Gatorade Sports Science Institute®

Sports Science Exchange 79

VOLUME 13 (2000) ■ NUMBER 4

DIETARY CARBOHYDRATE AND PERFORMANCE OF BRIEF, INTENSE EXERCISE

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KEY POINTS

- A high-intensity exercise bout uses carbohydrate at a very high rate, but the total use is limited due to the brief duration of exercise. Reduction of muscle glycogen during a typical resistance exercise bout or a single 30-s sprint is likely to be in the range of 25-35% of the total glycogen store in the active muscles, whereas repeated sprints will cause a greater drain on glycogen.
- Muscle glycogen is depleted more rapidly from Type II (fast) than from Type I (slow) fibers during high-intensity exercise. Thus, even when glycogen depletion in mixed muscle fibers is modest, extensive glycogen use by type II fibers as well as selective depletion of glycogen from specific cellular compartments may precipitate fatigue.
- Performance of a single sprint or of repeated sprints is usually superior after a high-carbohydrate compared to a low-carbohydrate diet.
- The benefit of high-carbohydrate diets versus moderate-carbohydrate diets for performance of high-intensity exercise has not been clearly shown.

INTRODUCTION

Most scientists and athletes agree that carbohydrate ingestion is helpful to performance of prolonged aerobic events. However, many sports rely on brief, repeated bursts of effort at high power. Is there evidence that dietary carbohydrate is also critical to performance in these sports? Few scientific studies have tested the value of dietary carbohydrate for athletes who perform high-intensity, brief exercise in sports such as wrestling, football, baseball, and weightlifting, and in track and swimming sprints. This review will focus on research concerning the effects of dietary carbohydrate on resistance exercise and on brief ($\leq$ 5 min) single or repeated sprints at high-intensity ($\geq$ 90% VO_2max). Research regarding the performance of sprints combined with prolonged aerobic exercise, as in a soccer game, will not be discussed because metabolism and other factors that might limit performance are likely to be different in these two types of activity.

RESEARCH REVIEW

Role of Carbohydrate as a Fuel during High-Intensity Exercise

Resistance Exercise. Resistance exercise depends to a great extent on phosphocreatine as fuel. However, there is also a significant reliance on muscle glycogen with multiple lifts. Several studies using multiple-set resistance exercise to fatigue described a drop of about 25-40% in total muscle glycogen (MacDougall et al., 1988; Robergs et al., 1991; Tesch et al., 1999). The magnitude of glycogen depletion was related to the intensity of the lift and to the amount of work performed, i.e., glycogen was used at a faster rate with more intense lifting, but total depletion of glycogen was dependent on the amount of work performed during the resistance exercise bout.

Single Sprint Exercise. Sprinting causes a rapid depletion of muscle glycogen. For example, glycogen concentration in the vastus lateralis muscle of the thigh fell 14% after a single 6-s bout of all-out cycle exercise (Gaitanos et al., 1993), and a 30-s cycling sprint can reduce muscle glycogen by up to 27% (Esbjornsson-Liljedahl et al., 1999). Although glycogen in Type I, slow-twitch muscle fibers is the primary carbohydrate source for low-intensity bouts of cycling, glycogen in Type II, fast-twitch fibers is reduced more readily during a high-intensity sprint. Depletion of glycogen in fast-twitch fibers could play a role in fatigue during high-intensity sprint exercise.

Repeated Sprints. Repeated cycling sprints can cause a dramatic reduction in muscle glycogen. For example, Hargreaves et al. (1997) measured a 47% drop in total muscle glycogen after just two 30-s sprints. However, the contribution of muscle glycogen to total energy production diminishes as sprints are repeated. For example, Spriet et al. (1989) had subjects complete three 30-s maximal cycling sprints and found that the rate of glycogen use was high during the first sprint but fell to almost nothing by the third sprint. So, although the total magnitude of muscle glycogen depletion is more dramatic after repeated sprints than after single sprints, the rate of glycogen use declines with each repeated sprint.

