CONTRACT NO. A733-149
FINAL REPORT
SEPTEMBER 1991

Study of Children's Activity Patterns

GT
2450
W55
1991

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

AIR RESOURCES BOARD
Research Division

STATE OF CALIFORNIA

PETE WILSON, Governor

AIR RESOURCES BOARD
1102 Q STREET
P.O. BOX 2815
SACRAMENTO, CA 95812

(916) 322-7145
(916) 322-4357 (FAX)

To: Interested Parties

Re: Final Report for Study of Children's Activity Patterns

This final report presents the methodology and summary results of the first statewide survey of the activity patterns of children. Because of increasing concern regarding exposures to pollutants in indoor locations and other microenvironments, the Air Resources Board funded this study to determine the time California's children spend in different microenvironments and their proximity to potential pollutant sources. The results of this study, together with data from a companion study of activity patterns of adults and adolescents in California, will be used to significantly improve the accuracy of exposure estimates which are used in health risk assessments. Thus, this study provides a very useful and unique data set for California.

In reading this report, some important caveats should be kept in mind:

- Because the report was written from a sociological perspective, the conclusions and recommendations regarding exposures or health risks may not reflect current thinking in the field of environmental health.

- The objective of this study was to obtain representative data and conduct certain basic comparisons. Consequently, extensive statistical analysis was beyond the scope of this report.

- The sample is representative of the statewide California population; however, the representativeness of subgroups within the statewide sample has not been fully assessed. Thus, the extrapolation of the data for specific population subgroups may be inappropriate.

- The survey questions were very carefully worded, sequenced, and pretested to obtain unambiguous data. Thus, the interpretation of the data should include careful examination of the specific wording and context of the pertinent questions.

The data also are available on tape or floppy disk. We encourage other researchers, risk assessors, and risk managers to use the data from this survey to improve our understanding of when, where, and how people are exposed to air pollution.

Sincerely,

T. J. Phillips

Thomas J. Phillips
Indoor Exposure Assessment Section
Research Division

STUDY OF CHILDREN'S ACTIVITY PATTERNS

Final Report
Contract No. A733-149

Prepared for:

Research Division
California Air Resources Board
2020 L Street
Sacramento, CA 95814

Submitted by:

Survey Research Center
University of California, Berkeley

Prepared by:

James A. Wiley
Principal Investigator

John P. Robinson
Yu-Teh Cheng
Tom Piazza
Linda Stork
Karen Pladsen
Research Staff

SEPTEMBER 1991

ACKNOWLEDGMENTS

The results of the present survey depended on the talents and energy of many individuals and groups. Contract personnel at the California Air Resources Board, particularly Peggy Jenkins and Tom Phillips, provided needed project guidance, advice and support. The members of our Scientific Advisory Panel (named in Appendix C) provided expert and timely advice on the content areas we needed to examine and helpful comments on drafts of this report.

At the Survey Research Center, Linda Stork and Karen Garrett acted as the key liaisons between the Air Resources Board and the day-to-day administration and control of the data collection. Dr. Thomas Piazza was responsible for designing and implementing the sampling plan. Yu-Teh Cheng and Karen Pladsen played crucial roles in coding the diary data and producing data files for the diary and interview responses.

This report was submitted in fulfillment of Contract # A733-149, Study of Children's Activity Patterns, conducted by the Survey Research Center, University of California, Berkeley, under sponsorship of the California Air Resources Board. Work was completed as of September 13, 1991.

DISCLAIMER

The statements and conclusions in this report are those of the contractor and not necessarily those of the California Resources Board. The mention of commercial products, their source or their use in connection with material reported herein is not to be construed as either an actual or implied endorsement of such products.

ABSTRACT

This report describes the purposes, methods, and preliminary findings of the first large-scale survey of children's activity patterns done in the United States. The survey was commissioned by the California Air Resources Board (ARB) in 1988 and was conducted by the staff of the Survey Research Center, University of California, Berkeley, during the period April 1989 through February 1990. A sample of 1,200 California children aged 11 and under (and adult informants living in the child's household) was selected by random-digit-dialing methods and interviewed by phone to determine potential exposure to selected sources of air pollution and to ascertain (via a time diary) the children's activities and locations during a 24-hour period. Time spent in various locations and activities and proportions potentially exposed to air pollutants are reported by child's age (0-2 years, 3-5 years, 6-8 years, and 9-11 years), child's gender, season of interview, and region of residence (Southern Coast, San Francisco Bay Area, and "Rest of State"). Comparisons between the ARB Children's Activity Survey and the earlier ARB Adult Activity Survey are also provided.

TABLE OF CONTENTS

Page

Acknowledgments i
Disclaimer i
Abstract ii
Table of Contents iii
List of Tables and Figures v
Summary and Conclusions vi
Recommendations x

Chapter I: Background and Purpose 1
1. Statement of the Problem 1
a. Activity Patterns and Potential Exposure to Air Pollutants 1
b. Importance of Activity Patterns of Younger Children 3
c. Limitations of Existing Data on the Daily Activities of Young Children 4
2. Objectives of the Children's Survey 5
3. The Precedent for Time-Diary Surveys 6
a. Studies of Adult Populations 6
b. Studies of Children 9

Chapter II: Methods of Sampling and Data Collection 12
1. Synopsis of the Research Design 12
2. A Small-Scale Pilot Study 13
3. Sample Design for the California Children's Activity Pattern Survey 16
a. The Target Population 16
b. Selection Procedures 17
4. Design of the Questionnaire 19
a. Questionnaire Coverage and Flow of Interview 19
b. Diary Procedures and Coding of Activities and Locations 21
c. Implementation of the Questionnaire as a CATI Instrument 26
5. Overview of Training and Supervision 28
6. Field Results 30
a. Response Rates for Households and Eligible Children 30
b. Outcomes for Children Selected as Subjects for the Survey 30
c. Characteristics of Persons Who Provided Interview and Diary Information 32
d. Interview Assessments of Diary Validity 33
7. Comparison of Survey Estimates with 1988 Current Population Survey Data and School Enrollment Figures 34

