

AIR FORCE HEALTH STUDY

An Epidemiologic Investigation of Health Effects in Air Force Personnel Following Exposure to Herbicides

SAIC Team

William D. Grubbs, Ph.D.
Michael B. Lustik, M.S.
Amy S. Brockman, M.S.
Scott C. Henderson, M.S.
Frank R. Burnett, M.S.
Rebecca G. Land, M.S.
Dawn J. Osborne, M.S.
Vanessa K. Rocconi, B.S.
Margaret E. Schrieber, B.A.
David E. Williams, M.D., SCRF

Project Manager: Manager E.B. Owens, Ph.D.
Statistical Task Manager: W.D. Grubbs
SAIC Editor: Jean M. Ault, B.A.

Air Force Team

Col William H. Wolfe, M.D., M.P.H.
Joel E. Michalek, Ph.D.
Col Judson C. Miner, D.V.M., M.P.H.
Col Gary L. Henriksen, M.D., M.P.H.
Lt Col James A. Swaby, Ph.D., B.C.E.

Program Manager: R.W. Ogershok

SCIENCE APPLICATIONS INTERNATIONAL
1710 Goodridge Drive
McLean, Virginia 22102

in conjunction with:

SCRIPPS CLINIC & RESEARCH FOUNDATION,
LA JOLLA , CALIFORNIA

NATIONAL OPINION RESEARCH CENTER,
CHICAGO, ILLINOIS

EPIDEMIOLOGIC RESEARCH DIVISION
ARMSTRONG LABORATORY
HUMAN SYSTEMS CENTER (AFMC)
BROOKS AIR FORCE BASE, TEXAS 78235

2 May 1995

Volume VI

1992 Followup Examination Results

May 1992 to May 1995

Contract Number F41624-91-C-1006
SAIC Project Number 01-0813-02-3005

(Distribution Unlimited)

AIR FORCE HEALTH STUDY

An Epidemiologic Investigation of Health Effects in Air Force Personnel Following Exposure to Herbicides

May 1995

Volume VI

1995 Followup Examination Results

**Epidemiologic Research Division
Armstrong Laboratory
Human Systems Center (AFMC)
Brooks Air Force Base, Texas 78235**

TABLE OF CONTENTS

VOLUME VI

	Page
CHAPTER 19 IMMUNOLOGIC ASSESSMENT	19-1
INTRODUCTION	19-1
Background	19-1
Summary of Previous Analyses of the Air Force Health Study	19-2
1982 Baseline Study Summary Results	19-2
1985 Followup Study Summary Results	19-3
1987 Followup Study Summary Results	19-3
Serum Dioxin Analysis of 1987 Followup Study Summary Results	19-4
Parameters for the Immunologic Assessment	19-5
Dependent Variables	19-5
Physical Examination Data	19-5
Laboratory Examination Data	19-5
Covariates	19-11
Statistical Methods	19-12
Longitudinal Analyses	19-13
RESULTS	19-21
Dependent Variable-Covariate Associations	19-21
Exposure Analysis	19-23
Physical Examination Variable	19-24
Composite Skin Test Diagnosis	19-24
Laboratory Examination Variables	19-29
CD3 Cells	19-29
CD4 Cells	19-34
CD5 Cells	19-34
CD8 Cells	19-43
CD14 Cells	19-48
CD16+56 Cells	19-48
CD20 Cells	19-57
CD25 Cells	19-62
CD4-CD8 Ratio	19-62
Double-Labelled Cells: CD3 with CD25	19-71
Double-Labelled Cells: CD5 with CD20 Cells	19-76
Double-Labelled Cells: CD4 with CD8 Cells	19-85
Double-Labelled Cells: CD3 with CD16+56 Cells	19-85
Total Lymphocyte Count	19-103
IgA	19-103
IgG	19-112
IgM	19-117
Lupus Panel: Antinuclear Antibody (ANA)	19-122
Lupus Panel: Thyroid Microsomal Antibody	19-122
Lupus Panel: MSK Smooth Muscle Antibody	19-131
Lupus Panel: MSK Mitochondrial Antibody	19-136

TABLE OF CONTENTS (Continued)

	Page
Lupus Panel: MSK Parietal Antibody	19-136
Lupus Panel: Rheumatoid Factor	19-145
Lupus Panel: B Cell Clones Detected by Serum Protein Electrophoresis	19-150
Lupus Panel: Other Antibodies (ANA and MSK)	19-150
Lupus Panel: Summary Index	19-159
Longitudinal Analysis	19-159
CD4-CD8 Ratio	19-159
DISCUSSION	19-167
SUMMARY	19-170
Model 1: Group Analyses	19-170
Model 2: Initial Dioxin Analyses	19-187
Model 3: Categorized Dioxin Analyses	19-187
Model 4, 5, and 6: Current Dioxin Analyses	19-188
CONCLUSION	19-188
REFERENCES	19-190