Dietary Carbohydrate and Performance of Resistance Exercise

Carbohydrate Loading. Few studies that have manipulated body carbohydrate status have measured single-effort, maximal force development or muscle endurance (the ability of specific muscle groups to persist in producing intense contractions) (Table 1). Data from our laboratory showed that carbohydrate may be critical to muscle endurance during negative energy balance, i.e., when dietary energy intake is less than energy expenditure (Walberg et al., 1988). Resistance trainers who consumed a low-energy diet containing a moderate amount (50%) of carbohydrate had decreased muscle endurance after 7 d of the diet, whereas those who consumed the same amount of energy—but with 70% of the energy derived from carbohydrate—maintained their isometric endurance at baseline levels (Walberg et al., 1988).

An attempt to increase the total volume lifted during a resistance-training workout by having the athletes consume a high-carbohydrate diet was not successful. Mitchell et al. (1997) had 11 resistance-trained males undergo a typical glycogen loading procedure prior to one resistance workout and a moderate-carbohydrate diet before the other. There was no difference in total amount of weight lifted during the two workouts, perhaps because muscle glycogen stores were not limiting for this type of exercise. Alternatively, it may be that the variability introduced by this “real-life” setting reduces the chance of determining any difference in performance caused by diet.

Acute Carbohydrate Consumption. One study tested the effect of carbohydrate ingestion just before and during a resistance exercise bout. Lambert et al. (1991) had resistance-trained males perform two trials of repeated-set, leg-extension exercise with consumption of either placebo or glucose polymer immediately before and between sets. Muscle endurance, as reflected by number of repetitions (149 vs. 129 for carbohydrate vs. placebo) and sets (17.1 vs. 14.4 for carbohydrate vs. placebo), tended to be higher with carbohydrate, but statistical significance was not achieved.

A study from our laboratory using a weight room setting did not support the value of a single high-carbohydrate feeding on performance of multiple-set resistance exercise when subjects were in negative energy balance (Dalton et al., 1999). Resistance trained subjects consumed a low-calorie (18 kcal/kg) moderate-carbohydrate, formula diet for 3 d. Resistance exercise performance was tested before and after weight loss by having the subjects perform repetitions to exhaustion in the last set of leg extension and bench press exercises within a four-exercise resistance workout. Half of the subjects consumed a high-carbohydrate beverage, whereas the others consumed a placebo beverage before the final performance test. Carbohydrate intake did not significantly improve performance during the resistance exercise tests.

Table 1. Effect of dietary carbohydrate on performance of resistance exercise.

GLYCOGEN LOADING	SUBJECTS	RESISTANCE PROTOCOL	DIETARY TREATMENTS	PERFORMANCE
Mitchell et al. 1997	11 RT males	5 sets of 3 exercises to failure @ 15 RM	Exercise + HC (80%) or LC (4%) for 48 h	No difference in volume lifted
Walberg et al. 1988	19 RT males	10 maximal-effort isometric contractions	7 d of hypoenergy diet (18 kcal/kg), either HC (70%) or MC (50%)	Reduced muscle endurance for MC; no change for HC
ACUTE INGESTION				
Dalton et al. 1999	22 RT males	5 sets of 10 of 4 exercises @ 80%, 80%, 70%, 60%, 60%, 60% 1 RM	Energy restricted for 3 d, 1 g CHO or placebo/kg 30 min before exercise	No diet effect on number of repetitions for final set of bench press or leg extension
Lambert et al. 1991	7 RT males	2 trials of repeated sets of 10 leg extensions @80% of 10 RM	Glucose polymer or placebo before and between sets	Number of sets tended to be > in CHO Number of reps tended to be > in CHO

RT= resistance trained; HC = high carbohydrate; LC = low carbohydrate; MC = moderate carbohydrate; CHO = carbohydrate.

In summary, studies of resistance exercise performance have not consistently demonstrated a benefit of high initial muscle glycogen stores or acute carbohydrate ingestion.