Chapter III: Methods of Data Analysis 37
1. Measurement of the Dependent Variables 37
a. Times Spent in Various Activities and Locations on the Diary Day 37
b. Measures of Time Spent in Proximity of Potential Pollution Sources on the Diary Day 38
c. Potential Exposure to Specific Sources of Air Pollution on the Diary Day 39

TABLE OF CONTENTS (Continued)

Chapter III: Methods of Data Analysis (Continued)
2. Selection and Definition of the Independent Variables 40
a. Season and Region 40
b. Characteristics of the Randomly-Selected Child 40
3. Methods of Data Analysis 41
a. Organization of the Data Tables 41
b. Statistical Tests 42
4. Use of Sampling Weights 43

Chapter IV: Major Findings 44
1. Time Spent in Different Activities 44
a. Age-Gender Differences 46
b. Season and Region Differences 47
2. Time Spent in Different Locations 49
a. Age-Gender Differences 50
b. Season and Region Differences 51
3. Indoor vs. Outdoor Location Time 52
a. Gender-Age Differences 52
b. Season-Region Differences 53
4. Time Spent in Potential Exposure Situations 54
a. Gender-Age Differences 54
b. Season and Region Differences 55
5. Proportion in Proximity to Potential Pollution Sources 55
a. Gender-Age Differences 56
b. Season and Region Differences 56
6. Comparison with Estimates Derived for Other Time-Diary Surveys . . . 57
a. Comparisons with the ARB Adult Survey 57
b. Comparisons with 1981 National Survey 65

Chapter V: Conclusions 70
1. Summary of Principal Findings 70
a. Field Results 70
b. Findings with Respect to Time Spent in Various Activities and Locations 71
c. Findings with Respect to Potential Exposures to Sources of Air Pollution 72
d. Findings with Respect to Comparisons with Other Surveys 73
2. Directions for Future Research 74
a. Characterization of Time Spent in Different Micro-environments 75
b. Analysis of the Relation Between Potential Exposures and Selected Independent Variables 77
c. "Internal" Comparisons Relevant to the Reliability and Validity of Survey Responses 78

References 81

Appendices
A. Coding Scheme for Diary Activities for the California Children's Activity Survey
B. Main Body of CATI Instrument Used for the California Children's Activity Survey
C. Scientific Advisory Panel for the California Children's Activity Survey
D. Sampling Report for the California Children's Activity Survey

LIST OF TABLES AND FIGURES

Table or Figures (F)	Title	Page
2.1	Distribution of Sample by Region	16
2.2	Distribution of Completed Interviews by Quarter of Calendar Year	16
F2.1	Flow of Interview	20a
2.3	Activity Codes for the California Children's Activity Survey	26a,26b
2.4	Location Codes for the California Children's Activity Survey	26c
2.5	Outcome for Households	31
2.6	Outcomes for Children Selected	32
2.7	Comparison Between the California Children's Activity Pattern Survey and the 1988 Current Population Survey: Selected Socioeconomic Characteristics	34a
2.8	Comparison Between the California Children's Activity Pattern Survey and School Enrollment Figures for California: Children in Grades K Through 6	35a
4.1	Time Spent in Major Categories of Activity	44a
4.2	Average Number of Minutes Spent in Ten Activity Categories by Child's Age and Gender	46a
4.3	Average Number of Minutes Spent in Ten Activity Categories by Season and by Region	47a
4.4	Time Spent in Major Location Categories	49a
4.5	Average Number of Minutes Spent on Six Locations by Age and Gender	50a
4.6	Average Number of Minutes Spent in Six Locations by Season and Region	51a
4.7	Average Number of Minutes Indoors, Outdoors, in Enclosed Transit and in Outdoor Transit by Age and Gender of Child	52a
4.8	Average Number of Minutes Indoors, Outdoors, in Enclosed Transit and in Outdoor Transit by Season and Region	53a
4.9	Average Potential Exposure Times in Minutes on Diary Day by Age and Gender	54a
4.10	Average Potential Exposure Times in Minutes on Diary Day by Season and Region	55a
4.11	Proportion of Children Potentially Exposed to Selected Air Pollution Sources on Diary Day by Gender and Age	55b
4.12	Percentage of Children Potentially Exposed to Selected Air Pollution Sources on Diary Day by Season and Region	56a
4.13	Activity Differences Between ARB Adult and ARB Child Studies	60a
4.14	Average Minutes Spent in Different Locations	62a
4.15	Comparisons of ARB Children's Data with Those From 1980-81 University of Michigan National Study of Time Use	66a

SUMMARY AND CONCLUSIONS

The California Children's Activity Pattern Survey was designed to provide statistically representative estimates of time children under 12 years of age spend in various activities and locations (micro-environments) on a typical day. The focus of this survey was on activities and locations likely to result in significant exposure to harmful air pollutants.

The target population consisted of children under 12 years old living in English-speaking households containing a telephone. The sample was drawn using Waksberg random-digit-dialing methods and was stratified to provide representative estimates for major regions of the state. Interviews were distributed over the four seasons (from April, 1989 through February, 1990) to take into account seasonal variations in activity and location patterns. The survey questionnaire included questions about potential exposure to selected sources of air pollution on the diary day, a complete inventory of children's activities and locations on the diary day, and a brief series of items pertaining to the characteristics of the selected child, the household, and an adult in the household who served as an informant about the child's activities. The questionnaire, including the diary component, was implemented using a computer-assisted

telephone interviewing (CATI) technology. A total of 1,200 eligible respondents were interviewed, representing an overall response rate of 77.9%.

One of the most important findings was that surveys such as the California Children's Activity Pattern Survey are clearly feasible and can provide data of acceptable quality. The response rate for this survey was considerably higher than the 70% standard normally used in the survey field. In general, the survey respondents found the interview experience enjoyable and had little difficulty in answering the questions. The uncodable and "don't know" responses on the diary accounted for an average of only 2 minutes per diary day for the activity responses and only 1 minute per diary day for the location responses. In the vast majority of cases, we were able to interview the adult in the household who had spent the most time with the selected child on the diary day, and furthermore, most of these adults (58%) had spent at least 8 hours with the child on the diary day. The interviewing staff rated their confidence in the diary responses as reasonably confident or better in all but a small number of instances.

