

Citation:

Dharod JM, Paciello S, Bermúdez-Millán A, Venkitanarayanan K, Damio G, Pérez-Escamilla R. Bacterial contamination of hands increases risk of cross-contamination among low-income Puerto Rican meal preparers. *J Nutr Educ Behav*. 2009 Nov-Dec; 41 (6): 389-397.

PubMed ID: [19879494](#)

Study Design:

Observational prospective cohort study

Class:

B - [Click here](#) for explanation of classification scheme.

Research Design and Implementation Rating:

NEUTRAL: See Research Design and Implementation Criteria Checklist below.

Research Purpose:

- To examine the association of microbial contamination of the meal preparer's hands with microbial status of food and of kitchen and utensil surfaces during home preparation of a "Chicken and Salad" meal
- To determine if the level of microbial contamination on the hands of meal preparers varies by sociodemographics, food safety attitude and acculturation (measured by proxy indicators such as language spoken at home and place of birth).

Inclusion Criteria:

- Puerto Rican female
- Primary meal preparer of the household
- Living in inner-city Hartford, CT
- Signed informed consent.

Exclusion Criteria:

- Not a Puerto Rican female
- Not a primary meal preparer of the household
- Not living in inner-city Hartford, CT
- Did not sign informed consent.

Description of Study Protocol:**Recruitment**

- Puerto Rican women were recruited by distributing flyers in local schools; grocery stores; the Supplemental Nutrition Program for Women, Infants and Children (WIC) offices; and on

inner-city streets of Hartford, CT

- After meeting inclusion criteria and submitting the signed study consent form, a trained bilingual (Spanish-English) outreach worker scheduled household visits for food delivery, microbial testing and interviewing in full consultation with the study participants.

Design

- Pilot Study:
 - A pilot study was conducted prior to the main study to:
 - Streamline and standardize microbiological testing
 - Test the feasibility of collecting samples without disrupting kitchen studies
 - Test the participants' routine behaviors
 - Ten simulations were conducted to rule out unintended research-driven secondary microbial contamination during the delivery of food ingredients and transportation of samples from the households to the microbiology laboratory
- Main study:
 - Each household was visited three times:
 - First visit:
 - Research staff purchased package of uncooked chicken breasts (CB) with skin and bones, lettuce and tomatoes (LT), oil, salad dressing and common Puerto Rican spices from local grocery store
 - After purchase, foods were taken to a microbiology lab and CB and LT samples were tested for baseline total bacterial and coliform counts, repacked and transferred to coolers until delivery to participant's home
 - From purchase to delivery (three-hour period), the CB and LT samples were maintained at 4°C or less in ice coolers (except for oil and spices, which were kept at room temperature)
 - Upon delivery, participants were asked to refrigerate the LT and freeze the CB and defrost it using their usual method so that the study staff could observe them preparing the "Chicken and Salad" meal during the second visit
 - Second visit (one day after first visit):
 - Household observations were conducted during meal preparation
 - All participants handled chicken first and then the LT
 - Before and after the participant had handled food, the food, kitchen surfaces and meal preparation utensils were sampled
 - Participants' hands, food and surface area samples (counter, cutting board, sink, knife) were tested for total bacterial and coliform counts and presence of *Campylobacter*, *Salmonella*, *Listeria* and *S. aureus*
 - Before starting any meal preparation, including hand washing, participants' hands were sampled by having them dip their hands one at a time for 30 to 50 seconds in 250ml of 0.1% peptone buffer in sterile stomacher bags
 - A chicken sample (about 25g) was collected after the participant began handling the chicken but before cooking (i.e., after cutting or removing skin and bones, and washing, if applicable)
 - Lettuce and tomato samples (about 25g) were collected after washing (if applicable), cutting, mixing or once salad was ready to serve
 - Food samples (CB and LT) were transferred to stomacher bags using sterilized tongs and all samples were transported to the laboratory at less than equal to 4°C for microbial testing
 - Refrigerator and freezer handle and knife surface samples were tested only for

pathogens (procedures for testing for presence of pathogens described in separate articles)

- Third visit (one day after second visit):
 - Meal preparation survey was conducted with the participant using bilingual outreach workers who conducted the interview in the client's preferred language
 - Survey included questions asking for sociodemographic and acculturation proxy information (e.g., language spoken at home and place of birth) and attitude toward food safety.

