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A Study of Dietary Intake in Adult Monozygotic Twins

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As a part of a study of the dietary habits of monozygotic twins, a nutrition survey including a 24-hour dietary recall interview and a three-day dietary diary was conducted on the members of 15 male and 13 female pairs of identical Caucasian twins ranging from 25 to 61 years of age. In this study, overall mean caloric, protein, fat, and carbohydrate intake of males was significantly greater than females. Members of male twin pairs also tended to be more similar than female twins in mean intake of all major nutrient groups. In general, the observed differences in overall intake between males and females were maintained even after adjustment of body weight. Male twins were characterized by greater similarity in intake of sodium and potassium; however, there was no consistent difference in the degree of correlation in intakes of members of male and female twins for either iron, calcium or phosphorus.

Key words: Twins, Nutrition surveys, Dietary intake

INTRODUCTION

Nutritional surveys have long been used as research tools in the characterization of diet and dietary intake patterns. A large number of studies have been directed towards the determination of differences in the diets of various groups or populations based upon dietary intake information obtained from a sample of individuals comprising the groups under study [2–4, 12, 13]. Much effort has also been expended in elucidating the degree to which dietary intake patterns of obese individuals differ from those of the nonobese to determine if obesity can be attributed simply to excessive caloric intake [5, 7]. While most authors still attribute obesity to excessive dietary intake, there is an increasing tendency to accede that obese individuals might not differ from the nonobese in the amount of food eaten.

Several authors have noted the significant relationship between socioeconomic status and obesity [9, 11]. This finding is in agreement with the results of a study by Corey and Nance [4] which, although it did not directly examine socieoeconomic status effects, found a significant paternal effect on body weight which was apparently environmental in origin. This study also found a significant maternal effect which appeared to be qualitatively different from the observed paternal effect. The most obvious explanation for the observed paternal effect on weight, in light of the previously reported effect of socioeconomic status on this trait, could lie in the traditional role of the male in the determination

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of this family's standard of living and the nature of its diet; while the observed maternal effect might be a reflection of the traditional role of the female in diet selection and food preparation. The study described here was designed to exploit the unique characteristics of monozygotic (MZ) twins to determine the extent to which the dietary intake patterns of adult male twins differ from those of adult female twins.

MATERIALS AND METHODS

Dietary intake measurements were made on 15 pairs of adult male and 13 pairs of adult female MZ twins using information obtained during a dietary recall interview and from a three-day dietary log completed by all twin pair members. The dietary recall interview was conducted by a trained dietician and involved the recall of all foods and beverages ingested during the previous 24 hours. The measures to be used when recording dietary intake information were defined for all participants by a dietician prior to initiation of the dietary log aspect of the study. Intake was recorded in common household measures since the weighing of all food prior to ingestion might have an influence on intake. All participants were requested to eat as they usually did during the three-day period covered by the dietary diary. Dietary intake information was converted from common household measures to metric measurements prior to data analysis and specific nutrient content determined using a computer program based upon the information provided by the "U.S. Department of Agriculture Handbook Number 8" [15].

Dietary data were analyzed separately from caloric content, as well as for levels of fats, carbohydrates, and proteins in the diet. Fat content was further broken down into saturated, monounsaturated, and polyunsaturated categories. In addition, individual analyses were conducted for each of 11 other substances including cholesterol, vitamin A, vitamin C, niacin, thiamin, riboflavin, iron, calcium, phosphorus, sodium, and potassium. Dietary recall and dietary diary data were analyzed separately. Separate analyses were also conducted for male and female twins.

Analysis of variance techniques were used to obtain estimates of variation among and within male and female MZ twin pairs. Intraclass correlations were estimated for all nutrients examined to determine if differences existed in the degree of similarity between twin pair members for specific nutrients which could be attributed to sex. Correlation analysis techniques were also used to assess the degree of similarity in results obtained from analyses based on dietary recall and dietary log information.

RESULTS

In this study, mean caloric intake of male twins was significantly higher than that of females based upon both dietary recall and dietary diary information (Table 1). Male twins were also characterized by greater protein, carbohydrate, and fat intake. When dietary intake was adjusted for body weight (BW), males still tended to show an increased level of intake over that of females; however, only the difference in mean protein intake between males and females, as estimated from dietary diary information, was found to be significant. As shown in Table 2, members of male twin pairs were, in general, more highly correlated for level of intake of major nutrient groups than were members of female twin pairs. The most consistent male–female difference in intraclass correlation was found for level of fat intake. Fifteen of 22 intraclass correlations estimated for male twins were significantly greater than zero as opposed to only 5 of 22 intraclass correlations for females. The correlation between recall and dietary diary information was significantly greater than zero in 8 of 11 instances for males and 7 of 11 instances for females. There were no significant differences between males and females in correlation between recall and diary data information in any category, with the exception of mean carbohydrate intake, where the dietary diary and recall information provided by male twins were significantly more correlated than that provided by female twins.