Dietary Carbohydrate and Performance of a Single High-Intensity Exercise Bout

Carbohydrate Loading. Maughan et al. (1997) reviewed a series of studies performed in the 1980's demonstrating that consuming a low-carbohydrate diet for several days reduced time to exhaustion by 18-50% during single bouts of high-intensity cycling at 100% VO_2max. One of these studies showed superior performance with consumption of a high-carbohydrate diet relative to a moderate-carbohydrate diet, whereas another did not observe any differences between a moderate-carbohydrate diet and either a high- or a low- carbohydrate diet.

The benefit of consuming a high-carbohydrate diet vs. a low-carbohydrate diet several days before high-intensity sprint exercise was further supported by later studies (Langfort et al., 1997; Pizza et al., 1995). Only one study found no difference in performance of a single 75-s all-out sprint in subjects who consumed low- or high-carbohydrate diets (Hargreaves et al., 1997). (See Table 2.)

Most studies do not observe a benefit of a high-carbohydrate diet vs. a moderate-carbohydrate diet on high-intensity sprint performance. For example, two studies using an intense (90% VO_2max; Pitsiladas & Maughan, 1999) or a highly intense (125% of VO_2max; Vandenberghe et al., 1995) exercise test found no difference in cycling time to exhaustion for a moderate- compared to a high-carbohydrate diet.

Table 2. Effect of carbohydrate loading regimens on performance of single sprints.

STUDY	SUBJECTS	EXERCISE PROTOCOL	DIET PROTOCOLS	EFFECT ON PERFORMANCE
Ball et al. 1996	6 active males	Cycle 4 times @ 95% VO_2max to exhaustion	3-d diets MC (48%) or LC (2%) Supplement: $CaCO_3$ or $NaHCO_3$	26-31% lower exercise time for LC; no effect of supplement
Hargreaves et al. 1997	9 trained cyclists	75-s maximal cycle bout	Exercise + HC (80%) or LC (25%) for 24 h	No difference in peak or mean power
Langfort et al. 1997	8 males	30-s Wingate test	3 d of MC (50%) or LC (5%)	8% lower mean power for LC
Pitsiladis & Maughan 1999	13 trained cyclists or triathletes	Cycle to exhaustion at 90% of VO_2max	7 d of either HC (70%) or MC (40%)	No difference in time to exhaustion
Pizza et al. 1995	8 trained male runners	Run 15 min at 75% VO_2max + run to exhaustion at 100% VO_2max	MC (4 g/kg) or HC (8.2 g/kg) for 3 d	8% shorter exercise time for LC
Vandenberghe et al. 1995	17 female and 15 male fit students	Cycle @ 125% of VO_2max until exhaustion	MC diet (50%) for 5 d with normal activity or MC for 2 d with exercise to deplete glycogen, then 3-d HC diet (70%)	No difference in performance

HC = high carbohydrate; LC = low carbohydrate; MC = moderate carbohydrate.

In summary, most, but not all, studies reported a superior performance of a single, high-intensity exercise bout lasting 30 s to 5 min in subjects consuming a high-carbohydrate diet versus a low-carbohydrate diet (Table 2). However few athletes actually consume a "low-carbohydrate" diet. There is little evidence for the value of increasing dietary carbohydrate to higher than moderate (~50% of energy) levels.

Dietary Carbohydrate and Performance of Repeated Sprints

Carbohydrate Loading. Numerous studies have reported a benefit of high- compared to low-carbohydrate diets for performance of repeated high-intensity interval sprints (Table 3). For example, in a trial to fatigue, subjects who had consumed a high-carbohydrate diet were able to perform 265% more 6-s intervals (intensity ~200% of VO_2max) than during a low-carbohydrate diet (Balsom et al., 1999). Other research groups found a similar detrimental effect of a low-carbohydrate diet on performance of 30-s (Casey et al., 1996) and 60-s sprints (Jenkins et al., 1993; Smith et al., 2000).

