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Discretionary salt consumption in airline food service : a feasibility study

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ABSTRACT

DISCRETIONARY SALT CONSUMPTION IN AIRLINE FOOD SERVICE: A FEASIBILITY STUDY

by

Kathleen E. Dierkes

Studies have estimated total daily salt consumption in the U.S. at 10 - 14.5 grams, despite increasing public awareness and decreased usage by the food industry. To avoid excess governmental regulation to modify current salt intake, determination of the amount of salt currently being used in a discretionary manner is needed.

This study investigated the feasibility/limitations of a data collection technique to assess discretionary salt intake in in-flight meal service. Discretionary salt use by airline passengers was determined by weighing salt packets remaining on used meal trays. Results showed an average discretionary salt consumption of 167 milligrams/meal among passengers able to add up to one gram of salt to their meal. At least 63% of the passengers used no discretionary salt. Intake was not influenced by sodium content of the menu, different flight days, or inclusion of a salad with the meal. Salt usage appeared to be an "indiscriminate" function of habit.

The data collection tool proved a feasible method for estimating discretionary salt intake and could be useful in future consumer education studies.

FLORIDA INTERNATIONAL UNIVERSITY
DEPARTMENT OF DIETETICS AND NUTRITION

DISCRETIONARY SALT CONSUMPTION
IN AIRLINE FOOD SERVICE,
A FEASIBILITY STUDY

A Thesis submitted to
The Department of Dietetics and Nutrition
in partial fulfillment of the
requirements for the degree of
Master of Science in Dietetics

By

Kathleen E. Dierkes

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CHAPTER I
INTRODUCTION

STATEMENT OF THE PROBLEM

Dietary sodium consumption has become a concern to the health professional^{1,2,3} and has received a great deal of attention from the news media,⁴ popular press,⁵ regulatory agencies,⁶ and Congress.⁷ It has been suggested that both hypertensive and normotensive persons would benefit by a reduction in sodium intake. Specifically, Fries has suggested that a decrease in dietary sodium intake to less than forty-five milliequivalent (Meg) per person (~1000 mg Na, ~2.5g salt per day) would eliminate essential hypertension as a major health problem.⁸ A large body of evidence exists to support this view.^{9,10,11} However, not all medical authorities agree that a nationwide policy of salt restriction would be beneficial.¹²

A recent governmental report estimated the current average salt consumption to be ten to twelve grams daily,¹⁴ which represents twenty times the estimated minimum need.

The possibility that such an excessive chronic ingestion of sodium may have adverse health effects has inspired a drive to increase public awareness of high salt use.¹⁵ However, consumption figures reported by Bowen,¹⁶ Meneely and Battarbee,¹⁷ Dickonson,¹⁸ and Shank,¹⁹ indicate

that American salt consumption has not decreased despite increasing public awareness and despite reported decreased use of salt by the food industry. If excessive governmental regulation of food industry salt use is to be avoided (regulation has already begun on a voluntary basis), it is necessary to determine the amount of salt currently being used in a discretionary manner and to identify appropriate media for effective public and professional education.

In this paper, a new methodology for determining discretionary sodium intake will be investigated for its feasibility as a data collecting tool. Estimation of discretionary salt use by airline passengers will be determined by weighing salt packets from meal trays.

HYPOTHESES

1. The technique of observing returned airline meal trays will, with acceptable efficiency, yield a measure of discretionary salt use by airline passengers.
2. There is no significant difference in salt consumption between airline passengers receiving different in-flight meals.
3. There is no significant difference between the salt consumption of those airline passengers who consume salad, compared to those who consume no salad.
4. There is no significant difference between salt consumption on a particular flight occurring on different days of the week.
5. Assayed sodium content of airline meals will not differ from estimations derived from standard tables.

DEFINITION OF TERMS

Table Salt

In this study, use of an approximate one gram salt packet (included in a pre-packaged "tray pack" with other condiments and serving utensils) was used to evaluate discretionary salt consumption by the airline passengers.

Salt

In this paper, the term "salt" refers to sodium chloride: 1) One gram of sodium chloride is approximately 400 milligrams of sodium, 2) one gram of sodium chloride is seventeen milliequivalents of sodium.

CHAPTER II

REVIEW OF THE LITERATURE

WHAT IS TABLE SALT

Chemically, table salt contains forty percent sodium and sixty percent chloride, with a minor admixture of other inorganic chemicals, several of nutritive value, such as iodine. Salt has the following usages/functions: a flavor enhancer (condiment), a curative/preservative, and an industrial ore (i.e., glass making). In ancient times it was used as a "medicine", a religious symbol, and a determinant of social status.²⁰

The thing we don't know with precision that we wish we did know is if there is an "ideal level" of sodium intake for a population.²¹

According to F.D.A.'s Dr. Alan Forbes, even though the optimum level of sodium intake has not been established, it is known that sodium is essential for normal growth and health maintenance. Sodium is involved with carbohydrate metabolism, is an integral part of the acid/base balance mechanism, is needed for maintenance of electrical activity of all cells, and in the regulation of extra cellular fluid volume. The sodium requirement for growth and replacement of unavoidable daily losses from skin and feces is 100 to 200 milligrams daily (250-500 milligrams salt.)²²

Salt appetite is acquired/learned rather than inherited and appears to change with development (age).²² Salt appetite and sodium intake seems to be controlled mostly through taste receptors.^{23,24} Although salt consumption increases when one is sodium deficient (in need), little is known about the physiologic basis for this phenomenon. The phenomenon is complex, as humans with sufficient sodium stores (non-need) will continue to take large quantities of salt. Recent studies have shown that decrease in salt intake is followed by changes in salt preference.²⁵ It takes approximately two to three months after a decrease in salt intake to modify taste preference and intensity judgments of saltiness. As salty foods become more common in the national food supply, the preferred level of salt in food is thought to increase, even by the developing infant. Today, as mentioned, the average salt intake is twenty times the nutritional requirement.

