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Sodium Trends in Selected U.S. Total Diet Study Foods, 2003-2011

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Abstract

Objective: Characterize trends in sodium concentrations in the general categories of foods analyzed in the U.S. FDA Total Diet Study (TDS) program from 2003 through 2011. **Methods:** Trends were assessed for sodium concentrations in a small convenience sample of TDS foods from 2003 to 2011 using simple linear regression with the SAS regression procedure, focusing on sodium concentrations in foods in USDA's sentinel food categories. **Results:** Levels of sodium in various TDS foods varied over time. Overall, 75 TDS foods did not have statistically significant linear changes in sodium content during that time, and 23 TDS foods did. Certain sentinel foods such as ramen-style noodles showed gradually increasing sodium content from 2003 through 2011. **Significance:** Over three quarters of foods show no statistically significant linear changes over time. Although a number of selected foods had a statistically significant decline, a limitation to this study is that specific brands of TDS foods were not necessarily the same for each period. The results suggest that some sodium reduction has been occurring in some foods and supports the idea that commercially viable reductions are possible. Such reductions in the sodium content of foods could have large public health implications—rates of hypertension and related health consequences would likely decline—thus saving thousands of lives and billions of dollars each year.

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1. Introduction

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Excessive sodium intake can lead to hypertension¹. Hypertension accounts for 62% of cerebrovascular disease and 49% of ischemic heart disease². Sodium is ubiquitous in foods. Over three-quarters of sodium consumed in the U.S. is from processed or restaurant foods. Over 40% of the sodium Americans consume comes from ten types of foods: breads and rolls, deli and cured meats, pizza, fresh and processed poultry, soups, sandwiches, cheese, mixed pasta dishes, mixed meat dishes, and snacks such as potato chips, popcorn, and crackers³. Thus, there is a great need for restaurants and food manufacturers to lower sodium content in their foods in order to curb the public health impact of excess sodium consumption. A large number of food and restaurant companies have made commitments to reduce the sodium content of their products and there is some evidence of success in many products. Additionally, several recent sodium reduction initiatives are underway such as the National Salt Reduction Initiative (NSRI), a public-private New York City Health Department partnership consisting of over 90 participating packaged food companies and restaurants that have pledged to meet relevant targets for salt content in their overall sales of given food categories⁴. Britain's Food Standards Agency set salt-reduction targets in different food categories over a decade ago and encouraged companies to meet these targets over time. England saw a reduction in sodium consumption by 15% from 2001 and 2011, and has also seen a decline in stroke and heart disease deaths that may be attributed to a decline in blood pressure⁵.

The TDS is an ongoing U.S. Food and Drug Administration (FDA) program initiated in 1961 that monitors levels of various contaminants and nutrients in over 280 foods identified as being of importance in the American diet. TDS collects each of these foods quarterly from one of four geographical regions of the U.S.⁶. Together, the foods collected in each sampling period are referred to as a "market basket." For each quarterly market basket, FDA purchases foods in each of three cities within the region and sends the food samples to FDA's Kansas City District Laboratory. Staff at a nearby institutional kitchen prepare the foods according to recipes or as per package directions, take samples, and make composites of the prepared food samples from the three cities. FDA's Kansas City District Laboratory analyzes the food composites to determine concentrations of mineral nutrients, toxic elements, and pesticides⁷. The study provides a snapshot in time of the nutrient and contaminant content in many widely consumed foods, including fresh and canned fruits and vegetables, grains, dishes prepared for the study, restaurant and processed foods, among others. The purpose of the present study was to characterize trends in sodium concentrations in the general categories of foods analyzed in the TDS program over time; because the brands included in composites may vary between market baskets, TDS data cannot be used to characterize trends in composition of specific brands. The TDS first analyzed products for sodium in 1977, and then quarterly beginning in 1980. The list of foods analyzed changed significantly in 2003, and therefore only foods beginning in 2003 were examined for the purposes of this paper.