We observed that subjects who began an exercise test with 43% lower glycogen did not experience a fall in initial power during a repeated sprint exercise bout, but subjects cycled significantly longer before achieving 30% fatigue in the high- than in the low-carbohydrate condition (57.5 vs. 42.0 min) (Smith et al., 2000). Given that muscle glycogen, phosphocreatine, and sarcoplasmic reticulum function (calcium uptake and release) recorded at baseline and at 15% and 30% fatigue fell in a similar pattern and that serum lactate rose identically for both the high- and low-carbohydrate conditions, these factors did not seem to explain the differential fatigue with the dietary treatments. Thus, the metabolic mechanism for improved repeated sprint performance with the high-carbohydrate dietary treatment was not obvious from the metabolic data collected.

The literature supports the superiority of a high-carbohydrate diet when energy is reduced as during intentional weight loss. Wrestlers who consumed weight-loss diets containing 41% of energy as carbohydrate experienced a decrement in their performance of high-intensity exercise (repeated upper-body cycling sprints), whereas those who consumed 66% of their energy as carbohydrate were able to maintain their performance (Horswill et al., 1990).

As with single sprints, a clear benefit of high- compared to moderate-carbohydrate diets has not been demonstrated for repeated sprints. In one study, collegiate swimmers were provided with a moderate- or high-carbohydrate diet for 9 d, and average times to swim intense events lasting 40-150 s were not affected by the diets (Lamb et al., 1990).

Acute Carbohydrate Consumption. Carbohydrate consumption prior to and during exercise allowed subjects to continue 45% longer during repeated 1-min cycling sprints separated by 3-min rest intervals (Davis et al., 1997). Muscle glycogen was not measured, but the authors speculated

Table 3. Effect of carbohydrate on repeated sprint performance.

STUDY	SUBJECTS	EXERCISE PROTOCOL	DIETARY TREATMENTS	PERFORMANCE
GLYCOGEN LOADING				
Balsom et al. 1999	7 males fit students	Fixed duration: 15 6-s cycling sprints with 30 s between, ~300% VO_2max; To exhaustion: 6-s sprint @ ~ 200% VO_2max	Glycogen depletion exercise + LC (4%) or HC (67%) for 2 d	Fixed duration: less work performed by LC to exhaustion; 265% more intervals performed by HC
Casey et al. 1996	11 males	4 bouts of 30-s isokinetic cycling with 4-min rest intervals (Before and after diet manipulation)	Glycogen depletion exercise + LC (7.8%) or HC (82%) for 3 d	No change in work performed pre vs. post diet for HC; work during first 3 sprints 8% less after LC
Jenkins et al. 1993	14 moderately trained males	Five 60-s cycle sprints @ 0.736 N/kg with 5 min rest intervals (Before and after each dietary manipulation)	3-d diets: HC 80% MC 55% LC 12%	Change in work performed during sprints: HC: + 5.6% MC: + 2.3% LC: -5.4%
Lamb et al. 1990	14 male collegiate swimmers	50 m X 20, 100 m X 20, 200 m X 15	9 d of HC (80%), or MC (43%)	No difference in average split time for HC vs. MC
Smith et al. 2000	8 trained cyclists	60-s repeated sprints @ 125-135% VO_2max to 30% fatigue	Glycogen reduction; then 36 h HC (80-85%) or LC (5-10%)	37% longer exercise until 30% fatigue in HC; 87% longer between 15% and 20% fatigue in HC
ACUTE INGESTION				
Davis et al. 1997	9 men and 7 women, untrained	1-min cycling sprints @ 120-130% VO_2max with 3 min rest intervals until power output declined 12.5%	4 ml/kg of 6% CHO solution before and every 20 min during exercise	50% more intervals done with CHO than with placebo

HC, high carbohydrate; LC = low carbohydrate; MC = moderate carbohydrate; CHO, carbohydrate

that higher blood glucose in the carbohydrate-fed trial allowed either reduced glycogen breakdown or increased glycogen synthesis during the recovery periods.

The consensus of research examining performance of repeated, brief sprints is that there is a substantial performance benefit of eating a high-carbohydrate diet versus a low-carbohydrate diet for several days in advance of high-intensity exercise to ensure high initial muscle glycogen stores. Similarly, high-carbohydrate feedings immediately before and during the exercise, when compared to low-carbohydrate feedings, also are likely to improve performance of high-intensity exercise. However, there is no evidence that a high-carbohydrate diet is superior to a moderate carbohydrate diet for performance of repeated sprints.