SALT INTAKE AND HYPERTENSION

Although the mechanism of essential hypertension (increased extracellular fluid, increased blood pressure) is still obscure, the evidence is very good, if not conclusive, that reduction of dietary salt to below two grams daily would result in prevention of hypertension and its disappearance as a major health problem.²⁶

Increased extracellular fluid volume is the most significant factor in initiating the sequence of events leading to chronic hypertension. Low sodium diets reduce

fluid volume and thus are contributory to reducing blood pressure. In studies by Fries, and Dahl and Love, sodium restriction to 200 milligrams daily had a positive effect on reducing blood pressure in mild hypertensive patients.^{26,27} Wilber reported that even though dietary sodium has not been demonstrated as a primary cause of hypertension, recent studies of diet modification on fluid retention do demonstrate (consistent with Fries and Dahl) that sodium restriction is an effective therapeutic tool in controlling hypertension.²⁸

Not all hypertension authorities support the view that dietary sodium intake is primarily, or even partially responsible for the development of essential hypertension.²⁹ Both the F.D.A. and the American Academy of Pediatrics state that it has not been conclusively established that salt consumption is a major factor in the onset of hypertension in human beings, but recent studies suggest an association between high sodium intake and the prevalence of hypertension.^{30,31}

POPULATION STUDIES OF SALT INTAKE AND HYPERTENSION

Even though the relationship between salt intake and the development of hypertension has been emphasized in earlier literature,³² the cause and effect hypothesis has not been confirmed. According to F.D.A.'s Dr. Lecos,

Although interpopulation studies suggest an association between high sodium intake and the onset of hypertension, it has not been conclusively established that sodium consumption is a major factor in its cause.³³

A correlation exists between the dietary habits of

different societies and the incidence of hypertension. Meneely and Dahl estimated the sodium chloride intake of several populations on the basis of twenty-four hour urine collections: twenty Alaskan Eskimos consumed an average of four grams of salt daily with no evidence of hypertension; 235 Marshall Islanders consumed an average of seven grams daily with 6.9 percent hypertension; 1,124 U.S. males consumed an average of ten grams daily and had a prevalence of 8.6 percent hypertension; and two groups of Japanese totaling averaged 14 to 26 grams daily with a prevalence several fold higher than in the U.S. group. The investigators proposed that chronic excess consumption of salt may play a primary role in the pathogenesis of hypertension in "responsive" individuals. Evaluation of population studies turns on assessment of the validity of intake data.

ESTIMATES OF SALT INTAKE

Contribution to daily salt intake comes from drugs, drinking water, natural salt content of foods, salt added in food processing, discretionary use of salt (table salt), and addition of salt to foods in cooking. Both Fregly and the Select Committee on GRAS Substance (SCOGS) reported that the estimated salt intake is derived from the following three sources; one-third from processed foods, one third from natural sources and the remaining third from discretionary addition of salt to food.^{35,36}

The most recent review of estimates of salt intake reported by Fregly (1983) indicated an average daily intake

of sodium chloride in the U.S. (discretionary and non-discretionary) ranging from 10 to 14.5 grams.³⁵ SCOGS reported a narrower range of average daily salt intake between 10 and 12 grams.³⁶ (See table 1). SCOGS made the following statement in regard to salt intake estimates:

Given the diversity of the data and the range of individual intakes, these estimates are considered very rough approximations of the national average. The best estimation of sodium intakes based on these data, expressed as sodium chloride, is not less than 10 to 12 grams.³⁶

Other earlier studies have reported conflicting data due to methodology utilized. The following are estimations by previous studies:

1. Dahl Studies (1961): 10 grams/day³⁷
2. Grollman Study (1961): 10-15 grams/day³⁸
3. Framingham Study (1962): 6-12 grams/day³⁹
4. Ahrens and Boucher, "Simulated American Diet" Study (1978): 5 grams/day⁴⁰

The following different methods have been utilized to assess salt intake: dietary interview, twenty-four hour urine samples, estimation of table salt intake, long term observations of a population's cooking and eating practices, survey (salt habit questionnaire), direct food analysis, per capita disappearance of snack foods, and per capita disappearance of salt use in food processing.⁴¹

RECENT ESTIMATES OF TOTAL DAILY SALT INTAKE

There are several intrapopulation studies of salt intake in the U.S. based on various data from dietary and industry

surveys, sodium excretion data, direct food analysis, and production sales reports.⁴² (See Table 1) Results of these investigations, organized by the mode of data collection can be summarized as follows:

Excretion Data

Altman and Dittmer (1974):

9 grams total salt intake/day⁴²

Mickelson (1977):

14 grams total salt intake/day⁴³

Direct Food Analysis Data

F.D.A. selected minerals-in-food survey or market basket collections⁴⁴ (1976):

17.1 grams total salt intake/day

F.D.A. total diet studies (1977-1980)⁴⁵:

1.8 - 2.2 grams/day for infants

4.0 - 4.5 grams/day for toddlers

16.7 - 17.3 grams/day for adults

Industrial Surveys

Bowens, Bureau of Mines data (1966-1970)⁴⁷:

14.5 grams/day

Dietary Survey

1. Tuthill and Callabrese (1981)⁴⁸:
 - 7.1 - 7.3 grams/day for children in high sodium water community
 - 6.3 - 6.4 grams/day for children in low sodium water community
2. Mickelson (1977)⁴³:
 - 14.0 grams/day

RECENT ESTIMATES OF NON-DISCRETIONARY SALT INTAKE

Total daily non-discretionary intake, range from 4.5 to 12.6 grams per day.⁴⁹ Sodium chloride ingested with grain and cereal products and meat comprise fifty percent of daily non-discretionary sodium chloride intake. (See Table 1). Results of investigations organized by mode of data collection:

Direct Food Analysis Data

1. F.D.A. Market Basket Collections (1976, 1977, 1978, 1980 surveys)⁵⁰:
 - 11.8 - 12.6 grams/day
2. N.R.C. Survey (1970)⁴⁵:
 - 7.1 grams/day

Industrial Survey

- N.R.C. Survey (1970 and 1977)⁴⁶:
- 1970 - 11.0 grams per capita/day
 - 1977 - 8.2 grams per capita/day

Production and Sales Data

Bowen, Bureau of Mines data (1966-1970)⁴⁷:

8.0 grams/day

Dietary Survey

Mickelson (1977)⁴³:

9.7 grams/day

RECENT ESTIMATES OF DISCRETIONARY SALT INTAKE

Studies dealing specifically with discretionary sodium intake are few. According to Fregly this is due to the difficulties in framing adequate study designs.³⁵

Estimates of discretionary salt intake reported range from 3 to 6.5 grams per day.^{50,51} (See Table 1) Organized by mode of data collection:

Direct Food Analysis Data

1. F.D.A. Market Basket Collections (1976)⁵²:

4.6 grams/day

2. F.D.A. Market Basket Collections (1977, 1978, 1980)

4.5 grams/day

Production and Sales Data

1. Wood, Retail Sales (1970)⁵⁴:

3.42 grams/day

2. Bowen, Bureau of Mines Data (1966-70)⁴⁷:

6.5 grams/day

3. Dickonson (1980)⁵⁵:

8.9 grams per capita/day

Dietary Survey

Mickelson (1977)⁴³:

5.6 grams/day

In summary, estimates of total daily salt intake range from 6.3 to 17.3 grams; estimates of non-discretionary daily salt intake range from 4.6 to 12.6 grams; and discretionary daily salt intake estimates range from 3.4 to 6.5 grams.¹¹ The large range of estimates may be due to the variety of data collection techniques utilized and the different time frames in which the studies were conducted.