The survey results indicate that the children spent an average of about 85% of their time indoors, especially at home, and that there are large individual differences. There were pronounced differences in activity and location

patterns between age groups. Age differences in average times spent (in minutes per diary day) were observed for eight of ten major activity categories and for five of seven major location categories. Time spent indoors decreased systematically with age, suggesting that air pollution in indoor microenvironments may be a particularly relevant concern for infants. Differences in location and activity patterns for boys and girls tended to be small.

Seasonal differences were found for five of ten activities and four of seven major locations. In general, these differences were of the form Summer vs. other seasons. As expected, children's outdoor time was highest in the Summer months. In contrast, there were few regional differences in time spent in the major activities and locations.

Average diary-day potential exposure times for environmental tobacco smoke, gasoline fumes, and gas oven fumes showed no sizable differences by gender or age. However, in comparisons between potentially exposed and unexposed children, the percentage exposed to tobacco smoke and aerosols were somewhat higher for girls. Furthermore, there were age differences in favor of higher potential exposure rates for older children with respect to glue, pesticides, household cleaning agents, and aerosols. Region was generally not related to potential exposure prevalence (except for higher rates of potential exposure to aerosols

among girls living in the Southern Coast). Rates of potential exposure to gasoline fumes were elevated in the Summer months. Rates of potential exposure to gas oven fumes were elevated in the Winter and Fall months.

RECOMMENDATIONS

1. Characterization of Time Spent in Different Micro-environments

The California Children's Activity Survey was designed to provide estimates of time spent in a large number of microenvironments and of potential exposure to sources of air pollution found in such environments. Our preliminary analysis focused on broad classes of activities and locations, aggregating over 115 uniquely coded activities and 62 locations to produce 10 activity categories, 6 location categories, and 4 indicators of time spent indoors and outdoors. The same kind of analysis can be conducted for much more detailed activities and locations, or for different ways of combining activities and locations to create aggregate measures. The choice of level of detail and of roles for combining activities and locations depends on the purpose to be served. Since the data are given in detailed (i.e., disaggregated form) on the data tape supplied to the Air Resources Board, this choice can be made by the final user.

There are at least two principles that can be used to guide the construction of aggregate activity and location measures: (1) a priori rules for grouping detailed activities and locations that combine those with similar potential for exposures to particular sources of air pollution (e.g., time traveling in gasoline-powered

vehicles), and (2) combinations derived from the associations between activities and locations -- that is, grouping activities and locations that "cluster" in the diary day. The latter procedure is essentially one of defining an empirical rule for grouping activities and locations based on the correlations between them in the sampled population. Such a rule can be derived from application of cluster analysis algorithms available in most mainframe statistical software packages (e.g., SPSS and SAS). Actually, these procedures can be done in tandem, first defining groups of activities and locations on an a priori basis, then using cluster analysis to find additional groupings within broadly defined classes of activities and locations.

2. Multivariate Analysis

The findings presented in Chapter IV of this report indicate that there are significant differences among various subpopulations of California children with respect to time spent indoors and outdoors and in particular microenvironments, time exposed to environmental tobacco smoke and gas oven fumes, and prevalence of potential exposure to common sources of air pollution. Our analysis can be extended by incorporating additional independent variables (e.g., family size, urban vs. rural location, household income, employment status of the adult informant) in a multivariate analysis. For example, it would be of

interest to provide a sociodemographic "profile" of the population subgroups most commonly exposed to each potential source of air pollution covered by the survey. This can be done, via ordinary regression analysis and/or logistic regression, by noting which groups (e.g., younger children vs. older children, girls vs. boys, urban vs. rural, high income vs. low income, etc.) appear to have elevated exposures as judged by the pattern of values of the regression coefficients for each of the subgroups. Our preliminary experiments with the use of multivariate analysis of potential exposure times (for environmental tobacco smoke and gas oven fumes) suggest that care should be taken in applying regression techniques due to the skewed nature of the distributions. It is necessary to make allowance for the large number of zero potential exposure times by conducting separate analyses of a) the prevalence of potential exposure (potentially exposed vs. unexposed, using logistic regression methods) in the total sample and b) potential exposure times in the subsample of children with non-zero exposure times. In addition, it may be advisable to experiment with transformations of raw data before applying multivariate techniques.

3. Comparisons Between Children and Adults

We recommend detailed and systematic comparisons be made between data from the California Children's Activity Pattern

Survey and data from the earlier survey of Activity Patterns of California Residents, which targeted the activity patterns of adults and adolescents age 12 to 17 years.

Although there are some differences between the surveys with respect to activity and location coding conventions, it is possible to construct comparable estimates of time use for a broad spectrum of activities and microenvironments. A careful combination of the findings from both surveys should provide a relatively complete portrait of activity and location patterns of California residents for the period 1987-1990 and of the extent to which these patterns are differentiated by age.

4. "Internal" Comparisons Relevant to the Reliability and Validity of Survey Responses

Like all survey responses, answers to questions about children's activity patterns are subject to a variety of errors: for example, omissions due to forgetfulness or lack of information, deliberate distortion in order to make the reporting task easier or to avoid "socially undesirable" responses, etc. Verification of such reports against an external standard is at best very expensive and at worst not feasible at all. Thus it is desirable to include in the survey instrument itself some items that allow for an assessment of data quality.

The California children's Activity Survey included a few items that may be useful in identifying bias in reports about children's activities on the diary day. These were a) the amount of time the adult informant spent with the selected child on the diary day, and b) an interviewer assessment of "confidence" in the diary responses. Although, as we have noted above, interviewers were generally confident in the diary responses and most adult informers had first-hand knowledge of the child's activities on the diary day, it would be useful to explore the relation between these indicators and i) the number of activities and locations reported and ii) the number of minutes unaccounted for in the diary reports. A reasonable a priori hypothesis is that adults who spent more time with the child also reported more activities, more potential exposures, and fewer unaccounted minutes. Such a finding would suggest that underreporting is most acute when the adult informant has the least first-hand information about the child's activities.