2. Methods

Trends in the sodium content in the selected U.S. TDS foods were examined using SAS V9.3⁸. Only the 251 TDS foods that were continually analyzed from 2003 through 2011 were considered for inclusion in the analysis.

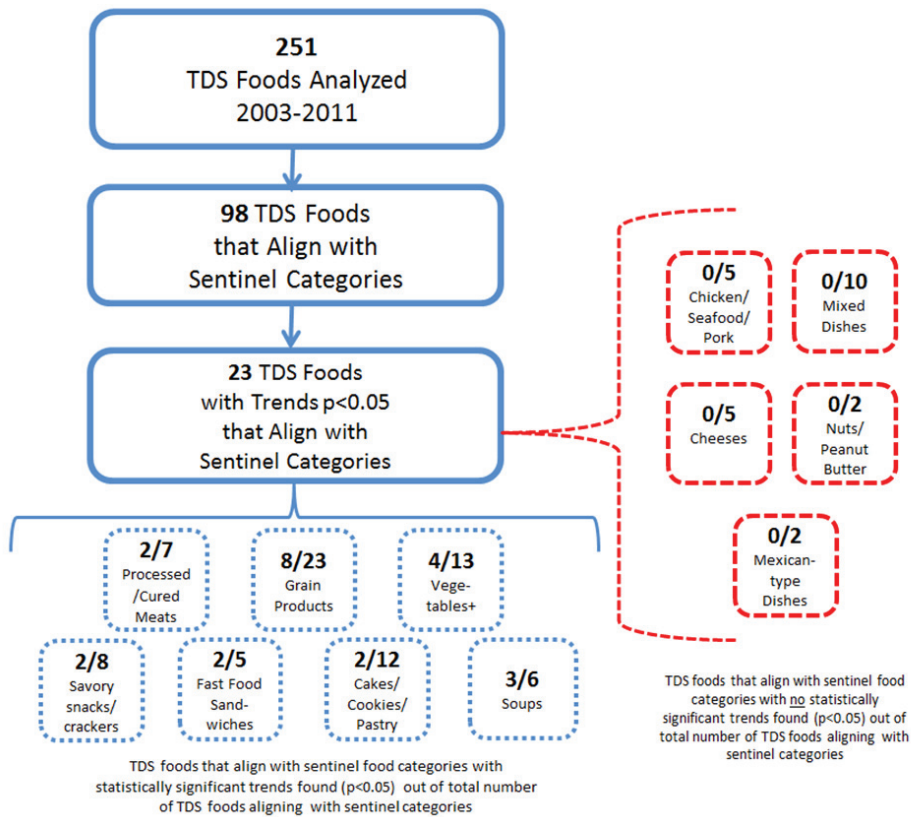
In order to take a closer look at foods of particular interest due to their contribution to population sodium intake, individual TDS foods were mapped to a list of sentinel food categories developed by multiple agencies including the USDA's Agricultural Research Service (ARS)⁹. The sentinel foods include "mainly commercially packaged and restaurant foods, selected based on evaluation of their sodium content, frequency of consumption, and potential for possible reduction in sodium content of the food"¹⁰. It is hoped that foods falling within these sentinel categories will serve as primary indicators of change in sodium content of foods.

Of the 251 TDS foods continuously analyzed from 2003 through 2011, 98 were identified as aligning with one of the sentinel categories for sodium monitoring. The concentrations of sodium (mg/100g) of these 98 foods were regressed on year for each food item using simple linear regression with SAS Proc Reg⁸. Each TDS food trend was based on 36 results, since each food was sampled quarterly over nine years; each sample is a composite of 3 subsamples.