TABLE 1
SOURCES OF DIETARY SODIUM AND
ESTIMATES OF TOTAL SODIUM INTAKE

Dietary Sources	Sodium Intake (gNaCl/d.)	Study Reference
Non-Discretionary Sources		
Naturally Occurring in foods	2.5 - 4.5	66-70 Bowen-Production Sales Data
	3.0	1976 F.D.A. Direct Food Analysis
Added by Industrial Processing	7.1	1970 N.R.C.-Industry Survey
	8.0	1966-70 Bowen
	9.0 - 9.5	1976 F.D.A.
	9.7	1977 Mickelson-Diet Survey
Total Non-Discretionary NaCl Intake	11.8-12.6	1976, 1977, 1978, 1980 F.D.A.
	4.6 - 6.3	1971-74 Hanes 1 Survey
Discretionary Addition by the Consumer	3.4	1970 Wood-Retail Sales
	6.5	66-70 Bowen
	4.6	1976 F.D.A.
	4.5	1977, 1978, 1980 F.D.A.
	5.6	1977 Mickelson
	10.0	1961 Dahl-Excretion Data
Total Dietary NaCl	14.5	66-70 Bowen
	7.1	1970 N.R.C.
	17.1	1976 F.D.A.
	16.7 - 17.3	1977, 1978, 1980 F.D.A.
	7.1 - 7.3	1981 Tuthill & Calabrese-Diet Survey
	6.3 - 6.4	1981 Tuthill & Calabrese
	14.0	1977 Mickelson
	8-10	1980 Dickonson

INFLUENCES ON SALT INTAKE

Fregly reported three major influences on non-discretionary salt intake: age, sex, and food consumption patterns of the individual.⁵⁶

AGE AND SEX

Abraham reported the mean daily non-discretionary intake of sodium chloride for males, ages 1 to 74 years, was approximately 6.3 grams. The maximum intake occurred from 18 to 44 years. Females were reported to have a lower non-discretionary salt intake, with an average of 4.6 grams. The maximum daily intakes occurred between 6 to 11 years.⁵⁷

FOOD CONSUMPTION PATTERNS

Investigators reported that frequency of food group eaten on a daily basis is the most potent influence on total salt intake.^{58,59,60}

The greatest amount of sodium chloride added by food processors was in the categories of baked goods, breakfast cereals, and grain products. The second largest contribution was in the category of mixed protein, meat, fish, and poultry. The third major source was from milk and milk products.

These three categories are the largest contributors to total daily intake and require special consideration in attempts to reduce sodium intake.

Fregly reported that although a number of factors are now known to influence non-discretionary salt intake, the influences of discretionary salt intake are still to be determined.⁶¹

Hypertension Debate

SCOGS reported to the F.D.A. that it was the prevalent judgement of the scientific community that consumption of sodium chloride be lowered in the U.S.

The evidence on sodium chloride is insufficient to determine that the adverse effects reported are not deleterious to the health of a significant proportion of the public when it is used at levels that are now current and in the manner now practiced.⁶²

The proposal of the nationwide policy of salt restriction appears to be based on the hypertension hypothesis. It is postulated that a nationwide moderate reduction in salt intake would:

1. Prevent high blood pressure in some proportion of the general population.
2. Control hypertension in those already hypertensive.
3. Do no harm, even if it were not beneficial.⁶³

Furthermore, the Select Committee favored the development of guidelines for restricting the amount of salt labeling on foods. The Select Committee conclusions are similar to sentiments of other governmental and medical organizations.^{64,65}

In contrast, Laragh and Pecker strongly oppose the nationwide public health policy of salt restriction. The researchers stated it is premature to make any definitive recommendation of moderate salt restriction until there is conclusive data. Furthermore, the idea that moderate reduction in dietary salt throughout our society would be harmless is unproved. The argument against a nationwide anti-salt policy is based on

the following:⁶³

1. No studies have been conducted that support the recommendation that moderate or drastic reduction of dietary salt consumption could prevent hypertension.
2. There is not a large body of evidence that restriction of dietary salt would help most persons who already have hypertension.
3. There is no proof that indiscriminate reduction of dietary salt would not do any harm. Lowering salt intake would mean decreased use of foods such as bakery goods and dairy products which could in turn decrease intake of essential nutrients.

Speculative reasoning, however appealing should not be a basis for a major change in public health policy and could intrude in many ways on quality of life. Public health policy should be decided by facts, not by hopes or opinions.

Effecting Change

Public awareness of the possible harmful effects of excess salt in the diet gained impetus in 1970 when baby food manufacturers moved towards elimination of salt added to their products. By 1977, addition of salt to all infant foods was discontinued by manufacturers.⁶⁶

In 1977, the dietary goals for the United States included a reduction in salt intake.⁶⁷ The U.S. dietary guidelines were then developed which supported the nationwide anti-salt policy.⁶⁸

A 1980 F.D.A. survey of 1,500 shoppers revealed that

American consumers were aware of the harmful effects of the salt consumption due to the recent widespread publicity. Results showed that 68% were trying to reduce salt intake.⁶⁹ A trend in increased consumer awareness responding to adverse publicity on salt consumption was also reported by Filer.⁶⁶ Per capita disappearance of salt used in food processing from 1970 to 1978 decreased from 10.9 to 8.4 grams per day. A recent F.D.A. survey showed the number of food packages displaying sodium information has increased between 1977 and 1979, from 7.5 to 13.4 percent of the dollar value of foods sold. It can be concluded that some of the food manufacturers are vigorously engaging in voluntary sodium labeling. However, only six percent of 1,031 national brands that list sodium containing ingredients, state the actual amount.⁶⁹ Contrary to the F.D.A. conclusion, The Center For Science in the Public Interest (C.S.P.I.) reported that the food manufacturers were resisting pressure to identify the salt content of foods.

It is F.D.A. policy to encourage health professionals to urge modification of salt intake for the general public and to encourage increased sodium labeling on food.⁷¹ In March 1981, the F.D.A. announced a five point plan in pursuance of increased regulatory initiatives concerning sodium. It includes the following:

1. Reduction of sodium content in processed foods.
2. Mandatory sodium labeling.
3. Continuation of the total diet study to detect trends

- in salt consumption.
4. Research to investigate consumer perception, knowledge and purchasing practices related to sodium and hypertension.
 5. Public education programs.