TABLE 1. Diet Characteristics of Male and Female MZ Twin Pairs

	Recall		Diary	
	males	females	males	females
Calories (k)				
mean	3046.5 ± 220.4	2286.6 ± 101.5	2756.4 ± 142.9	2073.5 ± 97.6
mean intake (kg/Bw)	39.64 ± 3.06	38.64 ± 2.67	35.85 ± 1.96	30.98 ± 1.94
Protein (g)				
mean	119.7 ± 8.7	83.0 ± 5.5	109.4 ± 6.3	67.2 ± 3.4
% of the total intake	15.9 ± 0.52	15.5 ± 0.74	15.6 ± 0.62	15.3 ± 0.49
mean intake (kg/Bw)	1.56 ± 0.12	1.44 ± 0.10	1.34 ± 0.06	1.16 ± 0.06
Carbohydrates (g)				
mean	324.5 ± 28.1	219.5 ± 15.5	283.0 ± 18.4	190.2 ± 12.2
% of total intake	43.1 ± 1.0	41.2 ± 1.5	42.2 ± 1.1	43.9 ± 1.7
mean intake (kg/Bw)	4.23 ± 0.39	4.10 ± 0.39	3.73 ± 0.24	3.43 ± 0.24
Fat (g)				
mean	132.9 ± 9.9	105.4 ± 7.8	124.7 ± 7.4	80.7 ± 6.1
% of total intake	41.0 ± 0.89	43.3 ± 1.6	42.2 ± 1.5	40.8 ± 1.3
mean intake (kg/Bw)	1.76 ± 0.14	1.85 ± 0.15	1.63 ± 0.10	1.41 ± 0.12

TABLE 2. Intraclass Correlations for Male and Female Twins With Respect to Dietary Intake Characteristics

	Recall		Diary		Recall-Diary	
	males	females	males	females	males	females
Calories (k)						
mean (g)	0.73**	0.66*	0.72**	0.46	0.48**	0.38
mean (kg/Bw)	0.84**	0.74**	0.73**	0.60*	0.49**	0.53**
Carbohydrates						
mean (g)	0.68**	0.15	0.63*	0.21	0.61**	0.13
% of intake	−0.18	−0.10	0.28	−0.19	0.47**	0.41*
mean (kg/Bw)	0.80**	0.15	0.56*	0.49	0.62**	0.25
Proteins						
mean (g)	0.65**	0.07	0.52*	0.31	0.36	0.42*
% of intake	0.44	0.06	0.38	−0.02	0.47**	0.49*
mean (kg/Bw)	0.73**	0.26	0.23	0.60*	0.33	0.42*
Fats						
mean (g)	0.79**	0.46	0.69**	0.04	0.38*	0.46*
% of intake	−0.10	−0.25	0.24	−0.49	−0.04	0.37
mean (kg/Bw)	0.79**	0.62*	0.71**	0.30	0.40*	0.55**

*, **Correlation coefficients greater than zero at the 5% and 1% levels, respectively.

Table 3 lists the mean intake, intake adjusted for body weight, and percent of fat intake accounted for by saturated, monounsaturated, and polyunsaturated fats in the diets of male and female twins. Males were characterized by an increased dietary intake of cholesterol, saturated, and monounsaturated fats over that of females. There were, however, no significant differences in intake of polyunsaturated fats attributable to sex. Adjustment for body weight resulted in a substantial decrease in the difference in intake associated with sex. Intake of males differed significantly from that of females only for monoun-

saturated fats as estimated from dietary diary records. While intake of males, adjusted for body weight, was slightly higher than that of females for all fat categories, based on diary data, intake of females surpassed that of males for all categories except polyunsaturated fats, based on recall data. An examination of the intraclass correlations (Table 4) for male and female twins revealed male twins to be more alike in intake of fats for each category as compared with female twins. Similar results were obtained from both dietary recall and diary information for saturated and monounsaturated fats but not for polyunsaturated fats and cholesterol.

