Obesity and cardiovascular risk intervention through the ad libitum feeding of traditional Hawaiian diet[1-3]

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ABSTRACT The Waianae Diet Program is a community-based intervention strategy designed to be culturally appropriate by using a pre-Western-contact Hawaiian diet to reduce chronic-disease risk factors in Native Hawaiians. This paper describes a trial of the traditional Hawaiian diet fed ad libitum to Native Hawaiians with multiple risk factors for cardiovascular disease to assess its effect on obesity and cardiovascular risk factors. Twenty Native Hawaiians were placed on a pre-Western-contact Hawaiian diet for 21 d. The diet was low in fat (7%), high in complex carbohydrates (78%), and moderate in protein (15%). Participants were encouraged to eat to satiety. Average energy intake decreased from 10.86 MJ (2594 kcal)/d to 6.57 MJ (1569 kcal)/d. Average weight loss was 7.8 kg ($P < 0.0001$) and average serum cholesterol decreased 0.81 mmol/L ($P < 0.001$) from 5.76 to 4.95 mmol/L. Blood pressure decreased an average of 11.5 mm Hg systolic ($P < 0.001$) and 8.9 mm Hg diastolic ($P < 0.001$). *Am J Clin Nutr* 1991;53:1647S–51S.

KEY WORDS Obesity, lipids, nutrition and disease, dietary fat.

Introduction

Native Hawaiians have long been a neglected population in the field of public health. Although studies in the early 1960s explicitly indicated high rates of cardiovascular disease mortality (1, 2) and related risk factors, including diabetes (3, 4), hypertension (5–7), and obesity (6–8), no intervention programs for that population were ever initiated. Preliminary data on obesity suggest that Native Hawaiians have one of the highest prevalences of obesity in America, second only to that of the Pima Indians (9). The irony is that in Hawaii, the healthiest state in the union from the standpoint of longevity (10), the Native Hawaiians have the shortest lifespan of all ethnic groups. Their lifespan is also among the shortest in the United States.

Historical accounts describing the physique of the ancient Hawaiians sharply contrast the contemporary descendants. In 1825 a writer named Stewart described the Native Hawaiians as follows (11): "The common people are . . . of a thin rather than full habit."

The traditional diet of Native Hawaiians (consumed before Western contact) was high in fiber, high in complex carbohydrates, high in the ratio of polyunsaturated to saturated fatty acids, low in fat, and low in cholesterol (12). A number of studies indicate that traditional diets of other cultures similarly low in fat are associated with low rates of obesity and cardiovascular risk (13–19). Some investigators have tried using low-fat diets and low-energy-density (LED) diets ad libitum to induce weight loss (20–23). One study tested the effect of an isocaloric traditional Hawaiian diet on the serum lipid concentrations of individuals with hyperlipidemia (23). However, no studies have been done to test the effect of the ad libitum consumption of a traditional Hawaiian diet on obesity and cardiovascular risk. This paper describes the Waianae Diet Program (WDP), a community-based intervention strategy designed to be culturally appropriate, which uses a traditional Native Hawaiian diet to reduce obesity and other chronic-disease risk factors in Native Hawaiians.

Methods

Study population

The participants were selected from the Waianae community located on the western coastline of the island of Oahu. Thirty-five miles from Honolulu, the state capital, Waianae has a population of 45 000 of which Native Hawaiians make up almost 50% as compared with 19% for the state population. There exist serious socioeconomic problems in the Native Hawaiian community, including low median income and disproportionately poor health status when compared with other ethnic groups in the state.

Selection of participants

A screening interview was conducted of individuals from the Waianae community who responded to newspaper advertisements and articles, flyers, and a public presentation about the program. Twenty Native Hawaiians (Native Hawaiians are defined as persons who had any ancestors residing in Hawaii before 1778 when the first Western contact was made) were selected from this population on the following basis: *1*) commitment to

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the program and its rules to ensure the success of the program, *2*) health problems that were diet related, *3*) potential for facilitating change in other Native Hawaiians, and *4*) Native Hawaiian ancestry.