Table 1. Sentinel food categories and examples of associated foods for sodium monitoring⁸

Sentinel food category	Example of foods
Mixed dishes	Pizza; pasta-based dishes; chili; egg roll
Grain products	Bread; rolls; tortilla; bagel; taco shell; ready-to-eat cereals; pancakes; biscuit
Vegetable dishes, beans	Canned corn; French fries/frozen and fast food; potato salad
Chicken, seafood, pork	Nuggets/frozen and fast food; rotisserie; breaded fish filet; fried shrimp; pork chops
Cured/processed meats	Deli ham/turkey; bologna; bacon; hot dog/corndog; salami
Fast food sandwiches	Double cheeseburger; hamburger
Mexican type dishes	Beef taco; bean burrito
Cheeses	Cheddar; fried mozzarella sticks; nacho cheese dip; cottage cheese
Soups/broths	Tomato soup; ramen noodles soup; chicken noodle soup/broth
Savory snacks/crackers	Pretzels; potato chips; popcorn; tortilla chips
Cakes, cookies, pastry	Doughnut; cinnamon bun; chocolate chip cookie
Nuts, peanut butter	Peanuts; peanut butter

Figure 1. U.S. TDS foods examined for statistically significant linear trends ($p < 0.05$), 2003-2011



3. Results

From 2003 to 2011, 251 TDS foods were analyzed quarterly for sodium concentration. Of the 98 TDS foods identified as aligning with one of the sentinel categories for sodium monitoring, 77% were found to have no statistically significant linear changes in sodium content over the period. The 23 TDS foods (23%) that were found to have statistically significant ($p < 0.05$) linear trends in sodium concentration from 2003 to 2011 are presented in Table 2. The percent difference in mean sodium (mg/100g) between 2003 and 2011 is also presented in Table 2. Of these 23 foods, 19 were found to have statistically significant decreasing trends and four were found to have statistically significant increasing trends. Of the twelve sentinel food categories identified in Figure 1, only seven categories included TDS foods with statistically significant trends.

Table 2. TDS Foods with Significant Trends ($p < 0.05$) in Sodium: 2003-2011*

TDS Food No.	Food Description	Slope of Na (mg/100g)	p-value	Lower 95% Confidence Interval	Upper 95% Confidence Interval	2003 mean** (mg/100g)	2011 mean** (mg/100g)	% Difference 2003-2011
75	Crisped rice cereal	-30.8	<0.0001	-41.6	-20.0	927	655	-29.3
77	Oat ring cereal	-30.1	<0.0001	-39.5	-20.6	857	509	-40.6
239	Luncheon meat (ham)	-19.7	0.037	-38.2	-1.3	1278	952	-25.5
372	Popcorn, microwave, butter-flavored	-17.4	0.008	-30.0	-4.8	846	674	-20.3
119	Tomato sauce, plain, bottled	-15.0	0.008	-25.8	-4.2	598	463	-22.6
74	Raisin bran cereal	-14.1	0.0004	-21.4	-6.8	592	477	-19.3
248	Bread, multi-grain	-13.0	0.002	-20.9	-5.1	484	414	-14.6
76	Granola w/ raisins	-12.8	0.021	-23.6	-2.1	200	104	-48.3
344	Pancakes, frozen, heated	-12.0	0.001	-19.0	-5.0	600	459	-23.6
261	Tomato juice, bottled	-11.9	0.001	-18.2	-5.5	338	219	-35.3
252	Crackers, butter-type	-11.8	0.032	-22.5	-1.1	850	780	-8.3
366	Chicken filet (broiled) sandwich on bun, fast-food	-9.4	0.022	-17.4	-1.5	528	461	-12.7
131	Beets, canned	-9.0	0.002	-14.4	-3.5	204	117	-42.8
55	Corn, canned	-8.5	0.036	-16.5	-0.6	235	138	-41.1
155	Soup, chicken noodle, canned, condensed, prepared w/ water	-8.0	0.027	-15.0	-0.9	435	320	-26.5
156	Soup, tomato, canned, condensed, prepared w/ water	-7.3	0.004	-11.9	-2.6	288	249	-13.8
185	Apple pie, fresh/frozen	-7.2	0.004	-11.94	-2.5	279	239	-14.2
65	Muffin, fruit or plain	-5.9	0.014	-10.5	-1.3	363	322	-11.1
58	Bread, white, enriched	-5.4	0.031	-10.2	-0.5	535	499	-6.8
278	Egg, cheese, and ham on English muffin, fast-food	5.9	0.006	1.8	10.0	593	646	8.9
370	Granola bar, w/ raisins	7.7	0.004	2.6	12.7	260	261	0.5
30	Salami, luncheon-meat type (not hard)	25.9	0.022	3.9	47.8	1188	1365	14.9
367	Soup, Oriental noodles (ramen noodles), prepared w/ water	29.4	0.001	13.7	45.2	318	650	104.8