LIST OF TABLES

	Page
Table 19-1. Medical Significance of the Immunologic Data	19-6
Table 19-2. Statistical analyses for the Immunologic Assessment	19-14
Table 19-3. Number of Participants with Missing data for, or Excluded from, the Immunologic Assessment	19-18
Table 19-4. Analysis of Composite Skin Test Diagnosis	19-25
Table 19-5. Analysis of CD3 Cells (cells/mm ³)	19-30
Table 19-6. Analysis of CD4 Cells (cells/mm ³)	19-35
Table 19-7. Analysis of CD5 Cells (cells/mm ³)	19-39
Table 19-8. Analysis of CD8 Cells (cells/mm ³)	19-44
Table 19-9. Analysis of CD14 Cells (cells/mm ³)	19-49
Table 19-10. Analysis of CD16 + 56 Cells (cells/mm ³)	19-53
Table 19-11. Analysis of CD20 Cells (cells/mm ³)	19-58
Table 19-12. Analysis of CD25 Cells (cells/mm ³)	19-63
Table 19-13. Analysis of CD4-CD8 Ratio	19-67
Table 19-14. Analysis of Double Labelled Cells: CD3 with CD25 (cells/mm ³) . .	19-72
Table 19-15. Analysis of Double Labelled Cells: CD5 with CD20	19-77
Table 19-16. Analysis of Double Labelled Cells: CD4 with CD8	19-86
Table 19-17. Analysis of Double Labelled Cells: CD3 with CD16+56	19-94
Table 19-18. Analysis of TLC (cells/mm ³)	19-104
Table 19-19. Analysis of IgA (mg/dl)	19-108
Table 19-20. Analysis of IgG (mg/dl)	19-113
Table 19-21. Analysis of IgM (mg/dl)	19-118
Table 19-22. Analysis of Lupus Panel: Antinuclear Antibody (ANA)	19-123
Table 19-23. Analysis of Lupus Panel: Thyroid Microsomal Antibody	19-127
Table 19-24. Analysis of Lupus Panel: Msk smooth Muscle Antibody	19-132
Table 19-25. Analysis of MSK Mitochondrial Antibody	19-137
Table 19-26. Analysis of Lupus Panel: MSK Parietal Antibody	19-141
Table 19-27. Analysis of Lupus Panel: Rheumatoid Factor	19-146
Table 19-28. Analysis of Lupus Panel: B Cell Clones Detected by Serum Protein Electrophoresis	19-151
Table 19-29. Analysis of Lupus Panel: Other Antibodies (ANA and MSK)	19-155
Table 19-30. Analysis of Lupus Panel: Summary Index	19-160
Table 19-31. Longitudinal Analysis of CD4-CD8 Ratio	19-164
Table 19-32. Summary of Group Analyses (Model 1) for Immunology Variables (Ranch Hands vs Comparisons)	19-171
Table 19-33. Summary of Initial Dioxin Analyses (Model 2) for Immunology Variables (Ranch Hands Only)	19-175
Table 19-34. Summary of Categorized dioxin Analyses (Model 3) for Immunology Variables (Ranch Hands vs Comparisons)	19-177
Table 19-35. Summary of Current Dioxin Analyses (Model 4, 5, and 6) for Immunology Variables (Ranch Hands Only)	19-181
Table 19-36. Summary of Group-by-Covariate and Dioxin-by-Covariate Interactions from Adjusted Analyses of Immunology Variables	19-185

TABLE OF CONTENTS

	Page
CHAPTER 20 PULMONARY ASSESSMENT	20-1
INTRODUCTION	20-1
Background	20-1
Summary of Previous Analyses of the Air Force Health Study	20-2
1982 Baseline Study Summary Results	20-2
1985 Followup Study summary Results	20-2
1987 Followup Study Summary Results	20-3
Serum Dioxin Analysis of 1987 Followup Study Summary Results	20-3
Parameters for the Pulmonary Assessment	20-4
Dependent Variables	20-4
Medical Records Data	20-4
Physical Examination Data	20-4
Laboratory Examination Data	20-4
Covariates	20-5
Statistical Methods	20-6
Longitudinal Analysis	20-6
RESULTS	20-10
Dependent Variable-Covariate Associations	20-10
Exposure Analysis	20-12
Verified Medical Records Variables	20-13
Asthma	20-13
Bronchitis	20-18
Pneumonia	20-18
Physical Examination Variable	20-27
Thorax and Lung Abnormalities	20-27
Laboratory Examination Variables	20-32
X-ray Interpretation	20-32
FVC	20-37
FEV ₁	20-42
Ratio of Observed FEV ₁ to Observed FVC	20-42
Loss of Vital capacity	20-47
Obstructive Abnormality	20-57
Longitudinal Analysis	20-63
Laboratory Examination Variable	20-64
Ratio of Observed FEV ₁ to Observed FVC	20-64
DISCUSSION	20-64
SUMMARY	20-69
Model 1: Group Analysis	20-69
Model 2: Initial Dioxin Analysis	20-78
Model 3: Categorized Dioxin Analysis	20-78
Model 4, 5, and 6: Current Dioxin Analyses	20-78