CONSUMER EDUCATION

The recently proposed F.D.A. plan concerning salt restriction cannot succeed without consumer education. Educating the consumer about sodium will require more than including sodium information on packages; government and industry should aim to explain what sodium is, where it is found in the diet, and how sodium labeling can be used. Hunt suggested that educational programs can help avoid the need for excessive governmental regulation for sodium content of prepared and processed foods.⁷²

MONITORING CHANGES IN SALT CONSUMPTION

Continuation of the F.D.A. total diet analysis program will identify trends in salt consumption. However, it cannot accurately measure the effectiveness of educational programs conducted by the food industry; by the medical profession, or by other nutrition educators. Thus, it is the opinion of various investigators that dietary intake studies concurrent with nutrition education efforts monitored over a period of years will be needed to target the consumer education effort.⁷³

It is concluded that new techniques are needed for use in studies of consumer awareness and consumer salting practices.

We need to learn other ways to reduce sodium content in the American diet, such as through public and professional education, and voluntary efforts such as labeling of canned and packaged food.⁷³

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CHAPTER III
CONDUCT OF THE STUDY

STUDY OBJECTIVES

The present study was conducted to determine the feasibility of a technique to estimate discretionary salt consumption by airline passengers. The study was designed to achieve the following objectives:

1. Determine feasibility of estimation of salt use in inflight food service by observation of returned airline food trays.
2. Determine usual salting practices during inflight meal service (coach).
3. Determine possible differences in use of discretionary salt by airline passengers that select different menus; and that fly on different days.
4. Determine sodium content of airline meals.

THE SETTING

The study was conducted between January and March 1983 at an inflight meal service facility located at a South Florida airport. The facility prepares meal trays for major airline flights, both domestic and international. The meals are prepared by a full kitchen food service staff,

with the exception of three catered food items. The meal trays from incoming flights are received directly from the flight terminal in thirty-six tier metal tray carriers. The food and refuse on the trays are discarded and trays are sanitized.

DESCRIPTION OF SUBJECTS

The subjects consisted of a population of airline coach passengers traveling on direct flights from Los Angeles to Miami. There was no control of ages, sex, occupations, ethnicity, income, or social levels. At the time the study was conducted, a \$99 fare special was being offered. Therefore, the passenger population may have included a wider range of income levels than normal.

The survey was conducted two consecutive nights weekly (one week night and one weekend night) for eight weeks. The passenger count of the study survey ranged from eighty-one to 175 per flight, with an average flight count of 128. A total of 1027 passengers were surveyed. The menu composition for each of the eight dinner flights was as follows: Flights one through four offered a choice of either roast beef which was chosen by 60% of the passengers, or stuffed shell florentine which was chosen by 40% of the passengers. Flights five through eight offered a choice of either roast veal which was chosen by 50 to 77% of the passengers or ravioli which was chosen by 23 to 50% of the passengers (See Table 2).

TABLE 2

PERCENT OF PASSENGERS SELECTING ALTERNATE MENU CHOICESCYCLE I MENU

<u>DATE</u>	<u>ROAST BEEF (%)</u>	<u>STUFFED SHELL FLORENTINE (%)</u>
2/17/83	58	42
2/18/83	63	37
2/24/83	59	41
2/25/83	57	43

CYCLE II MENU

	<u>VEAL LASAGNA COMBO (%)</u>	<u>RAVIOLI (%)</u>
3/03/83	66	34
3/04/83	49	51
3/10/83	77	23
3/11/83	72	28

The sodium content of menus varied and ranged from 1.675 to 2.185 grams of sodium per meal, with an average of 1.948 grams per meal. (See Appendix E)

COLLECTION OF DATA

Prior to the study, representative salt packets of the type included in the passenger's "tray pack" were weighed to the nearest one-hundredth of a gram, utilizing an electronic digital gram scale. A sampling of ten full packets were weighed. The full weight ranged from 1.18 to 1.28 grams, with the mean full weight of 1.23 grams. (See Table 3)

TABLE 3

WEIGHTS OF SALT PACKETS LEFT ON AIRLINE MEAL TRAYS,
JUDGED FULL, 3/4 FULL, 1/2 FULL, 1/4 FULL, AND EMPTY

<u>PACKET DESCRIPTION</u>	<u>AVERAGE WEIGHT OF SALT PACKET (G.)</u>	<u>WEIGHT OF NaCl LESS PAPER WEIGHT</u>
Full Packet	1.23	0.93
3/4 Full	1.01	0.70
1/2 Full	0.82	0.50
1/4 Full	0.55	0.25
Empty	0.30	0.00

The data was collected by the same person (the author) throughout the entire experimental period. Food service personnel and shift supervisors were informed of the study protocol to assure that the entire number of tray carriers were delivered intact to the food disposal area directly from the chosen flight.

The data collector arrived at the in-flight service meal facility 30 minutes after the scheduled arrival of the study flights. Study flights were all direct Los Angeles-Miami service arriving at 8:30 p.m. daily. The collector observed all returned meal trays from each study flight.

Flight date and menu were recorded for returned meal trays on tally sheets. The salt packets were collected man-

ually. As each packet was collected, the estimated weight or portion unused was visually observed and recorded. The salt packet estimated weight was marked on the actual packet, which was then taped and dated. The salt packets were then weighed on a gram scale. Other recordings included amount of entree and salad consumed. "Unusual" trays were noted, such as special therapeutic diet trays or two or more entrees or salads on a tray. The talley sheets from each flight were totaled at the completion of the three month period for purposes of data analysis. (See Appendix A)

A trial data collection had been conducted for six weeks from January to February, 1983. Although data will not be reported, this trial collection helped to develop the data collection routine. The passenger count for a trial survey ranged from 105 to 258 per flight, with an average count of 207. A total of 1,037 were surveyed.

Samples of all food items offered in flight were collected and sodium assays were performed on each. The laboratory analysis of the actual food served was then compared to sodium content of estimates for those items drawn from standard tables. (See Table 4)

TABLE 4

LABORATORY SODIUM ASSAY VERSUS SODIUM CONTENT ESTIMATE
FROM FOOD COMPOSITION TABLES FOR ENTREE ITEMS

<u>ENTREE</u>	<u>LAB ASSAY</u> <u>(mg)</u>	<u>VALUE CALCULATED</u> <u>FROM PENNINGTON</u> <u>AND CHURCH</u> <u>(mg)</u>	<u>PERCENTAGE</u> <u>DIFFERENCE</u>
Roast Beef	792	700	12
Ravioli	1030-1112	960	7-14
Stuffed Shell Florentine	1090	887	19
Veal Lasagna Combo	982	829	16

DATA ANALYSIS

The data from eight airline dinner flights were hand-tallied by the data collector. The salt packets were weighed and grouped into usage categories according to the amount of salt remaining in the packets. The central tendency (mean), variability (range), and percentage of the total number of packets collected were computed for each category. The standard deviation was determined for each mean score. These computations were also determined for estimated discretionary salt consumption according to flight and menu.