Ten men and 10 women aged 25–64 y were selected for study. One individual was unable to complete the program because of viral illness. The average weight of the remaining 19 participants was 120 kg (range 77.3–154.5 kg). All were obese on the basis of body mass index (BMI), calculated as the weight (in kg) divided by height (in m) squared. This was based on a cutoff point of 27.2 for men and 26.9 for women, which represents an excess body weight of ≥ 20% (24). The average BMI was 39.6 (range 27.7–48.7).

Preprogram diet and health history

The health status of each participant was assessed before the program period by standard history and physical examination by a physician. The program was described to the participants and consent forms were signed. A registered dietitian assessed their preprogram diet from a 3-d diet record, including 2 weekdays and 1 weekend day. Diets were analyzed by computer using the *Nutritionist III* program with the database adapted to include Hawaiian foods.

Diet and study design

The WDP was designed as a culturally appropriate, community-based intervention model with special consideration to accessibility, reasonable cost, and ability to be propagated and sustained in the community. The selection of food for the program consisted of foods available in Hawaii before Western contact, such as taro (a starchy root-like potatoes), poi (a mashed form of taro), sweet potato, yams, breadfruit, greens (fern shoots and leaves of taro, sweet potato, and yams), fruit, seaweed, fish, and chicken. All foods were served either raw or steamed in a manner that approximated ancient styles of cooking.

The study period was 21 d. Patients were informed of the protocol, the risks, and the benefits of the program, and a consent form was signed. This protocol was approved by the institutional review board of the University of Hawaii. The participants were instructed to adhere strictly to the dietary regimen and were not allowed to eat any food or drink any beverages other than what was prescribed. All meals were prepared at a meal site 3.8 km from the health center under supervision of one of the investigators. Food was premeasured in containers to aid in the evaluation of calorie intake.

Unlimited quantities of foods except fish and chicken were made available. To approximate the diet of the ancient Hawaiians, which was estimated to contain < 10% fat, the amounts of fish and chicken were limited to a total of 142–198 g/d. The participants were required to come to the meal site twice a day. In the morning breakfast was eaten as a group. Lunch and snacks were distributed at this time. In the evening everyone met for a cultural or health-education session during dinner. Each day these participants were asked if they were hungry by use of a hunger-satiety scale described by Haber (25); if they were not satisfied, they were encouraged to eat more and to take enough snacks so that they would be fully satisfied.

The WDP physician was present each day to evaluate and monitor medical conditions, including blood pressure, blood sugar, medication, and any other medical problems. Fasting blood-chemistry tests, including high-density lipoprotein (HDL), and brief physical exams were done weekly during the study period and again at the end of the program. Blood samples were analyzed at the largest licensed commercial laboratory in Hawaii. Weights were taken each day at the meal site on the same balance scale. All official blood pressures were taken by a trained physician. Food intake and wastage was recorded by a nutrition aide. The statistical significance of the results of the program was analyzed by using a paired, two-tailed t test, and a 95% confidence interval for the difference between the means was calculated.

Results

Energy intake

The average daily energy intake during the program was 41% less than intake before the program (**Table 1**). This was true even with moderate to high levels of satiety reported by the participants. Some participants indicated that at times they could not finish their snacks.

The decrease in energy intake may be understated because the preprogram dietary intake of the participants was lower in average fat (32%) than expected. It was apparent that some of the participants in their enthusiasm modified their diet before the program despite instructions not to do so. Surveys of the dietary intake of the general population in Hawaii indicate that the average intake of fat is ~38% of energy (26).

Weight loss was dramatic during the program, with an average weight loss of 7.8 kg (range 2–15 kg), or 6.4% of total weight, in just 3 wk (**Table 2**). BMI decreased from 39.6 to 37.0, a total decrease of 2.6 (±0.53).