If preliminary analysis suggests that underreporting is likely in some cases, it may be worth examining the relationship between the adult informant's time spent with the child and such variables as potential exposures on the diary day and time spent in specific locations and activities. In addition, time spent with the child on the diary day can be routinely included as an independent

variable in multivariate studies of selected dependent variables (such as potential exposure times and potentially exposed/not exposed). The predictive power of "time spent with child" would give a rough measure of the importance of its effect on underreporting, controlling on other independent variables (e.g., gender, age, race/ethnicity, etc.).

5. Simplified Coding Procedures

We recommend that careful consideration be given to the possibility of simplifying and/or refining the coding conventions used to categorize activities and locations reported in the diary part of the interview. Collecting and coding the diary reports accounted for a major part of the expense of the Children's Survey. A simpler coding scheme, which takes advantage of the experience gained in the Adult and Children's surveys and which allows characterization of time spent in the microenvironments most relevant to the study of potential exposures to air pollution, would reduce the cost of such surveys by a substantial margin. Development of **standard coding conventions** for diary-based surveys should be a high priority.

Chapter I: Background and Purpose

1. Statement of the Problem

a. Activity Patterns and Potential Exposure to Air Pollutants

As discussed in the Request for Proposals (ARB, 1988), personal exposure to air pollutants in various locations (microenvironments) has become a key question in performing realistic health risk assessments. A significant uncertainty in risk assessments is the actual dose of pollutants that people receive in their daily lives. Lack of adequate exposure data is frequently the major limiting factor in accurate evaluation of carcinogenic risks for humans. Human activity patterns, or time-activity patterns, have important implications for health risk assessment because they help determine dose by determining both the exposure duratión, the lung ventilation rate, and sometimes even exposure concentration when the person's activity increases or dilutes pollutants in the surrounding air. Consequently, the National Academy of Science has recommended that, for human exposure assessment, high priority be given to research on time-activity patterns (Sexton and Ryan, 1987).

Most human activity data come from sociological or transportation studies done on a national or international scale. The most comprehensive study (Szalai, 1972) found that human activity patterns mainly depend on social roles (which reflect age, sex, family status, etc.), time of day and week, national differences, and to a lesser extent climatic differences. This finding suggests that California's population may experience activity patterns different than those in other states due to differences in lifestyle, socioeconomic factors, and climate. More importantly, available human activity studies do not specifically address microenvironments, activities, and frequency distributions relevant to personal exposure and necessary for performing risk assessments (Ott, 1982).

To permit inferences about California's population for use in air pollution exposure assessments, the California Air Resources Board (ARB) issued a contract for a statistically representative survey of Californians' activity patterns (ARB, 1987). However, due to cost limitations, this study focussed on the activity patterns of adults and children 12 to 17 years of age. No data pertaining to younger children were collected in this survey.

b. Importance of Activity Patterns of Younger Children

Exposure of younger children to air pollution is very important for several reasons. Childhood exposures may have irreversible effects on growth and development, and young children are inherently more sensitive than adults to many toxic substances. Children have higher breathing rates, and hence higher potential inhalation exposure than adults. Also, childhood can represent a significant proportion of total lifetime exposure (EPA, 1986) and is therefore important in determining lifetime risk estimates for carcinogens.

In fact, several ambient (outdoor) air quality standards developed by the Air Resources Board and by the U. S. Environmental Protection Agency are partly based on protecting the health of children due to their sensitivity. In addition, several indoor pollutants have already been associated with increased health risks in children. These indoor pollutants include environmental tobacco smoke (NRC, 1986), benzene (Sandler et al., 1985; Stjernfeldt et al., 1986), formaldehyde (Helwig, 1977; Burdach and Wechselberg, 1980), and lead (EPA, 1986).

Various activities or behavioral characteristics of children may increase their potential exposure or dose. Enhanced exposure of children relative to adults can occur if

pollutants are emitted close to the ground, have a high density (IPCS, 1986), or are incorporated in house dust or soil (EPA, 1986). Increased amounts of physical activity (and therefore, ventilation rate) as a result of time spent in play and sports can increase pollutant dose. Children at play also have increased proximity and skin contact with contaminants in house dust and soil. Lack of mobility for infants may increase the potential for exposure to pollutants generated by the care provider's activities, e.g., cigarette smoking, cooking, etc.. Children also exhibit increased hand-to-mouth contact and pica, i.e., the ingestion of non-food substances (EPA, 1986). Thus, characterization of children's activity patterns is very important for estimating children's exposures or doses to pollutants.

c. Limitations of Existing Data on the Daily Activities of Young Children

No studies of children's activity patterns of children which are representative of the California or U.S. populations have been performed. In addition, existing studies of children's activity patterns suffer from the same problems as many studies of adults: inappropriate classification of activity and location, inappropriate data reporting, and limited relevance to California's population.

Personal exposure studies of children, which are sometimes part of epidemiological studies, often include studies of children's activity patterns. However, existing personal exposure studies only examined certain age groups, small sample sizes, few microenvironments, or few exposure-related activities, and have usually been performed in climates and cultures dissimilar to those of California. Therefore, the existing personal exposure studies have only limited relevance or representativeness for children's activity patterns in California.

2. Objectives of the Children's Survey

To provide basic information on the daily activities of young California children, the California Air Resources Board issued a contract to the Survey Research Center at the University of California, Berkeley, to conduct a survey of the daily activities and locations of a representative sample of Califórnia children of ages eleven years or less. The principal objectives of the survey are:

1. To determine the proportionate amount of time per day spent as a whole in general locations, including indoor (home, school, other's homes), outdoor, and in-transit microenvironments;
2. To determine the proportion of time spent in specific indoor and outdoor locations (e.g., living room, workplace) and activities (e.g., active sports,

hobbies), by California's children in general, and by their demographic and socioeconomic subgroups;

3. To the extent possible, determine the time spent in various indoor and outdoor locations and activities by children in major geographic regions of the state through representative sampling in each region.

3. The Precedent for Time-Diary Surveys

a. Studies of Adult Populations

The California Children's Activity Pattern Survey implements a relatively new methodology for studying the potential exposure of individuals to harmful pollutants. However, the core element of this methodology -- the collection of time-diary information in the context of probability-based surveys -- has been employed in several earlier representative surveys.