Statistical Analysis

- 14.0 version of SPSS was used to analyze microbiological and survey data
- Descriptive statistics and frequencies were used to assess percentage of samples testing positive for pathogenic species
- Analysis of variance or T-test and multiple logistic regression were used to estimate the differences in risk of microbial estimation on the participants' hands by sociodemographic, acculturation proxy indicators and attitudinal indicators
- Bivariate parametric tests were conducted to examine the relationship between microbial contamination on participants' hands and microbial counts in food, kitchen surfaces, and utensil samples before and after food preparation
- The paired T-test was used to compare pre- and post-handling changes in coliform count in food samples in those who tested positive or negative for coliform on their hands (sampled at beginning of second visit)
- Statistical significance was set at a probability value of $P \leq 0.05$
- Sample size for study was designed to detect a significant correlation in total bacterial counts at different stages of meal preparation with 80% statistical power and a tolerable σ error of 0.05 (N=60).

Data Collection Summary:

Timing of Measurements

Main study:

- First day of study: After purchase, food ingredients were taken to the microbiology laboratory and sampled to determine the presence of any pathogenic species and establish baseline total and coliform counts; later the same day, foods were delivered to participant households
- Second visit (one day after first visit):
 - Household observations were conducted during meal preparation
 - Before and after the participant had handled food, participants' hands, food and surface area samples (counter, cutting board, sink and meal preparation utensils) were taken
 - Total bacterial and coliform counts and presence of *Campylobacter*, *Salmonella*, *Listeria*, and *S. aureus* were checked
 - A chicken sample was collected after the participant began handling the chicken but before cooking (i.e., after cutting or removing skin and bones, and washing)
 - Lettuce and tomato samples were collected after washing, cutting, mixing or once salad was ready to serve
 - Food samples were transported to the laboratory at 4°C or less for microbial testing
- Third visit (one day after second visit): Meal preparation survey was conducted with the participant, using bilingual outreach workers.

Dependent Variables

Total bacterial and coliform counts and presence of *Campylobacter*, *Salmonella*, *Listeria*, and *S. aureus* on food and surface area samples (counter, cutting board, sink, meal preparation utensils, including knives) after participant handling:

- Sterilized tongs were used to collect the food samples (about 25g each of chicken breast and lettuce and tomatoes)
- Procedures for collection and testing of food and surface samples and for testing for the presence of pathogens, including incubation temperature and environment, selective agar and standardized confirmatory tests, have been previously reported in detail.

Independent Variables

- Estimated total bacterial and coliform counts on participant's hands: To estimate the total bacterial and coliform counts on participant's hands, the hand wash sample collected in 250 ml of 0.1% peptone buffer was serially diluted to prepare 10¹ and 10² dilutions; 100ml of the original sample and serial dilutions were spread plated on Tryptic Soy Agar (Difco/Becton Dickinson) and Violet Red Bile Agar (Difco/Becton Dickinson) for total bacterial and coliform counts, respectively. The plates were incubated at 37 °C for 24 hours. For enriching, a volume of 5ml of the original hand wash sample was transferred to 50ml of TSB + 0.6 YE (*Salmonella*, *Listeria*, *S. aureus*) and Brucella broth + 0.5% sheep's blood (for *Campylobacter* testing).
- Language spoken at home
- Age
- Place of birth
- Monthly income
- Education level
- Attitude toward food safety was assessed through the question, "How important is food safety for you?" Response options were:
 - Very important
 - Important
 - Somewhat important
 - Not at all important
- Answers were collected from a meal preparation food safety survey that collected sociodemographic and acculturation proxy information and food safety attitude; it was administered via interview with a bilingual outreach worker during the third study visit.