MetabolicMechanisms forEffects of Carbohydrate on Performance

Given that there is only a modest reduction of muscle glycogen after a single sprint, low total muscle glycogen is not thought to be a limiting factor for single sprint performance, even after a low-carbohydrate diet. However, selective depletion of glycogen from Type II fibers may contribute to a reduction in power output during sprinting (Greenhaff et al., 1994). In addition, although there is little evidence to support the hypothesis, it is possible that there is depletion of glycogen in different compartments, e.g., the sarcoplasmic reticulum, of each muscle fiber (Friden et al., 1989). If there were substantial depletion of glycogen from the sarcoplasmic reticulum (even if total muscle glycogen were not dramatically reduced), it could influence calcium flux and thus the contractile process. The hypothesis that a high-carbohydrate diet causes superior maintenance of glycogen in fast-twitch fibers or in specific compartments of each muscle fiber and that this better maintenance of glycogen explains improved performance of high-intensity exercise deserves further study.

Another potential contributor to premature fatigue after consuming a low-carbohydrate diet is a reduction in buffering capacity of the body. Evidence that low-carbohydrate diets cause metabolic acidosis and a reduced capacity to buffer acid has been observed in a number of studies, including those reported by Horswill et al. (1990) and Maughan et al. (1997). Although the evidence appears promising, Ball et al. (1996) found that correction of the acidotic condition does not normalize performance. In that study, consumption of sodium bicarbonate (0.3 g/kg body weight) by subjects who had consumed a low-carbohydrate diet normalized blood acidosis but not the performance of a cycle sprint at 100% of VO_2max.

Dietary Carbohydrate and Recovery between High-Intensity Exercise Bouts

Some athletes perform repeated events or games during a single day, so they need to recover as quickly as possible. Consumption of carbohydrate after exercise will accelerate glycogen replacement. For example, Pascoe et al. (1993) showed that muscle glycogen dropped to about 70% of resting values after a resistance exercise bout, but consumption of a carbohydrate beverage after exercise increased muscle glycogen to 75% of baseline after 2 h and to 91% of baseline after 6 h. On the other hand, there was far less restoration of muscle glycogen after 6 h when a water placebo was ingested after exercise. Thus, any athlete expecting to do multiple resistance workouts or competitions on a single day should make an effort to consume carbohydrate after the resistance workout to encourage optimal metabolic recovery.

Our laboratory looked at the ability of a high-carbohydrate diet to enhance recovery of repeated sprint performance in wrestlers who had lost an average 3.3% of body weight over 3 d with a formula diet (Walberg-Rankin et al., 1996). Work performed during eight repeated 15-s upper body ergometer sprints was reduced by weight loss; performance tended to rebound to baseline for wrestlers who consumed a high-energy (22 kcal/kg), high-carbohydrate diet but not for those who consumed an isoenergetic moderate-carbohydrate diet before testing (P= 0.07).

In summary, glycogen replacement is likely to be more rapid when carbohydrate is consumed after exercise. Consumption of high-carbohydrate meals between brief, high-intensity exercise bouts will accelerate glycogen synthesis and may improve subsequent performance of high-intensity exercise.

SUMMARY

Although there is substantial use of muscle glycogen during resistance exercise, there is only tentative evidence for the value of dietary carbohydrate on performance of resistance exercise. The available literature suggests that carbohydrate may be of value for high-volume, moderate-intensity resistance exercise, especially in those who have been consuming a low-energy diet for weight loss. It would be helpful to have more research investigating whether oral consumption of carbohydrate just before and during a resistance workout spares muscle glycogen use, as has been shown for intermittent sprinting on a cycle ergometer.

The use of muscle glycogen during sprinting exercise is more rapid than during resistance exercise. A 30-s sprint may use as much muscle glycogen as 5-6 sets of multiple-repetition resistance exercise. A high-carbohydrate diet for several days is beneficial compared to a low-carbohydrate diet for single bouts at $\geq$100% VO_2max (e.g., 30 s to 5 min) and for repeated sprints, each lasting 6-60 s, but such high-carbohydrate diets are probably not superior to moderate-carbohydrate diets. There is limited evidence that carbohydrate consumption just before and between high-intensity cycling and running sprints will delay fatigue and spare muscle glycogen.