Prior to the 1987-88 ARB-sponsored adult study, five national time-diary studies had been conducted using this general approach:

* Mutual Broadcasting Corporation (1954) study, in which more than 8000 American aged 15-59 kept time diaries for a two-day period (De Grazia, 1962).

* Survey Research Center, University of Michigan (1965) study, in which 1244 adult respondents aged 18-64 kept a single-day diary of activities (Robinson, 1977).

* Survey Research Center, University of Michigan (1975) study, in which 1519 adult respondents aged 18 and over kept diaries for a single day in the Fall of that year, along with 788 of their spouses (Juster and Stafford, 1985).

* Survey Research Center, University of Maryland (1985) study, in which single-day diaries were collected from more than 5000 respondents aged 12 and over across the entire calendar year of 1985. This study used a combination of mailback questionnaires (N=3354), telephone interviews (N=1210) and personal interviews (N=807) (Robinson and Holland, 1988).

* Survey Research Center, University of Maryland (1987) study, which was the first study to make the full transition to the telephone mode of data collection. Some 500 adult respondents were interviewed about their activities on the day before the interview (Robinson, 1990).

Time-diary estimates from these studies thus far have been found to produce rather reliable and replicable results at the aggregate level. For example, Robinson (1977) found a 0.95 correlation between time-use patterns found in the 1965-66 national time diaries (n=1244) and the aggregate figures for the single site of Jackson, Michigan (n=788). Similar high correspondence was found for the American data and for time-diary data from Canada, both in 1971 and in 1982 (Harvey and Elliot 1983). A correlation of 0.85 was found between time expenditure patterns in the U.S.-Jackson time study using the "day after" approach and the "day before" approach (Robinson 1977). In a smaller replication study in Jackson, an aggregate correlation of 0.88 was obtained (Robinson 1977).

Several studies bear more directly on the validity of the time diary, in the sense of there being an independent source or quasi-observer of reported behavior. In Bechtel, Achepohl and Akers' (1972) small scale study, the TV viewing behavior of a sample of 20 households was monitored over a week's time by means of a video camera mounted on top of the family's set that recorded all behavior in front of the TV screen. As in the earlier camera monitoring of TV audiences by Allen (1968), rating-service methods produced estimates of TV viewing that were 20 to 50 percent higher than primary or secondary activities that respondents reported in a full time diary.

Three more general validity studies subsequent to Bechtel et al. provided further evidence bearing on the validity of time-diary data. Robinson (1985) found a 0.81 correlation between activity durations from beepers that respondents kept and those from time diaries covering the same period (across the non-sleep periods of the day). Among a national telephone sample of 249 respondents, (Robinson 1985) found an overall correlation of 0.81 between activities reported in "random hours" and in time diary entries for those same random hours. Juster (1985) found the "with whom" reports in the 1975-76 University of Michigan diaries of respondents agreed with those of their spouses in more than 80% of the diary entries; in a separate analysis of these 1975 data, Hill (1985) found a 0.93 correlation between time spent on

various home energy-related activities and aggregate time-of-day patterns of energy use derived from utility meters.

In addition, diary results on time spent on activities from the 1987-88 ARB study (Wiley and Robinson, 1991) matched rather closely the results from the 1985 national study by the University of Maryland (Robinson and Holland, 1988). The difference was, however, that the ARB study also provided more exact estimates of exposure-related activities, such as those involving passive exposure to tobacco smoke, operating gasoline engines, or visiting dry-cleaning establishments. More importantly, the ARB study was able to produce much more accurate data on the locations of activities, whether they were indoors, outdoors, or in-transit. These advantages also extend to the present study of children.

b. Studies of Children

As implied above, almost all of the methodological and substantive data on activity patterns have come from samples of adults. Studies of children raise special issues, in particular because of the unknown abilities of children to report on their own behavior. Moreover, because children's activities tend to be different in character from the larger adult population, new data collection procedures and coding categories need to be developed for them.

Thus, while several previous studies of children's activity patterns have been undertaken, very few of them have been conducted with large representative samples that also provide full coverage of all daily activities. The literature does contain national studies such as those of Beschen (1972), but the focus of this study was only on transportation activities. Carpenter and colleagues (e.g., 1988) have conducted several in-depth observational studies of children's activity, but on limited Midwest samples of around 100 children or less and only for children's play or classroom play activities. Medrich et al.'s (1982) study of Oakland, California children only studied non-school activities and involved only children aged 11-12. Several personal exposure studies that collect diary data can also be found in the literature (e.g., Wallace 1987), but they have either involved small samples of children, limited age ranges of children (such as newborns or those aged 8-11), limited population bases (such as single communities) or diaries or questions that only examine limited aspects of everyday behavior (ARB 1988).

There are two studies, however, which have moved beyond some of these limitations. One is the 1981 activity-only study of 229 children, conducted as part of Juster and Stafford's (1985) larger national data collection -- as a follow-up of the children of adults interviewed in the 1975

University of Michigan study. The second study was conducted in Cincinnati in 1985 by PEI Associates (Johnson 1989). This study obtained 3-day activity and location diaries from 973 children. Both studies examined a full age range of children under age 12 (although the Michigan study did not collect data for children under 3 years of age), activities across the full 24 hours of the day, activities across multiple months of the year (2 seasons in each study), and a full range of daily activities (collected in open-end response format) that were coded using a comprehensive category scheme.

The current ARB Children's Survey stands as the most comprehensive study of children's activity patterns on representative samples done to date using state-of-the-art interviewing technology. Building on earlier methodological studies, it provides a unique and scientifically-based focus on exposure assessment for the children of California.