Laboratory assays of the sodium content of the food items was performed by the author at Florida International University Food Chemistry Laboratory. (See Appendix B)

The following procedure was used: A mortared two-gram meal sample of each menu entree with accompaniments (this did not include processed food items; cheese, bread, butter, and beverage), was diluted with .5 milliliter of K_2CrO_4 . The sample was then titrated with .1 normal $AgNO_3$ to determine the percent NaCl content (grams NaCl/100 milliliter sample).

Sodium assays were expressed as the amount of sodium (milligrams) per 3.6 ounce portion. (See Appendix D) Assays were performed only on main dish items (entree + vegetables), since the remaining accompaniments consisted of processed foods with established sodium values (roll, cheese, crackers, butter, and salad dressing). (See Appendix E)

The sodium content of each in-flight meal was also calculated according to: 1) values from Pennington and Church,¹ 2) standardized recipes for the airline prepared foods, and 3) nutrition information from food processing companies for catered food items. (See Appendix E)

The F value calculated from the one-way analysis of variance statistical test was used to determine the significance of the difference between the means for table salt consumed by groups of passengers on different flights, consuming different menus, and consuming different portions of salad and entree at a meal. The criteria for accepting statistical significance of the "F score" was set at $p < .01$ level for this study.²

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CHAPTER IV
RESULTS AND DISCUSSION

DATA RESULTS AND ANALYSIS

The range and average weights of salt packets were determined for each of five categories. (See Table 3) The empty packets containing no table salt weighed from .29 to .33 grams, with an average weight of .30 grams. The full packet weight ranged from 1.18 to 1.28 grams, with the average weight of 1.23 grams (.93g NaCl). The three-quarter full packet weight ranged from .95 to 1.10 grams, with the average weight of 1.01 grams (.70g NaCl). The half full packet weight ranged from .76 to .88 grams, with the average weight of .82 grams (.50g NaCl). The one-quarter full packet ranged from .47 to .63 grams, with the average weight to be .55 grams, (.25g NaCl). Thus, it appears that the average salt packet does contain approximately one gram of salt.

Table salt usage for the total airline passenger population was expressed as the percentage of passengers in each usage category (See Table 5). Sixty-three percent of the passengers did not use the salt packet (0.0g); six percent used the entire packet (.93g); five percent used three quarters of the packet (.70g); seven percent used half

TABLE 5

AIRLINE PASSENGERS IN EACH DEFINED CATEGORYOF TABLE SALT USE

<u>SALT USE CATEGORY</u>	<u>NUMBER OF PASSENGERS</u>	<u>PERCENT OF PASSENGERS</u>
No salt used (full packet left on tray)	651	63
1/4 packet used	76	8
1/2 packet used	70	7
3/4 packet used	52	5
Complete packet used	64	6
No evidence of packet on tray	114	11

of the packet (.50g), and eight percent used one-quarter of the packet (.25g) on the tray. Eleven percent of passengers returned trays with no evidence of a salt packet. Thus at least 26 percent of airline passengers consuming in-flight meals salt their food.

Table salt usage by the airline passengers per flight was estimated and averages were computed (See Table 6). Table salt consumption ranged from .9 grams to .21 grams per meal. The average table salt usage for the entire airline passenger population was .17 grams \pm .30 per meal. There was no significant difference in table salt consumption among flights.

Table salt usage according to entree consumed was estimated. Average consumption figures and standard deviations were computed. (See Table 7) Considering the total passenger population (those who added salt and those who did not), the average amount of table salt consumed for menu A was .18 grams \pm .33 for menu B, .15 \pm .29 for menu C, .19 \pm .31 and for menu D, .16 \pm .29. Estimations of table salt usage according to entree was also expressed as percent of passenger population in each usage category. (See Figure 1) As can be seen, there was no significant difference in table salt consumption between the different entrees. An average of 11 percent of the passengers from each menu category left no evidence of a salt packet on the tray.

TABLE 6

AVERAGE TABLE SALT USED ON DIFFERENT FLIGHT DATES

<u>FLIGHT DATES</u>	<u>AVERAGE GRAMS DISCRETIONARY NaCl USED</u>
2/17/83	.20
2/18/83	.17
2/24/83	.16
2/25/83	.21
3/3/83	.10
3/4/83	.15
3/10/83	.21
3/11/83	.15

Analysis of variance gave $F = 1.58$
No significant difference in salt used between
flights,