Male twins were characterized by an increased intake of dietary vitamins over that of females as shown in Table 5. While differences in vitamin intake due to sex were not significant when overall intake was adjusted for body weight, males did, however, appear to be characterized by a greater mean intake than females. Mean vitamin intake of male and female twins was well above that specified by RDA standards. While most of the intraclass correlations calculated for intake of selected vitamins were positive (Table 6), they did not differ significantly from zero. In general, twins tended to be more similar for vitamin intake, as estimated from the recall interview, than from the dietary diary.

Mean dietary intake levels of iron, calcium, phosphorus, sodium, and potassium for male and female twins are given in Table 7. Mean intake of these minerals tended to be greater for males than for females. This trend is seen both in total intake and intake adjusted for body weight. Differences in intake over sexes are most clear-cut for iron, calcium, and phosphorus. Males met their RDA requirement for iron, calcium, and phosphorus; however, females met their RDA requirements only for phosphorus, indicating the possible existences of a dietary deficiency for iron and calcium. As was seen with vitamin intake, twins tended to be more similar in intake of minerals when intake was estimated from recall interview data than from information provided by the dietary diary (Table 8). Male twin pair members were consistently more similar for intake of sodium and potassium than female twins; however, no consistent differences in the degree of similarity were found for either iron, calcium, or phosphorus between male and female twins.

TABLE 3. Dietary Intake of Saturated, Monounsaturated and Polyunsaturated Fats and Cholesterol

	Recall		Diary	
	males	females	males	females
Saturated fats				
mean (g)	51.2 ± 4.2	39.4 ± 3.3	46.5 ± 2.6	29.1 ± 2.4
% of total fats	37.0 ± 0.76	37.0 ± 0.69	37.6 ± 0.71	36.0 ± 0.86
mean (kg/Bw)	0.66 ± 0.06	0.69 ± 0.06	0.60 ± 0.03	0.51 ± 0.05
Monounsaturated fats				
mean (g)	53.8 ± 3.8	41.0 ± 2.8	51.9 ± 3.2	31.4 ± 2.2
% of total fats	39.8 ± 0.5	39.5 ± 0.65	40.8 ± 0.8	39.4 ± 0.65
mean (kg/Bw)	0.70 ± 0.05	0.72 ± 0.05	0.68 ± 0.04	0.55 ± 0.04
Polyunsaturated fats				
mean (g)	14.8 ± 1.6	13.2 ± 1.6	14.0 ± 1.2	10.7 ± 1.7
% of total fats	11.2 ± 0.91	12.3 ± 0.81	10.9 ± 0.6	12.3 ± 1.1
mean (kg/Bw)	0.19 ± 0.02	0.23 ± 0.03	0.18 ± 0.02	0.18 ± 0.03
Cholesterol				
mean (g)	0.53 ± 0.5	0.42 ± 0.03	0.47 ± 0.04	0.31 ± 0.03
% of total fats	0.38 ± 0.02	0.43 ± 0.03	0.41 ± 0.04	0.42 ± 0.04
mean (kg/Bw)	6.83 ± 0.59	7.36 ± 0.63	6.08 ± 0.42	5.53 ± 0.61

TABLE 4. Intraclass Correlations for Male and Female Twins for Fat and Cholesterol Intakes

	Recall		Diary	
	males	females	males	females
Saturated fats				
intake (g)	0.64*	0.61*	0.46	0.21
% of fat intake	0.26	0.58*	0.29	−0.08
intake (kg/Bw)	0.74**	0.70**	0.49	0.34
Monounsaturated fats				
intake (g)	0.63*	0.43	0.60*	0.28
% of fat intake	0.16	−0.001	0.12	0.10
intake (kg/Bw)	0.75**	0.63*	0.68**	0.42
Polyunsaturated fats				
intake (g)	0.19	0.16	0.83**	−0.04
% of fat intake	0.09	0.41	0.45	0.03
intake (kg/Bw)	0.28	0.30	0.81**	0.01
Cholesterol				
intake (g)	0.62*	−0.02	−0.05	0.34
% of fat intake	0.59*	0.27	−0.004	−0.12
intake (kg/Bw)	0.65**	−0.13	−0.11	0.36

*, **Correlation coefficients greater than zero at the 5% and 1% levels, respectively.