Chapter II: Methods of Sampling and Data Collection

1. Synopsis of the Research Design

The California Children's Activity Survey was designed to provide estimates of time children under 12 years of age spend in various activities and locations (micro-environments) on a typical day. The target population consisted of children under 12 years living in English-speaking households containing a telephone. The sample was drawn using Waksberg (1978) random-digit-dialing methods and was stratified to provide representative estimates for major regions of the state. Interviews were distributed over the four seasons (from April 1989 to March 1990) to take into account seasonal variations in activity and location patterns. The survey questionnaire included questions about proximity to selected potential sources of air pollution on the diary day, a complete inventory of children's activities and locations on the diary day, and a brief series of items pertaining to the characteristics of the selected child, the household, and an adult in the household who served as an informant about the child's activities. The questionnaire, including the diary component, was implemented using a computer-assisted telephone interviewing (CATI) technology. A total of 1,200 eligible respondents were interviewed, representing an overall response rate of 77.9%.

2. A Small-Scale Pilot Study

To help identify any potential sources of reporting bias and to develop efficient probing techniques to improve parent recall, a small pilot study was conducted from March 15 through March 23, 1989. Telephone numbers were selected from rural and urban communities; interviews were attempted only with English-speaking households. Special attention was devoted to comparing those cases in which the interview was completed on the day of the study introduction with a parent and those in which the interview was conducted a day following the day of the study introduction. The first group was referred to as the unrehearsed group and the second, the rehearsed group. Of 135 telephone numbers, 115 were given an enumeration interview to determine the composition of the household. Of these, 38 households contained children eleven or under. Six experienced interviewers who had worked on the previous California Activity Pattern survey completed a total of 27 interviews. Eleven of these interviews were rehearsed, 16 were unrehearsed.

The pilot study results indicated that diaries from rehearsed interviews were not substantially improved. There were no important differences between rehearsed and unrehearsed groups with respect to number of activities reported or time to complete the diary. (Note that due to

small sample sizes, no significance tests were conducted.) In fact, interviewer attentiveness and probing were the most significant factors determining the quality of the interview. Interviewers were instructed to probe any activity that lasted two or more hours to determine whether or not the randomly selected child had done anything else during that period. For the most part probing seemed to help most respondents provide a more accurate account of the randomly selected child's activities. Thus, as a result of the pilot study, there were improvements in the questionnaire and the interviewer instructions for prompting and probing.

Based on the pilot results, the decision was made to conduct interviews directly with children between nine and eleven. For children between the ages of six and eight, the diary was completed with parents who were encouraged to consult with the randomly selected child. Surprisingly few children had difficulty responding to questions in the diary. Not only were they able to relate rather detailed descriptions of their daily activities, they seemed to enjoy being interviewed.

3. Sample Design for the California Children's Activity Pattern Survey

a. The Target Population

The target population for the Children's survey consists of children eleven years old and younger living in California households at the time the survey was conducted. Households with no telephones were excluded, as were households in which there were no English-speaking adults.

The sample was stratified by region to provide a sufficient number of interviews to make comparisons among three major areas of the state: The Southern Coast (including Los Angeles, Orange, and Riverside counties and parts of San Bernardino and San Diego counties); The S.F. Bay Area (including San Francisco, Alameda, Contra Costa, San Mateo, Napa, and parts of Solano, Sonoma and Santa Clara counties); and counties not included above i.e., "The Rest of State". Table 2.1 below shows the distribution of completed interviews by residence in the three major geographic areas that were used to stratify the sample.

Table 2.1: DISTRIBUTION OF SAMPLE BY REGION

Area of Residence	No. of Completed Interviews	%
Southern Coast	224	18.7
S.F. Bay Area	263	21.9
Rest of State	713	59.4
Totals	1,200	100.0

Because there are marked seasonal variations in children's daily activities and locations, the sample was constructed to provide a representative selection of households in each of four quarters of the calendar year. The distribution of completed interviews by quarter is given below in Table 2.2.

Table 2.2: DISTRIBUTION OF COMPLETED INTERVIEWS BY QUARTER OF THE CALENDAR YEAR

Quarter	No. of Completed Interviews	%
Spring - April to June, 1989	204	17.0
Summer - July to September, 1989	407	33.9
Fall - October to December, 1989	271	22.6
Winter - January to February, 1990	318	26.5
Total	1,200	100.0

b. Selection Procedures

The sample was designed as a clustered random-digit telephone sample, using the Waksberg method (Waksberg, 1978). The steps used to generate the sample are listed below.

1) All California telephone prefixes, consisting of an area code plus a three digit telephone number prefix, were listed and classified into one of the three geographical areas (Southern Coast, S.F. Bay Area, or Rest of State) used as stratification criteria.

2) Within each major geographic stratum, prefixes were listed in order of their positional coordinates (east-to-west or north-to-south).

3) The prefixes within each major geographical stratum were selected by systematic random sampling (every nth prefix after a random start), with sampling fractions of 0.120 (200 of 1668 prefixes) for the Southern Coast, 0.241 (157 of 819) for the S.F. Bay Area, and 0.480 (544 of 1,133) for Rest of State.

4) A total of 941 prefixes were selected in this way. Each selected prefix was augmented by a random sequence of four digits to form a "primary telephone number" consisting of an area code and a seven-digit phone number.

5) Each primary telephone number was called to determine whether the number was a residential phone number. Of the

941 primary numbers, 279 were identified as residential phone numbers. These numbers were used to generate the clusters for the sample.

6) To generate the clusters, the last two digits of each of the 279 primary residential numbers were varied at random. These final numbers were called in random order until a cluster size of 23 or 24 residential numbers was obtained or until the pool of 100 available numbers was exhausted. A total of 6,242 telephone numbers were identified as eligible sample units.

7) When a household was reached by phone, SRC staff conducted an enumeration interview to determine whether or not the household contained a child eleven years old or younger. When more than one eligible child was present, a single child was selected at random as the subject for the main interview and daily diary.

For a more complete account of the sampling procedures used for the California Children's Activity Survey, the reader should refer to Appendix D, "Sampling Methods and Field Results for the 1989-90 Activity Pattern Survey of California Children", by Dr. Thomas Piazza and Yu-Teh Cheng.