TABLE 7

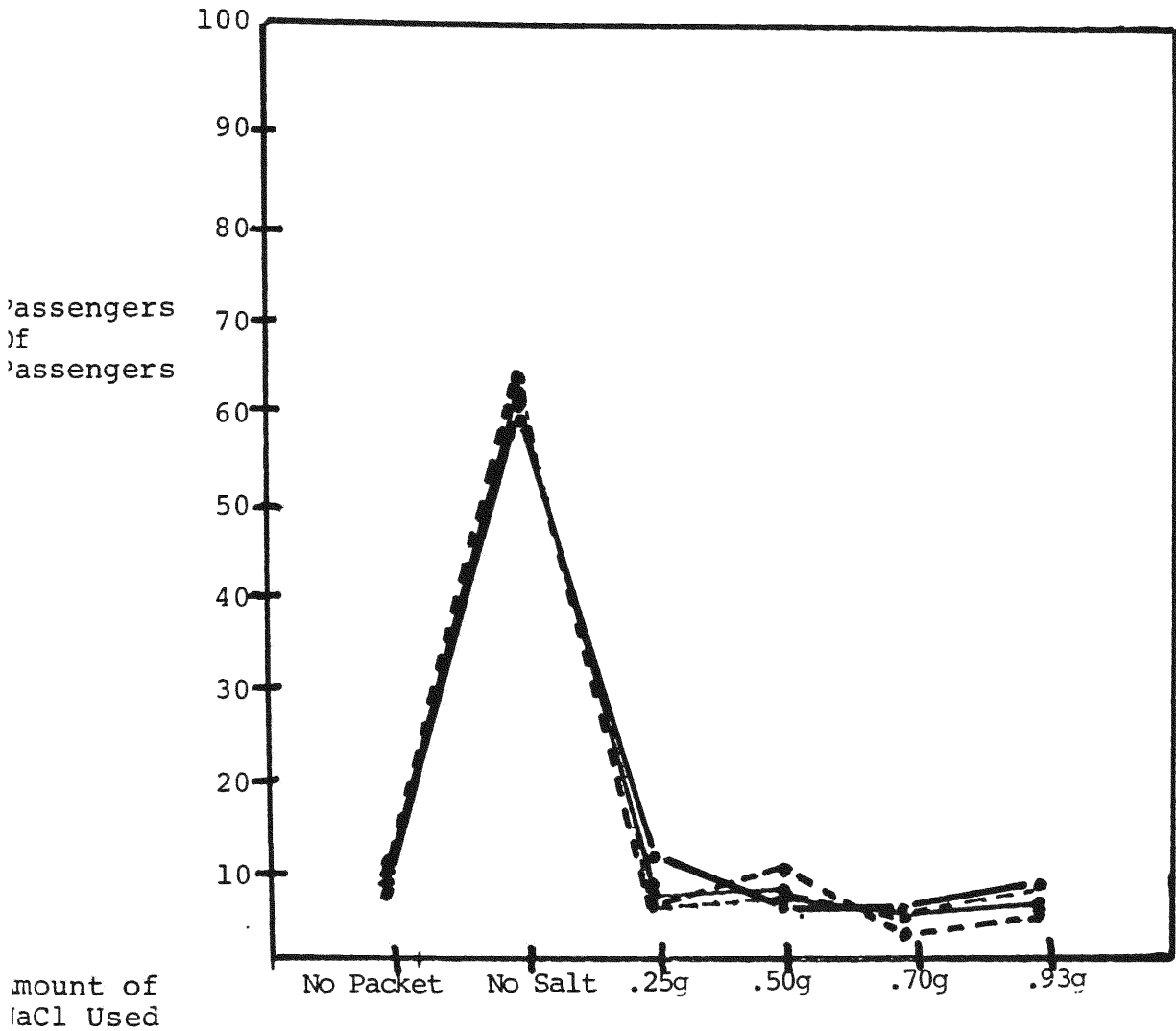
AVERAGED TABLE SALT USE BY AIRLINE PASSENGERSWHO SELECTED DIFFERENT ENTREES

<u>ENTREE SELECTED</u>	<u>NUMBER OF PASSENGERS</u>	<u>AVERAGE GRAMS DISCRETIONARY NaCl USED</u>	<u>RANGE</u>
Roast Beef	241	.18	0 - 1.86
Ravioli	172	.15	0 - .93
Stuffed Shell Florentine	168	.19	0 - .93
Veal Lasagna Combo	332	.16	0 - 1.86

Analysis of variance: $F = .75$;
 No significant difference in salt use among passengers choosing different entrees.

FIGURE 1

COMPARISON OF TABLE SALT USE BY AIRLINE PASSENGERS
SELECTING DIFFERENT MEAL ENTREES



Menu Choice:

- A - Roast Beef —————
- B - Ravioli - - - - -
- C - Stuffed Shell Florentine —————
- D - Veal Lasagna Combo - - - - -

Among passengers who did use salt packets, the average amount of table salt consumed for menu A was .57 grams \pm .35 for menu B .59 grams \pm .25; for menu C .60 grams \pm .24; and for menu D .58 grams \pm .28. For all menus the average salt use, among those who did use salt packets was .583g. \pm .287.

The average table salt consumption was calculated according to amount of salad/entree consumed. (See Table 8) Results showed that for plates with no salad and part of entree consumed, the average table salt consumed was .07 grams. For those plates with both salad and entree consumed, the average table salt consumed was .19 grams. It can be seen that as more food was consumed, more table salt was used by the passenger.

The one-way analysis of variance was calculated to determine the significance of the difference between table salt consumption figures according to entree. The F value of .75 (Table 7) among the four entrees was not statistically significant (p .01).

One-way analysis of variance was calculated to determine the significance of the difference in table salt consumption according to amount of salad/entree consumed. The F value of 3.46 was statistically significant (p .01). It was observed that one category (A/A - all salad consumed / all entree consumed)

TABLE 8

AVERAGE TABLE SALT USED BY AIRLINE PASSENGERS
CONSUMING DIFFERENT AMOUNTS OF ENTREE AND SALAD

<u>NUMBER OF PASSENGERS</u>	<u>AMOUNT OF ENTREE CONSUMED</u>	<u>AMOUNT OF SALAD CONSUMED</u>	<u>AVERAGE GRAMS NaCl</u>
2	None	Part	.35
72	Part	None	.07
62	Part	Part	.11
70	Part	All	.14
115	All	None	.14
107	All	Part	.22
472	All	All	.19

Analysis of variance: $F = 3.46$
Significant difference in salt use between passengers
consuming different amounts of entree and salad.

accounted for 52 percent of all table salt consumed by the passengers; it was suspected that this was probably responsible for the statistical significance. Eliminating the A/A category, the analysis was repeated. Contrary to expectation, the F value of 3. was also statistically significant ($p < .01$).

Thus, amount of entree/salad consumed did affect salt consumption. To examine the effect of salad consumption alone, the test was repeated again, holding the amount of entree consumed constant. The F value for the remaining three plates of 1.84 did not represent a significant difference ($p < .01$).

DISCUSSION

Factors held constant during data collection were the following: the same flight on the same consecutive days of the week were surveyed; the composition of the meal offered was relatively consistent (standardized recipes and standard portions were utilized); the menu was limited; the in-flight service staff working with the meal trays were relatively constant; and data was collected by the same person during the entire experimental period.

Limitations in the experimental design could affect the accuracy of the estimated table salt consumption figures. First, the degree of uniformity of the airline passenger population could not be assessed. Second, the data collector had to estimate

the weight or portion of sodium chloride unused, label, date, and tape each packet for subsequent actual weighings in the laboratory. During transport, the taped salt packets could lose some salt granules. Third, the time required for each collection period was lengthy, i.e., approximately four hours, and the sharpness and accuracy of the recordings toward the end of the time period could have been compromised by fatigue. The latter two sources of error could have been eliminated 1) by the use of a digital gram scale at the facility site so that packet collection and weighing could be done simultaneously and 2) by additional manpower so that one person could collect packets while a second person recorded the weight and tray observations. These time saving considerations are important for future studies.