TABLE 5. Dietary Intake of Selected Vitamins for Male and Female Twins

	Recall		Diary	
	males	females	males	females
Vitamin A				
mean (IU)	7467.3 ± 834.4	4824.5 ± 730.9	4633.9 ± 488.6	7012.8 ± 2109.8
intake (kg/Bw)	97.8 ± 10.4	84.4 ± 13.0	59.9 ± 6.2	123.1 ± 37.3
% RDA	149.3 ± 16.7	120.6 ± 18.3	92.7 ± 9.8	175.3 ± 52.7
Vitamin C				
mean (mg)	105.5 ± 14.9	71.6 ± 6.7	107.1 ± 12.6	80.3 ± 11.5
intake (kg/Bw)	1.38 ± 0.20	1.26 ± 0.13	1.38 ± 0.17	1.38 ± 0.20
% RDA	242.4 ± 32.3	155.0 ± 15.6	238.0 ± 28.0	178.8 ± 25.7
Niacin				
mean (mg)	27.6 ± 2.1	18.3 ± 1.4	24.2 ± 1.6	15.8 ± 1.1
intake (kg/Bw)	0.36 ± 0.03	0.31 ± 0.03	0.32 ± 0.02	0.28 ± 0.02
% RDA	158.0 ± 11.5	142.5 ± 10.8	138.6 ± 8.8	123.0 ± 8.4
Thiamin				
mean (mg)	1.56 ± 0.14	1.07 ± 0.10	1.50 ± 0.15	0.95 ± 0.12
intake (kg/Bw)	0.02 ± 0.002	0.019 ± 0.002	0.019 ± 0.002	0.016 ± 0.002
% RDA	117.4 ± 10.5	107.2 ± 10.4	111.6 ± 10.6	95.4 ± 12.0
Riboflavin				
mean (mg)	3.20 ± 0.33	1.95 ± 0.17	2.12 ± 0.20	1.58 ± 0.17
intake (kg/Bw)	0.04 ± 0.004	0.03 ± 0.003	0.027 ± 0.002	0.027 ± 0.003
% RDA	203.2 ± 21.2	164.4 ± 14.1	134.6 ± 12.3	133.9 ± 14.5

TABLE 6. Intraclass Correlations for Selected Vitamin Intakes of Male and Female Twins

	Recall		Diary	
	males	females	males	females
Vitamin A				
mean (IU)	−0.05	−0.02	−0.08	−0.05
intake (kg/Bw)	−0.05	−0.01	−0.13	−0.04
% RDA	−0.05	−0.02	−0.09	−0.05
Vitamin C				
mean (mg)	0.50	0.11	0.20	0.04
intake (kg/Bw)	0.50	0.28	0.12	0.01
% RDA	0.47	0.23	0.20	0.04
Niacin				
mean (mg)	0.59*	0.39	0.08	0.53
intake (kg/Bw)	0.67**	0.40	0.11	0.65*
% RDA	0.59*	0.37	0.04	0.51
Thiamin				
mean (mg)	0.44	0.52	0.24	0.09
intake (kg/Bw)	0.55*	0.56*	0.21	0.03
% RDA	0.41	0.52	0.22	0.09
Riboflavin				
mean (mg)	0.33	0.34	0.10	0.30
intake (kg/Bw)	0.38	0.48	0.01	0.36
% RDA	0.32	0.31	0.09	0.28

*, **Correlation coefficients greater than zero at the 5% and 1% levels, respectively.

TABLE 7. Dietary Intake of Male and Female Twins for Selected Minerals

	Recall		Diary	
	males	females	males	females
Iron				
mean (mg)	18.5 ± 1.2	13.7 ± 0.8	16.0 ± 0.63	10.2 ± 0.7
intake (kg/Bw)	0.24 ± 0.02	0.238 ± 0.02	0.20 ± 0.01	0.18 ± 0.01
% RDA	184.5 ± 11.7	84.8 ± 6.4	162.1 ± 7.2	63.7 ± 5.2
Calcium				
mean (mg)	1213.5 ± 156.9	798.0 ± 71.1	850.4 ± 130.7	637.6 ± 56.7
intake (kg/Bw)	15.6 ± 2.0	13.9 ± 1.2	10.9 ± 0.9	11.0 ± 1.0
% RDA	151.6 ± 19.6	102.2 ± 10.0	106.2 ± 9.4	79.7 ± 7.1
Phosphorus				
mean (mg)	1820.5 ± 161.6	1268.0 ± 82.3	1556.5 ± 95.7	1945.9 ± 60.7
intake (kg/Bw)	23.6 ± 2.1	22.0 ± 1.4	20.2 ± 1.1	18.2 ± 1.1
% RDA	227.5 ± 20.2	158.5 ± 10.3	194.5 ± 12.0	130.7 ± 7.6
Sodium				
mean (mg)	3285.2 ± 233.1	2520.5 ± 115.6	3394.5 ± 172.5	2251.5 ± 178.0
intake (kg/Bw)	42.8 ± 3.3	44.0 ± 2.3	44.2 ± 2.4	39.4 ± 3.4
Potassium				
mean (mg)	3723.5 ± 327.0	2517.1 ± 147.8	3401.2 ± 178.6	2325.2 ± 132.2
intake (kg/Bw)	48.1 ± 4.5	43.8 ± 2.7	44.1 ± 2.2	40.3 ± 2.2