Control Variables

- Total bacterial counts at the retail (baseline) level
- Coliform counts at the retail (baseline) level.

Description of Actual Data Sample:

- *Initial N*: 60 Puerto Rican women
- *Attrition (final N)*: 60 Puerto Rican women
- *Age*: 40 years, average age
- *Ethnicity*: More than half of the participants (N=36) reported speaking only Spanish at home
- *Other relevant demographics*:
 - More than half of the participants (N=33) had less than a high school education

- 56% of the participants (N=34) had a monthly income of \$1,000 or less
- The majority (N=51) were unemployed
- Some of the participants (30%) reported receiving benefits from the Housing Assistance Program
- *Location:* Hartford, Connecticut, US.

Summary of Results:

Key Findings

- Participants considering food safety as “very important” were less likely to test positive for *S. aureus* on hands (P<0.05)
- *S. aureus* in chicken and salad during meal preparation and in the kitchen, counters and cutting boards and sink was positively associated with *S. aureus* on participants’ hands at baseline (P<0.05)
- Baseline coliform count on the counter and cutting board and sink was significantly higher when participants' hands tested positive for coliform at baseline
- Coliform count in chicken increased significantly during meal preparation among meal preparers that tested positive but not among those who tested negative for coliform on their hands at baseline.

Association Between Microbial Contamination (*S. aureus* and Coliform) on the Meal Preparers’ Hands and Food and Kitchen Surfaces During the Preparation of “Chicken and Salad” Meal at the Household Level

Variables	Presence of <i>S. aureus</i> on Hands N (%)	Absence of <i>S. aureus</i> on Hands N (%)	P	Presence of Coliform on Hands Log CFU Mean ± SD	Absence of Coliform on Hands Log CFU Mean ± SD	P
Before starting meal preparation						
Refrigerator/freezer handles (N=60)	9 (36)	11 (31)	0.711	N/A	N/A	
Knife (before used to cut chicken) (N=60)	8 (33)	7 (21)	0.305	N/A	N/A	
Counter or cutting boards (N=60) (cutting board: 45; counter: 15)	8 (40)	7 (26)	0.241	1.22±1.27	0.54±1.07	0.053
Sink (N=60)	13 (52)	10 (29)	0.066	1.77±1.30	0.85±1.19	0.007
During or after meal preparation						
Counter or cutting board (N=43)	11 (55)	0	0.007	1.40±1.06	0.68±.96	0.021

Chicken (N=60)	15 (60)	7 (20)	0.002	2.34±1.55	1.89±1.46	0.255
Lettuce and Tomato (N=60)	10 (40)	4 (11)	0.010	2.82±1.23	2.25±1.35	0.109

Other Findings

- Coliform counts were significantly higher among the older (more than 40 years) than the younger (less than 40 years) individuals
- Coliform counts on hands did not differ by language preference or birthplace of participants
- Odds of having *S. aureus* on the hands was four times higher among the income group earning \$1,000 or less per month when compared to the income group earning \$1,001 or more (P<0.05).

Author Conclusion:

Meal preparer's hands can be a vehicle of pathogen transmission during meal preparation.

Reviewer Comments:

Limitations noted by authors:

- *Regarding interview on third visit: Only a single question was used to assess food safety attitude and it could not be tested for reliability, although its association with hard microbiological outcomes suggests it is of value*
- *During the interview, participants were not asked about their understanding of the term "food safety"; thus, the difference in this understanding was not controlled for in the food safety attitude analysis*
- *Social desirability bias: Study involved direct household observation and collection of samples for microbial analysis during meal preparation may have lead participants to practice better food safety behaviors than usual (authors believe this potential bias was attenuated, given extensive exploratory work preceding it and the highly trained, culturally skilled staff that supported the research)*
- *Regarding external validity of the study, Latinas represent a very diverse group and the results from one subgroup (Puerto Ricans) do not necessarily apply to others such as Mexicans and Central and South American Latino groups.*

