon cancer, the incidence of this malignancy was invariably low before the technological advances that rendered sedentary lifestyles and obesity common, and increased availability of highly processed carbohydrates and saturated fatty acids. Efforts to counter these patterns are likely to have the most potential to reduce colon cancer incidence, as well as cardiovascular disease and diabetes mellitus.
Grey Donald K, Robinson E, Collier A (2000), Carried out a study entitled “Intervention to reduce weight gain in pregnancy and gestational diabetes mellitus: an evaluation”. The study suggested that the intervention and control group did not differ at baseline regarding their mean age (24.3-yr.), mean pregnancy weight (81 kg) and mean gestational age at recruitment (17.1 weeks). The intervention did not result in differences in diet measured at 24-30 weeks gestation, rate of weight gain over the second half of pregnancy or plasma glucose level between 24 and 30 weeks. Mean birth weights were similar. The only change in dietary intake were a reduction in caffeine and increase in folate. This intervention had only minor impact on diet.

Manny Noakes and Peter M Clifton (1987). Study entitled “Changes in plasma lipids and other cardiovascular risk factors during 3 energy-restricted diets differing in total fat and fatty acid composition” stated the well-established relation between changes in dietary fatty acids and plasma lipids has been determined in energy-balance states. Whether this relation is altered in states of energy restriction and active weight loss is not clear. The objective of this 12-wk study was to compare the time course of lipid changes and other cardiovascular risk factors in 3 energy-restricted diets (all 6500 kJ) with different total fat and fatty acid compositions. Sixty-two subjects with a body mass index (in kg/m2) >24 were stratified into 1 of 3 parallel dietary intervention groups: 1) a very-low-fat (VLF) diet (10% of energy from fat; 3% from saturated fat), 2) a high-saturated-fat (HSF) diet (32% of energy from fat; 17% from saturated fat), and 3) a high-unsaturated-fat (HUF) diet (32% of energy from fat; 6% from saturated fat). After 12 wk, LDL cholesterol decreased by $0.66 \pm 0.11$ (± SEM) and $0.68 \pm 0.12$ mmol/L (20%) with the VLF and HUF diets, respectively, compared with a decrease of only $0.24 \pm 0.11$ mmol/L (7%) with the HSF diet ($P < 0.02$ between groups). Diet affected the
time course of changes in HDL cholesterol with both high-fat diets, resulting in smaller reductions in HDL cholesterol at weeks 1 (P = 0.0004) and 4 (P = 0.02); however, these differences were no longer apparent by 12 wk. Overall weight loss was 8.6 ± 0.4 kg (9.7%) and waist circumference decreased by 7.3 ± 5 cm (8%) for the combined groups, with no significant differences between diets. Significantly greater decreases in LDL cholesterol during active weight loss are achieved with diets low in saturated fatty acids. Changes in HDL cholesterol between diets appear dependent on both the fat content of the diet and the duration of energy restriction.

Randall J Kaplan, Carol E Greenwood, Gordon Winocur and Thomas MS Wolever (1987) The objective of this study was to determine 1) whether an association between cognition and glucose regulation is apparent in healthy seniors and 2) the effects of dietary carbohydrates on cognition. After an overnight fast, 10 men and 10 women (aged 60–82 y) consumed 50 g carbohydrate as glucose, potatoes, or barley or a placebo on 4 separate mornings. Cognitive tests were administered 15, 60, and 105 min after ingestion of the carbohydrate. Plasma glucose and serum insulin was measured. In a multiple regression analysis, poor baseline (placebo) verbal declarative memory (immediate and 20-min delayed paragraph recall and word list recall) and visuomotor task performance were predicted by poor β cell function, high incremental area under the glucose curve, low insulin resistance, and low body mass index. The difference in plasma glucose after food consumption [glucose > potatoes > barley > placebo (P < 0.03)] did not predict performance. Although overall performance did not differ with consumption of the different test foods, baseline score and β cell function correlated with improvements in immediate and delayed paragraph recall for all 3 carbohydrates (compared with placebo); the poorer the baseline memory or β cell function, the greater
the improvement (correlation between β cell function and improvement in delayed paragraph recall: \( r > -0.50, P < 0.03 \)). Poor β cell function correlated with improvement for all carbohydrates in visuomotor task performance but not on an attention task. Glucose regulation was associated with cognitive performance in elderly subjects with normal glucose tolerance. Dietary carbohydrates (potatoes and barley) enhanced cognition in subjects with poor memories or β cell function independently of plasma glucose.

**Schwartz SL, Fischer JS and Kipnes MS** (2001), demonstrated that several clinical trail have shown that zinc gluconate glycine lozenges can reduce symptoms severity and duration of symptoms in patients with common cold. Over the counter zinc lozenges is used commonly by the general population, including people with diabetes. The purpose of this study was to assess the effects of sugar-free cold-Eeze, a commonly used zinc preparation, on glucose control in-patients maintained on stable anti-diabetic therapy. Forty eight patients with either type 1 (\( n=3 \)) or type 2 (\( n=45 \)) diabetes were randomized in a 3:1 ratio to receive either zinc lozenges (4 to 6 lozenges/ day 10 days) or matching placebo. The primary endpoint was change in serum fructosamine concentration. Secondary endpoints included daily home glucose and fasting blood glucose monitoring (baseline, days 10 to 21). The mean age for all patients was 54 years (range, 25 to 76), with slightly more women (60%). The treatment group did not differ with respect to age, sex, body mass index, and duration of diabetes, base line hemoglobin A1C level, or fasting plasma glucose level. The patients treated with placebo (\( n=13 \)) and zinc (\( n=34 \)) had similar fructosamine levels (mean +/-SD) at baseline (318 +/- 90 versus 297 +/- 86 micromol/l, respectively). After 10 days of dosing, both groups showed modest reductions in serum fructosamine (-7 +/- 42 and -9
These changes were not statistically significant. In conclusion, these findings suggest that sugar free zinc lozenges can be administered safely to patients with diabetes without deleterious effects on glycemic control.

Singh RB and et.al. (1998) Worked to compare the prevalence of type 2 Diabetes, CAD and hypertension in rural and urban population of North India. They found that hypertension and CHD were significantly more frequent among subject with Diabetes as compared to non-Diabetic. The association of CAD and hypertension with Diabetes Mellitus was greater in Urban than rural subjects. Excess body weight and obesity, Central Obesity, Sedentary life style, higher visible fat intake, Social higher and middle class were significantly associated with Diabetes.

Singh RB and et.al. (1999) Aimed their study to find out the association between social class and coronary heart Disease and Diabetes Mellitus risk factors in women. Women aged 25-64 years were randomly selected from five different cities. All the subjects, after pooling of data were divided into five social groups. Based on various attributes of socioeconomic status. Spearmans rank correlation was used to assess the association between various risk factors and Social groups. It was then concluded on the basis of result attained that higher social classes among urban Indian women have higher prevalence of coronary risk factors, Hypertension, Diabetes Mellitus, obesity, sedentary life style and family history of Diabetes.