*Of 98 foods in TDS study aligning with sentinel food categories
 **n=36 results per food (quarterly sample collections over nine years)

Fit plots of selected foods found to have statistically significant linear trends ($p < 0.05$) of sodium concentration (mg/100g), 2003-2011 are shown in Figures 2-7

Figure 2. TDS food no. 75, Crisped rice cereal

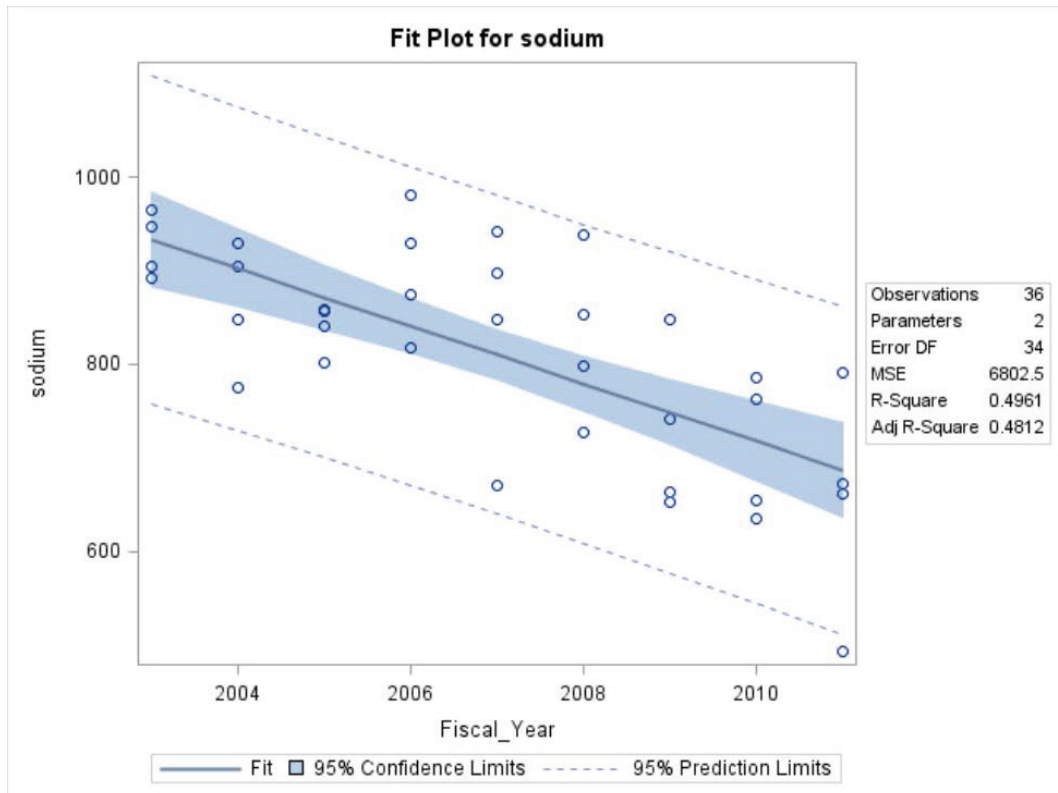


Figure 3. TDS food no. 239, Luncheon meat (ham)