TABLE OF CONTENTS (Continued)

	Page
CONCLUSION	20-79
REFERENCES	20-80

LIST OF TABLES

	Page
Table 20-1. Statistical Analyses for the Pulmonary assessment	20-7
Table 20-2. Number of Participants with Missing Data for, or Excluded from, the Pulmonary Assessment	20-9
Table 20-3. Analysis of Asthma	20-14
Table 20-4. Analysis of Bronchitis	20-19
Table 20-5. Analysis of Pneumonia	20-23
Table 20-6. Analysis of Thorax and Lung Abnormalities	20-28
Table 20-7. Analysis of X-ray Interpretation	20-33
Table 20-8. Analysis of FVC (Percent of Predicted)	20-38
Table 20-9. Analysis of FEV ₁ (Percent of Predicted)	20-43
Table 20-10. Analysis of Ratio of Observed FEV ₁ to Observed FVC	20-48
Table 20-11. Analysis of Loss of Vital Capacity	20-52
Table 20-12. Analysis of Obstructive Abnormality	20-58
Table 20-13. Longitudinal Analysis of Ratio of Observed FEV ₁ to Observed FVC .	20-65
Table 20-14. Summary of Group Analyses (Model 1) for Pulmonary Variables (Ranch Hands vs Comparisons)	20-70
Table 20-15. Summary of Initial dioxin Analyses (Model 2) for Pulmonary Variables (Ranch Hands vs Comparisons)	20-72
Table 20-16. Summary of Categorized Dioxin Analyses (Model 3) for Pulmonary Variables (Ranch Hands vs Comparisons)	20-73
Table 20-17. Summary of Current dioxin Analyses (Models r, t, and 6) for Pulmonary Variables (Ranch Hands Only)	20-75
Table 20-18. Summary of Group-by-Covariate and Dioxin-by-Covariate Interactions from Adjusted Analyses of Pulmonary Variables	20-77

TABLE OF CONTENTS

	Page
CHAPTER 21 CONCLUSIONS	21-1
INTRODUCTION	21-1
STUDY PERFORMANCE ASPECTS	21-1
POPULATION CHARACTERISTICS	21-1
STATISTICAL MODELS	21-2
CLINICAL RESULTS	21-3
General Health Assessment	21-3
Neoplasia Assessment	21-4
Neurological Assessment	21-5
Psychological Assessment	21-5
Gastrointestinal Assessment	21-6
Dermatology Assessment	21-7
Cardiovascular Assessment	21-8
Hematologic Assessment	21-9
Renal Assessment	21-9
Endocrine Assessment	21-10
Immunologic Assessment	21-11
Pulmonary Assessment	21-12
INTERPRETIVE CONSIDERATIONS	21-13
SUMMARY	21-14
Glucose Intolerance	21-14
Cardiovascular Mortality	21-14
Serum Lipid Abnormality	21-14
Liver Enzymes	21-15
Increase in IgA	21-15
Decrease in Serum Testosterone	21-15
Decrease in MSK and Lupus Panel Positives	21-15
No Significant Difference in Incidence or Prevalence of Neoplastic Disease	21-15
CHAPTER 22 FUTURE DIRECTIONS	22-1

TABLE OF CONTENTS - REPORT

VOLUME I	EXECUTIVE SUMMARY ACKNOWLEDGEMENTS CHAPTER 1 - Introduction CHAPTER 2 - The Dioxin Assay CHAPTER 3 - Questionnaire Methodology CHAPTER 4 - Physical examination Methodology CHAPTER 5 - Study Selection and Participation CHAPTER 6 - Quality Control CHAPTER 7 - Statistical Methods CHAPTER 8 - Covariate Associations with Estimates of Dioxin Exposure CHAPTER 9 - General Health Assessment
VOLUME II	CHAPTER 10 - Neoplasia Assessment CHAPTER 11 - Neurological Assessment
VOLUME III	CHAPTER 12 - Psychological Assessment CHAPTER 13 - Gastrointestinal Assessment
VOLUME IV	CHAPTER 14 - Dermatologic Assessment CHAPTER 15 - Cardiovascular Assessment CHAPTER 16 - Hematologic Assessment
VOLUME V	CHAPTER 17 - Renal Assessment CHAPTER 18 - Endocrine Assessment
VOLUME VI	CHAPTER 19 - Immunologic Assessment CHAPTER 20 - Pulmonary Assessment CHAPTER 21 - Conclusions CHAPTER 22 - Future Directions
VOLUME VI	APPENDIX A - 1 through F-2
VOLUME VII	APPENDIX G - 1 through I-4
VOLUME IX	APPENDIX J - 1 through N-4
VOLUME X	APPENDIX O - 1 through R