A fourth source of potential error was that approximately 11 percent of those passengers surveyed left no evidence of a salt packet on the tray or left two or more packets on one tray. This source of error could be reduced if flight personnel were informed of the study protocol and trained accordingly. For example, they could assure proper disposal of trays into the carrier to eliminate disarray and stacking of two or more entrees on the tray. Also, the personnel could be asked to leave all refuse on the tray and not dispose of refuse into "waste bags." This would help assure most trays showing evidence of a salt packet.

A limitation of the data collection technique for extrapolation of results to the general American public was that the survey was limited to those persons who could afford to travel by air: Lower middle to high economic class. Even though the airline passenger population surveyed probably did encompass a wider income range than usual due to the special \$99 fare offered during this time period, the low income population was still eliminated in the survey. The possibility exists that the low income population may have different salting practices than other segments of the population. This is an important concern since there is a higher incidence of hypertension in the lower economic bracket.¹

Despite the limitations of the technique, the monitoring of table salt usage on airlines could be useful, especially if combined with an assessment of nutritional knowledge of the air passenger population. It might be used to predict, with reasonable accuracy, the effects of different types of intervention, such as informative inserts about salt use in airline magazines. The technique could also be used to determine the salt sensitivity of the airline passenger population, if entrees containing widely differing amounts of NaCl were presented.

The table salt consumption figures were compared to the estimated discretionary salt intake figures from previous studies (See Table 9): the 1968-70 retail sales survey

TABLE 9A

COMPARISON OF DISCRETIONARY SALT CONSUMPTIONFIGURES WITH OTHER STUDIES*

<u>STUDY</u>		<u>AVERAGE CONSUMPTION NaCl PER DAY/(g)</u>
1966-70	Bureau of Mines Data (Bowen)	6.5
1977	Dietary Survey (Mickelson)	5.5
1977-80	F.D.A. Total Diet Studies	4.7
1976	F.D.A. Total Diet Studies	4.5
1968-70	Retail Sales Survey (Wood)	3.4
1983	Survey (Dierkes)	2.4

TABLE 9B

COMPARISON OF TABLE SALT CONSUMPTION FIGUREWITH DIETARY SURVEY

<u>STUDY</u>		<u>AVERAGE CONSUMPTION NaCl PER DAY(g)</u>
1977	Dietary Survey (Mickelson)	3.2
1983	Survey (Dierkes)	.50

*Discretionary salt denoted here includes both salt used in cooking and salt used at the table

(Wood), the 1965 U.S.D.A. survey, the 1966-70 Bureau of Mines survey (Bowen), the 1972-1980 F.D.A. total diet studies, and the 1977 dietary survey (Mickelson). For comparison, data from this study were extrapolated, speculating that the salt levels in the study meals are not unusual and that salting practices in flight is typical of the passengers' usual behavior. The amount of salt used on the airline meal was multiplied by three meals per day. If used at all meals the levels of salt usage in this study would represent a decrease in discretionary salt use from the usage reported in previous studies. An optimistic conclusion is that this study may provide the first glimpse of a trend toward decreased discretionary salt use since the advent of the Dietary Goals.

However, since the previous reported study estimates were from four to fourteen fold greater than the airline estimates, reason for difference must be sought. The difference in estimated table salt consumption could be due to a number of factors: First, many passengers who normally salt their food at home may not do so on an airline meal, due to high salt content of airline food. For example, one of the two entrees offered at each meal was an Italian dish that is highly seasoned. Second, public perception that airline food is "processed," may lead some passengers to abandon their usual salting practices. Third, as mentioned before, the survey is not representative of the entire population and there is the possibility that the omitted low income group may, perhaps, practice heavier salting than others.

Two possible predictors of salt use were investigated in this study: The sodium content of the meal and inclusion of a salad with the meal. (See Tables 4, 7, 8) It was found that table salt intake figures did not differ significantly among the menu choices; thus, it can be inferred that the airline passenger is not influenced by the sodium content of the meal and appears to salt the food without discretion. The table salt intake figures did not differ significantly according to the absence/presence of a salad with the meal. However, it was observed that the amount of the entree left on the tray (amount consumed) influenced salting practice. It appeared that the amount of entree consumed (on any menu) influenced the amount of table salt used by the passenger, without respect to the sodium content of the meal.

The sodium estimates of the inflight meals derived from the laboratory assays and from standard references differed by approximately 100 milligrams. (See Table 4, Appendix E) The variation between the sodium estimates could be due to a number of factors. First, the values reported in a standard reference do not always reflect the sodium content of homemade items due to variability in the use of salt as a seasoning by the cook. Specifically, the sodium content of entrees in this study were expected to vary from meal to meal due to utilization of standardized recipes which call for "salt to taste" (veal roast, pot roast of beef, and mushrooms in cream sauce).

Second, the laboratory procedure is dependent on the experimenter's perception of a color change. (See Appendix C) In this experiment, the experimenter looked for a brown color change. Perhaps a delayed response to the immediate color change could be responsible for the higher sodium values. Whatever the source of error, it can be seen that the sodium content per menu was similar using both techniques of estimation. For example, both techniques estimated the sodium content of roast beef as the lowest value of the various entrees. Thus, "book estimates" are useful for obtaining a "ball-park figure" for ranking entrees by their sodium content.

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CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

SUMMARY

Review of the literature revealed that there is awareness, by the food industry and by the consumer, of potential harmful effects of chronic excess sodium chloride consumption. It also revealed that the food industry is decreasing the amount of salt in processed foods available on the market today.

The study investigated the feasibility and limitations of a data collection technique used to assess discretionary salt intake in in-flight meal service. Discussion of the limitations of the technique, such as lack of control of subjects, exclusion of low income population, and limited menu selection was offered.

Flight day, sodium content of the inflight meal, and salad consumption at the meal were found not to influence salting habits of passengers as measured by the study technique. Amount of entree consumed did influence the amount of salt added to the meal.

Extrapolating inflight salting practice to estimate an habitual level of salt use revealed a lower level of use than would be predicted from other types of studies.

Reliability of laboratory assay of sodium content of the airline meal was discussed.

CONCLUSIONS

The study results suggest that sodium content of an inflight meal does not influence discretionary salting practice; rather, it appeared to be dictated by habitual practice of the passenger. Also, the study results showed that the inclusion of a salad at the meal did not affect the airline passenger's salting practices.

The data collection technique employed in the study seemed a feasible method for collecting discretionary salt intake data and could be useful in future studies to determine effectiveness of consumer education/media techniques. However the data collection technique will not provide accurate estimates of discretionary salt intake of the American public in general.