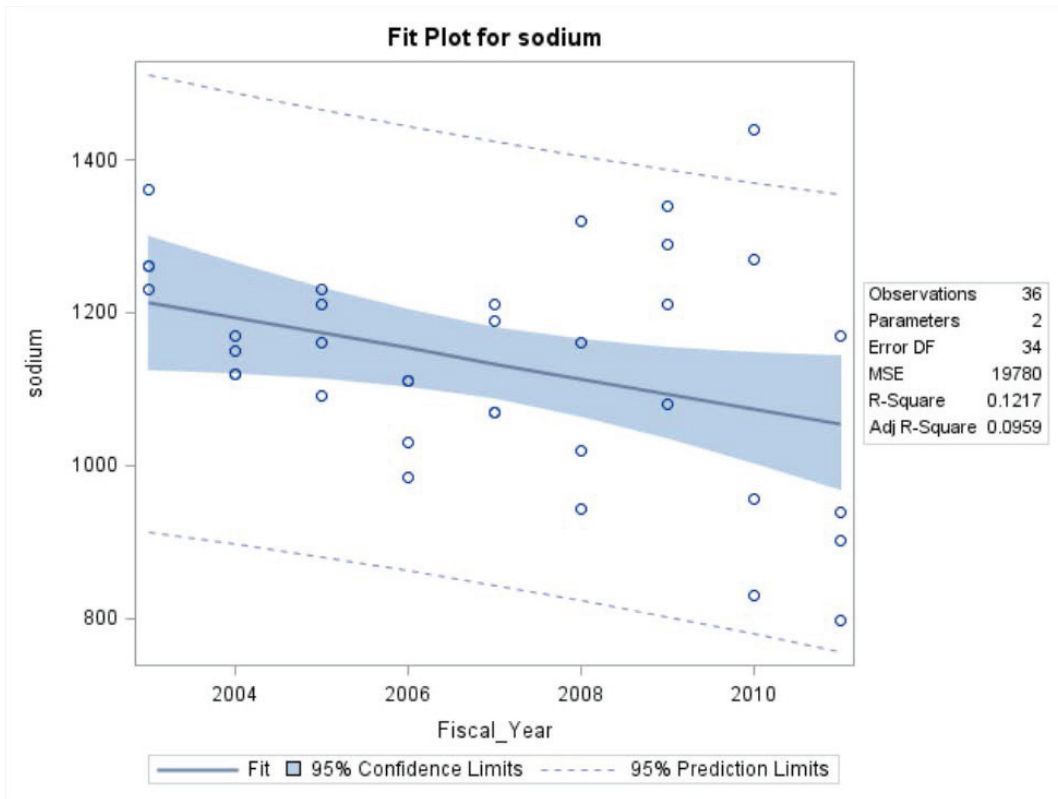


Figure 4. TDS food no. 372, Popcorn, microwave, butter-flavored

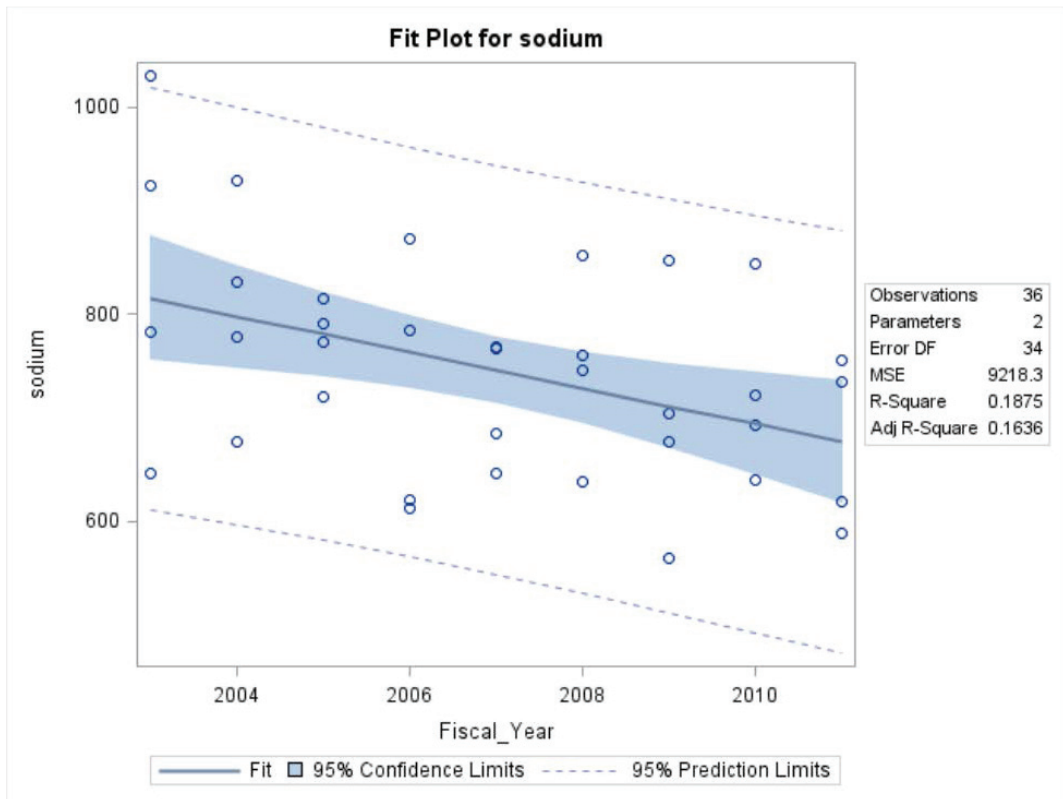