Serum lipids

Total serum cholesterol concentrations decreased an average of 14.0%. Initially, there were 16 participants with cholesterol concentrations > 5.18 mmol/L compared with only 3 participants with such elevated concentrations at the end of the program. Low-density lipoprotein (LDL) decreased moderately and HDL decreased slightly but not significantly. There was also a slight but nonsignificant decrease in the cholesterol-HDL ratio. Serum triglyceride levels fell significantly although the confidence interval was broad because of the high concentrations of triglycerides in two of the patients (up to 8.85 mmol/L).

Blood pressure

Both systolic and diastolic blood pressures fell significantly. The average systolic blood pressure decreased 7.8% and the average diastolic pressure decreased 11.5%.

TABLE 1
Average energy intake of participants before the program (preprogram diet) and during the program (Hawaiian diet)

Total daily energy	Preprogram diet, 10.86 MJ (2594 kcal)	Hawaiian diet, 6.57 MJ (1569 kcal)
Fat	830 [32%]*	99 [7%]
Carbohydrate	1323 [51%]	1233 [78%]
Protein	441 [17%]	237 [15%]

* Percent of energy given in brackets.

TABLE 2
Average change in health risk factors after 21 d on the traditional Hawaiian diet*

	Before	After	Change	95% CI	P
Weight (kg)	120.0	112.2	−7.8	1.7	<0.0001
BMI†	39.6	37.0	−2.6	0.53	<0.001
Cholesterol (mmol/L)	5.76	4.95	−0.81	0.36	<0.001
HDL (mmol/L)‡	0.976	0.905	−0.071	0.122	NS
LDL (mmol/L)§	3.81	3.37	−0.45	0.37	<0.02
Cholesterol-HDL ratio	6.3	5.7	−0.6	0.9	NS
Triglycerides (mmol/L)	2.67	1.56	−1.107	0.81	<0.01
Glucose (mmol/L)	8.99	6.86	−2.14	1.52	<0.01
Systolic blood pressure (mm Hg)	133.6	122.1	−11.5	6.9	<0.01
Diastolic blood pressure (mm Hg)	84.2	75.3	−8.9	5.7	<0.01

* $n = 19$.
† Body mass index, in kg/m^2.
‡ High-density lipoprotein.
§ Low-density lipoprotein. $n = 17$ because two values were invalid because of high triglycerides.

Serum glucose

There was a striking decrease in average serum glucose with a drop of 2.14 mmol/L. The wide confidence interval was partly due to four starting glucose readings of > 11.1 mmol/L and one of 20.26 mmol/L. The significance of the effect of the diet on serum glucose is difficult to assess because some medication levels had to be altered during the program to prevent hypoglycemia.

Discussion

Epidemiologic studies of traditional diets indicate that there is a correlation between modernization of diets and the rising rates of obesity and other cardiovascular risk factors (13–19). Studies have been conducted that show the value of a low-fat diet in producing weight loss (20–22, 26). Studies have also been done to show the effect on weight loss of the ad libitum feeding of individuals with an LED diet (20, 21, 26). These studies suggest that a low-fat, LED diet will produce steady and safe weight loss and sustain it over a long period (21). The traditional Hawaiian diet is both low in fat (< 10%) and low in energy density (3.5 kJ/g, or 0.83 kcal/g).

The change in energy intake observed in this group was remarkably similar to the findings of Duncan et al (21) in a trial involving the ad libitum feeding of an LED diet. The average caloric intake changed from 10.86 to 6.57 MJ/d (from 2594 to 1569 kcal/d) in this study. Duncan et al (21) documented a change from 12.56 to 6.47 MJ/d (from 3000 to 1545 kcal/d). It was also consistent with other low-fat diet programs that show a decrease in daily intake from 7.70 to 5.71 MJ/d (from 1840 to 1365 kcal/d) on a 23% fat diet (27) and a decrease from 11.36 to 8.74 MJ/d (from 2714 to 2087 kcal/d) on a 15–20%-fat diet (23). The apparent satiety despite the decrease in energy intake in the WDP may be due to participants eating more in grams of food on the program (1872 g/d) than before it (1711 g/d).