Research Design and Implementation Criteria Checklist: Primary Research

Relevance Questions

- | | | |
|----|---|------------|
| 1. | Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies) | Yes |
| 2. | Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about? | Yes |

3.	Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice?	Yes
4.	Is the intervention or procedure feasible? (NA for some epidemiological studies)	Yes

Validity Questions

1.	Was the research question clearly stated?	Yes
1.1.	Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified?	Yes
1.2.	Was (were) the outcome(s) [dependent variable(s)] clearly indicated?	Yes
1.3.	Were the target population and setting specified?	Yes
2.	Was the selection of study subjects/patients free from bias?	???
2.1.	Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study?	Yes
2.2.	Were criteria applied equally to all study groups?	Yes
2.3.	Were health, demographics, and other characteristics of subjects described?	No
2.4.	Were the subjects/patients a representative sample of the relevant population?	???
3.	Were study groups comparable?	N/A
3.1.	Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)	N/A
3.2.	Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?	???
3.3.	Were concurrent controls used? (Concurrent preferred over historical controls.)	N/A
3.4.	If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?	???
3.5.	If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)	N/A

3.6.	If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?	N/A
4.	Was method of handling withdrawals described?	N/A
4.1.	Were follow-up methods described and the same for all groups?	N/A
4.2.	Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)	N/A
4.3.	Were all enrolled subjects/patients (in the original sample) accounted for?	N/A
4.4.	Were reasons for withdrawals similar across groups?	N/A
4.5.	If diagnostic test, was decision to perform reference test not dependent on results of test under study?	N/A
5.	Was blinding used to prevent introduction of bias?	No
5.1.	In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?	N/A
5.2.	Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)	N/A
5.3.	In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?	No
5.4.	In case control study, was case definition explicit and case ascertainment not influenced by exposure status?	N/A
5.5.	In diagnostic study, were test results blinded to patient history and other test results?	N/A
6.	Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were intervening factors described?	Yes
6.1.	In RCT or other intervention trial, were protocols described for all regimens studied?	N/A
6.2.	In observational study, were interventions, study settings, and clinicians/provider described?	Yes
6.3.	Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?	Yes
6.4.	Was the amount of exposure and, if relevant, subject/patient compliance measured?	N/A
6.5.	Were co-interventions (e.g., ancillary treatments, other therapies) described?	N/A
6.6.	Were extra or unplanned treatments described?	N/A

6.7.	Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?	N/A
6.8.	In diagnostic study, were details of test administration and replication sufficient?	N/A
7.	Were outcomes clearly defined and the measurements valid and reliable?	Yes
7.1.	Were primary and secondary endpoints described and relevant to the question?	Yes
7.2.	Were nutrition measures appropriate to question and outcomes of concern?	Yes
7.3.	Was the period of follow-up long enough for important outcome(s) to occur?	Yes
7.4.	Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?	Yes
7.5.	Was the measurement of effect at an appropriate level of precision?	Yes
7.6.	Were other factors accounted for (measured) that could affect outcomes?	???
7.7.	Were the measurements conducted consistently across groups?	Yes
8.	Was the statistical analysis appropriate for the study design and type of outcome indicators?	Yes
8.1.	Were statistical analyses adequately described and the results reported appropriately?	Yes
8.2.	Were correct statistical tests used and assumptions of test not violated?	Yes
8.3.	Were statistics reported with levels of significance and/or confidence intervals?	Yes
8.4.	Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?	N/A
8.5.	Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?	Yes
8.6.	Was clinical significance as well as statistical significance reported?	Yes
8.7.	If negative findings, was a power calculation reported to address type 2 error?	N/A
9.	Are conclusions supported by results with biases and limitations taken into consideration?	Yes
9.1.	Is there a discussion of findings?	Yes
9.2.	Are biases and study limitations identified and discussed?	Yes
10.	Is bias due to study's funding or sponsorship unlikely?	Yes

10.1.	Were sources of funding and investigators' affiliations described?	Yes
10.2.	Was the study free from apparent conflict of interest?	Yes