Figure 5. TDS food no. 119, Tomato sauce, plain, bottled

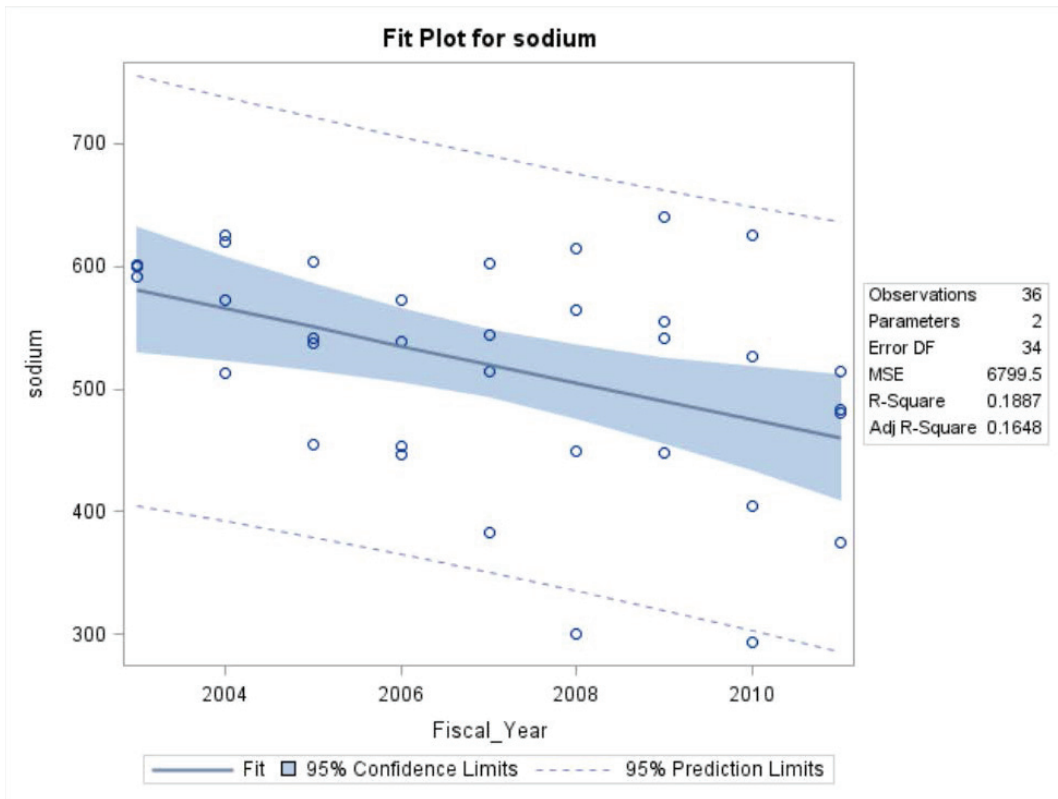


Figure 6. TDS food no. 