RECOMMENDATIONS

The data collection techniques used in this study might be used to monitor changes in salting practices by airline passengers and to test effectiveness of consumer education techniques. For example, consumer information on sodium could be placed in an insert in the airline magazines, on a place card on the meal tray, or on the placemat itself. Salting practices could be monitored to detect changes due to this educational intervention.

Also, the collection technique could be useful for investigating other factors influencing discretionary salt use by the passengers. For example, the technique could be applied when lower sodium entrees (traditional continental versus italian cuisine) are used or when one low sodium entree is included among menu choices to determine if the sodium content/knowledge of sodium content of the meal influences the airline passenger's salting practice. A re-survey when continental cuisine is offered should be conducted to test reliability of the results from this study.

APPENDIX

MENU KEY: POT ROAST BEEF-a
 RAVIOLI-b
 STUFFED SHELLS-c
 VEAL LASAGNA COMBO-d

TABLE SALT COLLECTION

Date:

No	SALT IN PACKET					SALT SPILL	#	SALAD			FOOD ON TRAY			MENU
	1.0	.75	.50	.25	0.0			ALL	PART	NONE	ALL	PART	NONE	
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
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LABORATORY PROCEDURE: SODIUM CHLORIDE ASSAY

SUPPLIES: 100 ml. Beakers
250 ml. Flasks
Funnels
#4 Filter Paper
2 Biurets
 $K_2 CrO_4$
.1 N $AgNO_3$
Dionized Water
Food Processor

- PROCEDURE:
1. Blenderize sample.
 2. Weigh 2 gram sample in beaker, mix with 20 ml. hot water.
 3. Filter into flask. Wash beaker into filter with additional 10 ml. hot water.
 4. Add .5 ml. $K_2 CrO_4$ to flask.
 5. Titrate with .1N $AgNO_3$ until color turns brown.
 6. Formula for percent sodium chloride:

$$\% \text{ (grams NaCl/100 grams)} = \frac{\text{ml. .1 N AgNO}_3 \times .585}{\text{Wt. Sample (2g)}}$$

LABORATORY ANALYSIS: TITRATIONS

<u>Menu Item</u>	<u>Form</u>	<u>Wt. Beaker + 2 g. Sample</u>	<u>Ml. AgNO₃ To Achieve Color Change</u>
Stuffed Shell Florentine	J	43.13	7.50-11.25=3.75
	P	42.63	11.25-15.00=3.75
Salad	J	49.79	17.25-19.25=2.00
	P	52.10	15.00-17.25=2.25
Ravioli	J	45.36	19.25-22.25=3.00
	P	44.53	26.50-29.75=3.25
Veal Lasagna Combo	J	44.06	37.75-40.50=2.75
	P	45.99	40.50-43.25=2.75
Roast Beef	P	44.17	43.25-45.75=2.5
	P	44.10	45.00-47.50=2.5
Peach Tart	P	42.62	21.00-21.50= .5
	P	42.62	21.50-22.0 = .5
Strawberry Tart	P	46.03	20.00-21.00= .5
	P	46.03	20.00-22.50= .5
Salad Dressing	J	49.66	47.00-52.0 =5.0
	J	49.66	52.00-57.0
Test = 1NaCl/100 ml. H ₂ O			5.75-25.75=20.0 complete color change

$$\% \text{ NaCl} = \frac{\text{ml. } .1 \text{ AgNO}_3 \times .585}{\text{Wt. Sample}}$$

*J = Juiced

P = Pureed

ESTIMATES OF SODIUM CONTENT OF IN-FLIGHT MEALS

BY LABORATORY ASSAY

LABORATORY ANALYSIS:

<u>Meal Sample</u>		<u>g. NaCl/100g Sample From 3.6 Portion</u>	<u>Na (g)</u>
(1) Stuffed Shell Florentine	#1	1.09	.436
	2	1.09	.436
(2) Salad	#1	.59	.236
	2	.66	.264
(3) Ravioli	#1	.88	.352
	2	.95	.380
(4) Veal Lasagna Combo	#1	.80	.320
	2	.80	.320
(5) Roast Beef	#1	.73	.292
	2	.73	.292
(6) Peach Tart	#1	.15	.060
	2	.15	.060
(7) Strawberry Tart	#1	.15	.060
	2	.15	.060
(8) Salad Dressing	#1	1.46	.584
	2	1.46	.584

SODIUM CONTENT ESTIMATED FROM FOOD COMPOSITION

TABLES FOR COMPLETE MENUS

<u>MENU</u>	<u>CALCULATED Na VALUE*</u>
(1) <u>Menu A</u>	<u>Na (mg)</u>
3 oz. Roast beef with sauce (1.5 oz.)	154.
1 oz. Carrots and peas	74.
2.5 oz. Stuffed baked potato	175.08
1.5 oz. Broccoli spears in butter	297.20
Market salad	135.95
Herb dressing	366. -439.5
Hard roll	219
Butter cup	50.
Peach tart	142.75
Cheese	62. -177.
Crackers	100. -176.
	<u>1675.78-1970.28 Total</u>
(2) <u>Menu B</u>	<u>Na (mg)</u>
7 oz. Ravioli Bolognese	490.5
1.5 oz. Scandanavian buttered vegetables	71.
1.75 oz Broiled tomato half	398.83
Alfalfa salad	20.
Herb dressing	366. -439.5
Hard roll	219.
Butter cup	50.
Strawberry tart	142.75
Cheese	62.
Crackers	100 -176.
	<u>1920.05-2184.55 Total</u>

(3) <u>Menu C</u>	<u>Na (mg)</u>
5.5 oz. Stuffed shell florentine	478.17
2 oz. Bolognese meat sauce	111.8
1.5 oz. Broccoli spears in butter	297.2
Market salad	135.95
Herb dressing	366. -439.5
Hard Roll	219.
Butter cup	50.
Peach tart	142.75
Cheese	62. - 177.
Crackers	100. - 176.
	<u>1862.87-2127.37 Total</u>

(4) <u>Menu D</u>	<u>Na (mg)</u>
3 oz. Veal roast in mushroom cream sauce (1.5 oz.)	173.25
3 oz. Vegetable lasagna	186.38
1.5 oz. Scandanavian butter vegetables	71.
1.75 oz Broiled tomato half	398.83
Alfalfa salad	20.
Herb dressing	366. - 439.5
Hard Roll	219.
Butter cup	50.
Strawberry tart	142.75
Cheese	62. - 177.
Crackers	100. - 176.
	<u>1809.21-2073.71 Total</u>

*Calculated from Pennington and Church, Marriott Inn Standardized Recipes, and Vendor Nutritional Information

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