4. Design of the Questionnaire

a. Questionnaire Coverage and Flow of Interview

The questionnaire was developed by staff of the Survey Research Center in consultation with the staff of the California Air Resources Board and a panel of scientific advisors (see Appendix C). The content of the questionnaire is similar to that used for the 1987-88 California survey of the activity patterns of adults and children aged 12-17 years. The majority of the substantive content of the questionnaire consists of three kinds of questions: a) direct questions about potential exposures to sources of air pollution on the diary day; b) the daily diary, an inventory of the child's activities and locations on the diary day, which includes beginning and ending times (i.e., durations in minutes), whether or not tobacco smoke was present, and a classification of each activity with respect to whether it occurred in an indoor or outdoor location; c) sociodemographic characteristics of the selected child (age, gender, race-ethnicity, grade in school) and the adult respondent (marital status, employment status, years of schooling, and household annual income).

The direct questions about potential exposures were generally the same as those used in the adult survey and included items dealing with proximity to the following

sources of air pollution, mainly on the diary day (i.e., the day before the interview): gasoline fumes from vehicles parked in attached garages or parking areas (on diary day), use of mothballs in the home (in general), use of toilet bowl deodorizers (in general), use of scented room fresheners (in general), gas heat on (on diary day), open windows (on diary day), use of a fan for ventilation (on diary day), use of air conditioners (on diary day), working vacuum cleaner (in general), child on floor and/or outside surface (on diary day), child around a humidifier or vaporizer (on diary day), child at gas station or auto repair shop (on diary day), child in room with gas oven on (on diary day), and potential exposure to paint products, solvents, pesticides, soaps or detergents, household cleaning agents, personal care aerosols, hot showers or baths (all on diary day).

The flow of the interview is illustrated in Figure 2.1. The interviews began with a "front end" section which enumerated the number of children 11 years or less, selected an eligible child at random to be the subject of the interview, and identified the adult household member who spent the most time with the child on the diary day. This section was followed by questions addressed to the adult respondent dealing with the child's potential exposures to pollutant sources on the diary day and questions about the characteristics of the household related to possible

Figure 2.1: Flow of Interview

1. The "Front End" contains:

Dialing instructions,
Enumeration of eligible children
Random selection of child
Identification of preferred adult respondent
Callback routines

2. Pre-diary questions for adult respondents:

House and garage type
Use of mothballs, deodorizers, etc.
Type of heating, ventilation
Child on floor, outside surface, yesterday
Time spent with child yesterday

3. Pre-diary questions for adult respondent or child 9-11 yrs: Exposures to various pollutants yesterday

4. Time Diary: completed by adult respondent or child 9-11

5. Follow-up of activities at daycare, at school, or during babysitting not fully specified in diary interview

6. Post-diary questions for adult respondent:

Child's school grade, race/ethnicity
Adult respondent's relation to child
Adult's marital status, employment status
years schooling
Household income
Number of telephone numbers in household

exposures. The next series of questions, asked of the adult respondent or the child if 9-11 years old, dealt exclusively with potential exposures to various additional sources of air pollution on the diary day. The daily diary of activities of locations followed. The diary was supplemented by additional questions about daily activities if it included any unspecified activities related to daycare, babysitting, or school attendance. The final series of questions, dealing with the sociodemographic characteristics of the child and adult, were addressed to the adult respondent.

b. Diary Procedures and Coding of Activities and Locations

In contrast to most surveys which examine people's activities in isolation from the natural temporal context in which they are embedded (e.g., by asking people to compress their actual behavioral experiences by saying whether they "often" or "usually" do something), time-diary activity accounts report activities as they naturally and sequentially occur in daily life. Studies of time use provide us the opportunity, then, to study human activities in "real time" -- as individuals are actually involved in the stream of daily behavior.

Time diaries can be seen as a prime example of the "micro-behavioral" approach to survey research. This micro-behavioral approach recognizes the limited ability of respondents to report very complex behavior in a survey context. Thus, most survey questions are limited to the most elementary experiences about which respondents can accurately report. The micro-behavioral approach also provides researchers with a more basic and flexible data base from which to draw conclusions about human activity.

The time diary is a micro-behavioral technique for collecting self-reports of an individual's daily behavior in an open-ended fashion on an activity-by-activity basis. Individual respondents reported such activities for a short, manageable period, namely the full 24 hours of a single day. In that way, the technique capitalized on the most attractive measurement properties of the time variable; namely, completeness, equal distribution and understandability. Thus, this technique provides the following advantages:

a. all daily activity is potentially recorded (including that which occurs in early morning hours when most "normal" people may be asleep);

b. all 1440 minutes of the day are equally distributed across respondents (thus allowing certain "trade-offs" between activities to be examined);

c. respondents are allowed to use a time frame and accounting variable that is maximally understandable to them and accessible to memory; and

d. the open-ended nature of activity reporting was automatically geared to detecting new and unanticipated activities, (e.g., aerobic exercises, use of new communications technologies), as well as capturing the context of how daily life is experienced.

In the retrospective diary used in the California Children's Activity Survey, respondents (either the adult informant or the child if 9-11 years) reported each activity they engaged in on the diary day, beginning at midnight or the preceding day, where they were at the time, if they were inside, outside, or equally inside and outside, and whether or not a tobacco smoker was present. The interviewers recorded the time the activity began and ended, entered a single-digit code (one of eight precoded categories) indicating the major category of the activity, and entered a brief description of the activity in words (up to 44 characters in length). When the activity was related to school or childcare, the interviewer entered an additional code (one of seven precoded categories) that further specified the type of activity. Locations were recorded in two stages, by first entering a one-digit code (one of six precoded categories)

for major type of location, and then entering a second code which indicated the nature of the location in greater detail. For example, "In transit" (code 5) "on a bus" (code 5 within the category "In-transit") resulted in code 55 for "In-transit on a bus".

If the randomly selected child was less than 9 years old, and the diary contained unspecified "daycare", "baby sitting", or "school" activities, interviewers asked the adult respondents to estimate the time the child spent in a variety of activities typical of such settings: eating snacks or meals, napping or resting, watching TV, doing arts and crafts, actually playing outdoors, and going on field trips. An alternative approach which would have involved contacting teachers or other caretakers was considered but was rejected because of the additional costs and methodological problems.