155, Soup, chicken noodle, canned, condensed, prepared with water

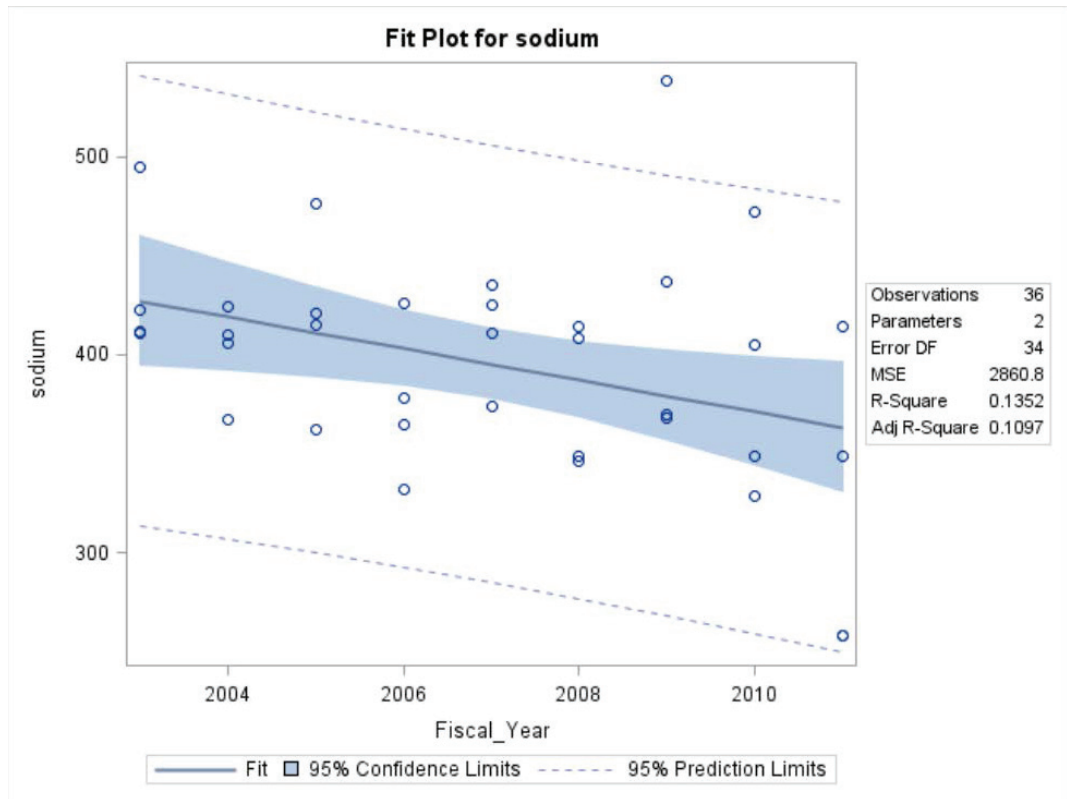
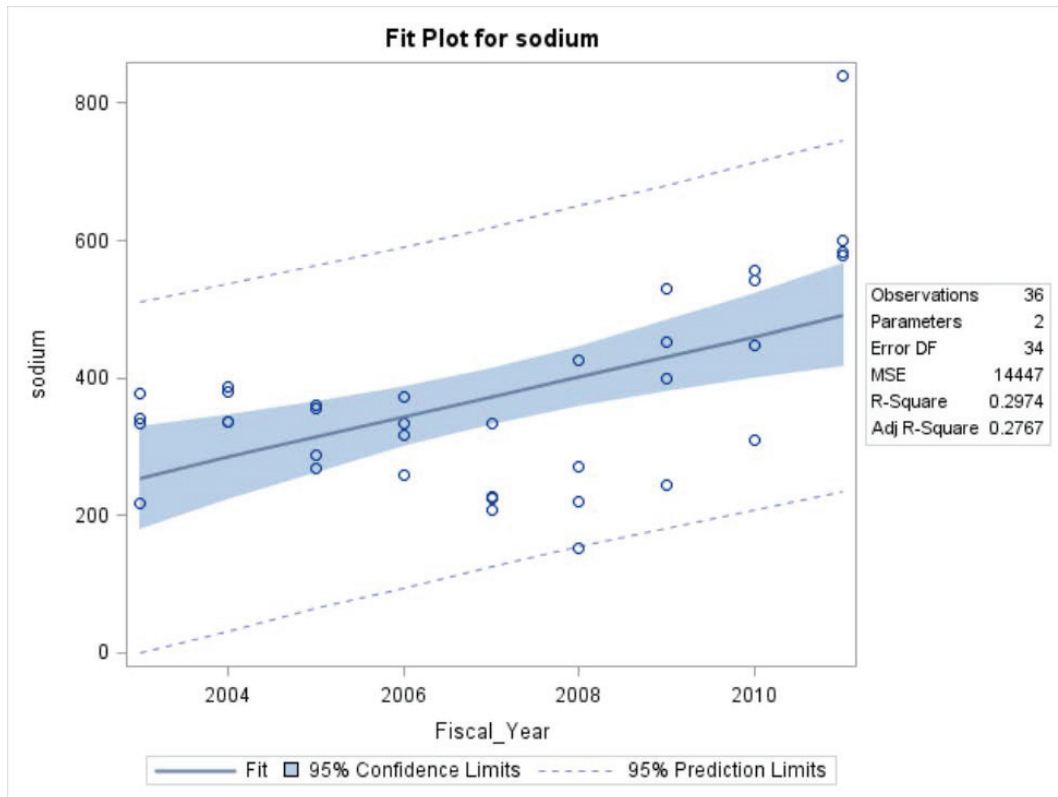