TABLE 8. Intraclass Correlations for Male and Female Twin Pairs for Selected Minerals

	Recall		Diary	
	males	females	males	females
Iron				
mean (mg)	0.52*	−0.11	0.11	0.41
intake (kg/Bw)	0.67**	0.16	−0.02	−0.01
% RDA	0.52*	0.23	0.04	0.46
Calcium				
mean (mg)	0.49	0.57*	0.27	0.23
intake (kg/Bw)	0.50	0.57*	0.21	0.23
% RDA	0.49	0.47	0.27	0.19
Phosphorus				
mean (mg)	0.65**	0.46	0.36	0.44
intake (kg/Bw)	0.71**	0.59*	0.29	0.53
% RDA	0.65**	0.46	0.35	0.44
Sodium				
mean (mg)	0.60*	0.21	0.17	−0.05
intake (kg/Bw)	0.73**	0.44	0.30	0.04
Potassium				
mean (mg)	0.72**	0.31	0.46	0.28
intake (kg/Bw)	0.80**	0.47	0.48	0.44

*, **Correlation coefficients greater than zero at the 5% and 1% levels, respectively.

DISCUSSION

The finding that members of male twin pairs tend to be more similar in dietary intake patterns than are members of female twin pairs is in agreement with the existence of a socioeconomic status (SES) effect on eating patterns whose influence is exerted through an impact on dietary selection due to monetary factors rather than through differences in dietary intake due to variation in food selection and preparation or awareness of nutritional needs. Since MZ female twins would tend to be as similar in level of education as MZ males, but may differ in income level through their marriage to unrelated spouses, while male twins tend to be characterized by similar SES levels, the existence of an increased intraclass correlation for male twins over that of female twins with respect to dietary intake characteristics would tend to rule out education as an overriding factor in the determination of eating habits. This implication, however, is indirect since the relationship between income level and education and dietary intake was not directly examined in this study.

Numerous studies have been conducted to assess the reliability of dietary recall and diary methods as techniques for measuring actual dietary intaka of respondents [6, 10, 14]. The general consensus of these analyses is that, while both techniques are generally equally reliable, neither provides completely precise estimates of actual intake. Gersovitz et al [6] reported that dietary recall methods tended to overestimate actual mean intake of each nutrient except vitamin A, with the difference being significant only for protein; while the dietary log tended to underestimate actual intake with estimates of calories and thiamine, only, being significantly different. The results of this study suggest a similar phenomenon. Intake of various nutrients, as estimated from recall, tended to be greater than estimates of intake based upon dietary log information. Male twins were generally

found to be more similar for intake of the major nutrient groups when estimates were based on recall rather than upon diary information. Similar results were obtained with respect to female twins for calories and fat intake. There are two possible explanations for this finding. First, the increased similarity in dietary intake of co-twins could reflect the fact that the individuals questioned ate together during the time period recalled whereas they were specifically requested to eat apart during the period detailed in the dietary diary. An alternative explanation could be that twins, given their identical genotypes, tend to remember food eaten in the same manner, with a similar degree of accuracy. The discrepancy between males and females might result from increased accuracy in recall by female twins given their traditional role in food preparation and their increased familiarity with household measures.

In interpreting the results of this study, several factors should be kept in mind. First, while the sample size is adequate in many instances to detect significant differences between the male and female twins examined in this study, it is too small to permit the valid extrapolation of results to twins in general. Second, the individuals examined in this study represent a sample of Caucasian twins who fall within a mid- to upper-socioeconomic status level. Further, the mean dietary intake levels for all substances and nutrient categories examined were generally higher than those reported for upper SES Caucasians found by the Hanes Nutrition Survey [15].

CONCLUSION

The results of this study suggest that members of male twin pairs are characterized by a greater degree of similarity in dietary intake patterns than are members of female twin pairs – even though they reside in different homes and have their meals selected and prepared, for the most part, by genetically unrelated spouses. These findings stress the great potential which twin studies have as a tool in elucidating the factors which influence nutrition and nutritional choices, as well as in assessing the relationship between obesity and overnutrition.

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