The average weight loss observed was somewhat greater than that found in other studies using LED diets [Weinsier et al (20) 0.68 kg/wk] and ad libitum low-fat diets [Lissner et al (22) 0.45 kg/wk] to reduce weight or other health risks [Buzzard et al (27) 0.23 kg/wk]. These observations may be explained by the relatively high initial weight and BMI of the participants and to some extent early water loss because of the low sodium content of the diet. They may also be explained by the lower fat content of the WDP diet (7%) compared with those of other programs (15–23%). This hypothesis is based on studies that suggest that percent body-fat retention is related to the percentage of fat in the diet (28, 29) and that fat may count more than previously thought in terms of weight retention (30). Another factor contributing to the greater weight loss in WDP may be the higher carbohydrate content of the diet; other studies suggested that weight loss is directly proportional to the amount of carbohydrate in the diet. This hypothesis is based on the thermogenic effect of carbohydrates (31) and on evidence that shows that only a small percentage of carbohydrates in vivo is actually converted to body fat (32, 33). These results and those of other recent studies suggest that varying the mix of nutrients (in particular, the amounts of fats and carbohydrates) may be an effective way of dealing with obesity without requiring calorie counting (22, 28–30).

Although interviews based on an objective satiety scale and comments in general indicated that there was an adequate level of satiety, closer monitoring is needed to be sure that the decrease in caloric intake was not because of conscious calorie restriction. The reporting of satiety levels may have been influenced by the participants' awareness of the purpose of the study. In addition, some measure of the desirability of the food is needed to ensure that the satiety was not an aversion to the monotony of having similar food every day.

The decrease in serum cholesterol could be attributed to the low-fat, low-cholesterol content of the traditional Hawaiian diet (34, 35). Induced weight loss also may play a part in lowering cholesterol, although even massive weight loss does not necessarily induce a decrease in cholesterol (36). There was a moderate decrease in LDL and a slight but nonsignificant decrease in HDL. Although even the slight decrease in HDL is not desirable, the large decrease in total cholesterol yielded a net decrease in cardiovascular disease risk along with a slight but nonsignificant decrease in the cholesterol-HDL ratio. The reduction in triglycerides is consistent with some high-carbohydrate-diet studies (21, 32, 33) and inconsistent with others that indicate that a high carbohydrate diet causes a rise in triglycerides (37).

The moderate reduction in serum lipids with this diet occurred

over a relatively short period. This suggests that a longer period on this low-fat diet could result in even lower lipid concentrations and a greater decrease in cardiovascular disease risk than has been demonstrated here. A recent diet study that yielded low cholesterol concentrations and radiographic evidence of reversal of atherosclerosis used a diet that was similarly low in fat (10%) and suggests that WDP could do the same (38).

The decrease in fasting serum glucose was surprisingly large but consistent with other programs using high-complex-carbohydrate, high-fiber diets in the management of diabetes (39, 40). However, as stated earlier, the decrease is difficult to assess because of changes in medication levels during the program.

Adherence to the diet was excellent in sharp contrast to other existing diet programs for this population. This may be attributed to the selection method and the strict monitoring of the diet by health professionals. However, a major motivating factor for the excellent adherence appeared to be cultural pride and appropriateness of the methodology. For this reason the program has important public health implications in that it provides a diet that is much more desirable to the high-risk Native Hawaiian population than other nutrition interventions available.

In conclusion, the traditional Hawaiian diet administered ad libitum was an effective approach in the treatment of obesity and associated cardiovascular disease risk factors in this population of Native Hawaiians. Acceptability and adherence was high, which suggests that the WDP approach may have important public health implications. Further research is needed to assess the long-term effectiveness of such a program and to verify some of the finer points of the study, such as satiety levels, biases before and after changes in caloric intake, the role of the social network setting, and the motivational impact of the WDP's cultural and community-based design. In addition, the dramatic impact of this diet on fasting serum glucose suggests that further study of this approach on the control of diabetes is warranted.

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