PRACTICAL IMPLICATIONS

Many athletes involved in high-intensity sports do not focus on consuming a high-carbohydrate training diet, nor do they use carbohydrate supplements just before their events because this has not been traditionally believed to be critical to their performance. Although the research is less plentiful than for prolonged, aerobic exercise, a low-carbohydrate diet (3-15% carbohydrate) has almost uniformly been shown to impair performance of high-intensity single or multiple sprints compared to a moderate- or high-carbohydrate intake. Several studies show superior performance of single and repeated sprints when athletes have consumed high-carbohydrate diets (66-84% carbohydrate) compared to moderate-carbohydrate diets (40-50%), but this is not consistent among studies. Given that there is no known detriment to consumption of a high-carbohydrate diet (other than body weight gain due to water retention) and some research reports a benefit, it is recommended that all athletes consume a high-carbohydrate training diet, i.e., at least 60-70% of energy as carbohydrate (7-10 g/kg), and increase this to 65-85% for the few days before competition. Use of a carbohydrate supplement before and during exercise will likely improve performance of intermittent, high-intensity sprints.

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SUPPLEMENT

VOLUME 13 (2000) ■ NUMBER 4

ARE YOU EATING ENOUGH CARBOHYDRATE?

To optimize performance in your sport, you must eat foods that contain plenty of carbohydrate. Doing so will increase the stored carbohydrate (glycogen) in your muscles and help maintain the level of sugar (glucose) in your blood. Both muscle glycogen and blood glucose are critical fuels that provide energy for your sport. Most experts recommend that serious athletes, especially endurance athletes, should consume 60-80% of their total dietary energy as carbohydrate. However, it is preferable to express this carbohydrate requirement as 7-10 grams of carbohydrate per kilogram of body weight (3.2-4.5 grams/pound) every day. You can calculate the range for the total grams of carbohydrate you should be eating each day by multiplying your body weight in kilograms by 7 and then by 10. If you prefer to use pounds for your body weight, multiply by 3.2 and then by 4.5. For example, if you weigh 130 pounds, you should be consuming between 416 and 585 grams each day (130 x 3.2 = 416 grams; 130 x 4.5 = 585 grams).

Unless you skip meals, intentionally starve yourself, find yourself in situations where good food is not available, or make poor choices of food items, you should be able to obtain plenty of carbohydrate from the ordinary foods in your diet (see Table 1). Still, you may want to check your total diet to make sure you are getting enough carbohydrate daily to help you perform to the best of your ability.

How do you find out how much carbohydrate is in your normal diet? You can determine this by keeping a food record and having a nutritionist or dietitian analyze this record using a computer program. But with a little effort, you can also do this yourself by using the free *Healthy Eating Index* on the website (www.usda.gov/cnpp/) of the U.S. Department of Agriculture's Center for Nutrition Policy and Promotion. Once you arrive at this website, scroll down to "Interactive Healthy Eating Index" and click on the link to the appropriate website to begin your diet analysis.

Using The Healthy Eating Index Site

- You need to have kept track of your food consumption for one full day (24 hours) prior to using the site.
- After entering your age and gender, you will have access to the food entry screen.
- Type in each food item, e.g., "chicken," that you consumed during the day, and then click on "Search" to bring up a list of types of chicken, e.g., fried, roasted, nuggets, etc.
- Click on the appropriate type of food in the search list to add it to your food list on the right of the page, and then repeat for each food item you consumed that day.
- Once you have entered all the foods you consumed, click on "Select Quantity" at the bottom of the list of foods you have entered on the right side of the page. This will show you the typical serving sizes for the food item; choose the multiple of the most appropriate serving size. For example, if you ate 1/2 cup of rice and selected a serving size of 1 cup, list 0.5 servings of rice.
- When your list is complete, click on "Analyze." You can view the output of the analysis by three methods: ***HEI Score*** (a total score from 0-100 as well as 10 component scores such as "variety" and "total fat"), ***Food Pyramid*** (your degree of compliance with this diet assessment tool), or ***Nutrient Intake*** (list of kcal, macronutrients, and micronutrients).