Figure 7. TDS food no. 367, Soup, Oriental noodles (ramen noodles), prepared with water



4. Discussion

Other governments have had success with programs designed to lower the sodium content of foods in their countries. At least one of these initiatives has shown that gradual industry reductions in the sodium content of packaged and restaurant foods⁵, along with educational messages focused on reducing sodium intake, show promise as methods for increasing consumer control over intake and making recommended intake levels and their associated improvements in public health more attainable. Taste, as well as technological feasibility, is a consideration when reducing sodium content in foods.

There are limitations to the conclusions that can be drawn from this analysis due to the methodology inherent to the TDS. The TDS provides a limited look into the food supply and further analysis is warranted. The TDS does not collect brand information and the protocol was not designed to be sensitive to manufacturer variation in food formulation over time. Specific brands of TDS foods analyzed over time were not necessarily the same for each period. While some TDS foods show trends, this study is not representative of the entire food supply. However, the analysis presented here suggests that some sodium reduction has been occurring in some foods and supports the idea that commercially viable reductions are possible.

Proposed next steps include continuing the suggested industry progress to further reduce the sodium content of foods, and refining and coordinating various complimentary sodium content monitoring projects across agencies to ensure a system that supports comprehensive, up-to-date monitoring of sodium levels in the U.S. food supply as a critical component of understanding sodium intake in the U.S. population. FDA continues to monitor other food component trends and the data from the TDS program can be utilized for these determinations.

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