The last method of analysis (***Nutrient Intake***) provides an estimation of your total carbohydrate intake in grams. You can compare this value to the calculated amount of carbohydrate that you should consume, i.e., 7-10 g/kg or 3.2-4.5 g/lb (see the first paragraph of this article).

To convert the total grams of carbohydrate intake to a percentage of energy as carbohydrate, you must multiply the grams of carbohydrate by 4 kcal/g to calculate the kcal of energy from carbohydrate, divide that value by the total kcal of energy you consumed (as shown on the *Nutrient Intake* analysis), and then multiply by 100 to convert to a percentage:

____ grams of carbohydrate x 4 kcal/g = ____ kcal of carbohydrate

____ (kcal of carbohydrate/ total kcal of energy) x 100 = ____ % of total energy as carbohydrate

For example, if the *Nutrient Intake* analysis shows that you consumed 500 grams of carbohydrate and 3200 total kcal of energy for the day, your calculations would be as follows:

500 g of carbohydrate x 4 kcal/g = 2000 kcal of carbohydrate energy

2000 kcal of carbohydrate energy/ 3200 kcal of total energy = 0.6250

0.6250 x 100 = 62.5% of total energy as carbohydrate

Note that the accuracy of the *Health Eating Index* or any dietary assessment is only as accurate as the data you enter. You must carefully estimate portion sizes, include all items (e.g., mayonnaise on a sandwich) and eat normally to get a true assessment of your diet. Contact a professional, e.g., a registered dietitian, if you are confused or need help interpreting this information.

Carbohydrate in Typical Foods

If you determine that you need to boost your carbohydrate intake, choose foods from the accompanying table of energy and carbohydrate contents of common foods that are high contributors to carbohydrate intake.

(See Over)

Energy And Carbohydrate Content Of Selected Common Foods

Food Item	Serving Size	Energy/Serving (kilocalories)	Carbohydrate/Serving (grams)
Grains			
Bagel	1	160	31
Bread	1 slice	70	12
Cereal, dry	1 oz	110	23
Muffin, biscuit, pancake	1	130	20
Rice	1/2 cup	110	23
Pasta	1 cup	160	34
Vegetables			
Carrot	1	31	7
Corn	1/2 cup	70	17
Legumes	1/2 cup	115	20
Peas	1/2 cup	60	12
Potato	1 medium	220	50
Winter squash	1/2 cup	40	9
Fruits			
Dried	1/3 cup	150	37
Juice	1/2 cup	56	13
Solid (e.g., apple, orange)	medium piece	75	18
Dairy			
Flavored yogurt	1 cup	225	42
Ice cream	1 cup	270	32
Milk	1 cup	80	12
Sherbet	1 cup	270	59
Mixed Foods			
Baked beans	1/2 cup	200	30
Burrito	1	390	50
Pizza, cheese	1 piece	170	20
Beverages			
Gatorade®	8 oz	50	14
Soda	8 oz	103	27
Torq™ Energy Juice Drink	12 oz	300-310	77
Gator Lode®	8 oz	200	49
Snacks			
Cake w/icing	1 piece	230	34
Chocolate bar	1.6 oz bar	254	27
Cookies			
Ginger snap	1	34	5
Fig bar	1	53	11
Sandwich	1	50	7
Gatorade Energy Bar	1 bar	250-260	47
Hard candy	1 oz	109	26
Popcorn	1 cup	40	5
Pretzels	1 oz	110	22
Saltine crackers	4	50	9
Condiments			
Honey	1 tablespoon	65	17
Jelly	1 tablespoon	50	13
Sugar	1 teaspoon	16	4
Syrup	1 tablespoon	50	13

Note that there is very little carbohydrate in meats, fish, cheeses, oils and fats, nuts, or leafy green vegetables