Considerable research effort was invested in obtaining a very detailed account of activities during the day -- one that includes all the important changes that occur during the day. Through prompts and probing, the interviewers attempted to ensure that each respondent's report was complete and accurate. The restricted sequential approach of the diary reminded respondents of the need for detail and consistency in activity reporting. The diary task instead is one in which respondents have minimal opportunity to give

superficial or distorted responses, or responses that they perceive will somehow "please" the interviewer. With at least 20 to 30 activities to recall and report on for a particular day, the respondent's attention is kept very focused.

SRC staff conducted an extensive coding operation for the diary data after the interviews were completed. A detailed activity coding scheme was developed by SRC staff in collaboration with the ARB project director. It is given as Appendix A of this report and describes the rules used in assigning detailed codes to the activity reports. The "raw data" for coding consisted of the one-digit major activity code (assigned during the diary portion of the interview), the 44-character description of the activity, and additional diary-based codes for school and childcare activities. Application of the coding scheme to these data resulted in the creation of ten major categories of activities and 113 detailed activity codes. These are given in Table 2.3.

The majority of the locations were coded at the time the diary was conducted, using the two-step pre-coding procedure described above. The post-diary coding operation for locations consisted mainly of assigning previously uncoded locations to new codes or pre-existing codes, based on a 25-character description that was recorded during the diary portion of the interview. Coding operations used 63

detailed location codes which fell into six major categories of locations: home; school or childcare location; friend's or other's house; stores (places for eating, shopping, errands; in transit; and other locations.) These are shown in Table 2.4.

c. Implementation of the Questionnaire as a CATI Instrument

The questionnaires were administered using the state-of-the-art Computer-Assisted Telephone Interviewing (CATI) technology developed at the University of California at Berkeley. That technology a) allows one question on the interviewer's "screen" at a time; b) permits automatic "branching" responses so that, for example, follow-up questions are only asked of respondents who said they had experienced some form of potential exposure; c) prevents any interviewer key strokes that are not eligible codes; and d) allows automatic coding onto a computer tape, thus eliminating the need for human coding (with its multiple possible sources of error).

The value of having the diary on CATI was evident in several ways. First, the interviewer could concentrate on only one facet of reporting at a time, either the main activity, the location, the times began and ended, or the presence of smokers. Second, the open-end features of CATI made it possible for the interviewer to transcribe the respondent's

Table 2.3

ACTIVITY CODES FOR THE CALIFORNIA CHILDREN'S ACTIVITY SURVEY

01-09 WORK AND OTHER INCOME PRODUCING ACTIVITIES

01 Not Ascertained activities
02 Unemployment
03 Travel during work
05 Children's Paid Work
06 Eating at work/school/daycare
08 Accompanying or watching adult at work
09 Travel to work/school meals

10-19 HOUSEHOLD ACTIVITIES

10 Food preparation
11 Meal cleanup
12 Indoor house cleaning
13 Outdoor house cleaning
14 Clothes care
149 Washing clothes at laundromat
15 Car repair/maintenance
16 Home repairs
166 Repairing boats
167 Painting a room or home
169 Building a fire
17 Plant care
18 Other household
19 Pet care
199 Travel to home, household activities

20-29 CHILD CARE

20 Baby care
21 Child care
22 Helping and teaching children
23 Talking and reading
24 Indoor playing while caring for a child
25 Outdoor playing while caring for a child
26 Medical care for other children
27 Other child care
28 Watching someone provide any kind of child care to another child (not used)
29 Travel related to child care

30-39 OBTAINING GOODS AND SERVICES

30 Everyday shopping/grocery
301 Picking up or dropping off dry cleaning
31 Shopping for durable goods and household items
32 Personal care services (haircut/hairdresser)
33 Medical appointments
34 Governmental and financial service
35 Car repair services
36 Other repair services
37 Time spent seeking or obtaining other services
38 Errands - goods or services
39 Travel related to goods and services

50-59 EDUCATION AND PROFESSIONAL TRAINING

50 Students' classes
51 Other classes
52 Unspecified day care
54 Doing homework (anywhere)
549 Doing homework while watching TV
55 Using the library
56 Other education, breaks between classes
57 At day care/nursery before or after school
58 Watching someone else receive educational training
59 Travel related to education

60-69 ORGANIZATIONAL ACTIVITIES

60 Attending meetings of organizations
68 Watching others engaged in or accompanying others engaged in organizational activity
69 Travel related to organizational activity

70-79 ENTERTAINMENT/SOCIAL ACTIVITIES

70 Sports events
71 Miscellaneous events
711 Eating and amusements
72 Movies
73 Theater
74 Visiting museums, zoos, art galleries, exhibitions
75 Visiting with others
76 Parties
77 Bars/lounges/coffee shops
78 Other social events
79 Travel related to event/social activity

80-89 RECREATION

80 Active sports
801 Golf, miniature golf, golf lessons
802 Bowling, pool, ping pong, pinball
803 Yoga
81 Outdoor leisure
811 Unspecified outdoor playing
82 Walking/running/hiking/biking for recreation - not traveling
83 Hobbies
84 Domestic crafts
85 Art
86 Music/drama/dance
87 Indoor Games
875 Playing and eating
877 Playing and talking with family members
879 Playing and watching TV
88 Watching others engaged in recreation
89 Travel related to active leisure

Table 2.3

ACTIVITY CODES FOR THE CALIFORNIA CHILDREN'S ACTIVITY SURVEY (Continued)

40-49 PERSONAL NEEDS AND CARE

40 Washing,etc.-bathing/showering/going to bathroom
41 Medical care
42 Help and care
43 Meals at home (own home)
44 Meals out - also at friends' homes
45 "Night" sleep
46 Naps
47 Dressing and grooming
474 Washing and dressing
48 Watching personal care
49 Travel related to personal care or travel when purpose is unclear

90-99 COMMUNICATION AND PASSIVE LEISURE

90 Radio use
91 TV use
914 TV and eating
915 Watching TV and doing something else
92 Records/tapes
93 Reading books
934 Reading books and eating
937 Reading and TV
938 Reading and listening to music
94 Reading magazines/not ascertained, being read to
944 Reading magazines and eating
95 Reading a newspaper
954 Reading a newspaper and eating a meal/snack
96 Conversations
97 Letters, writing, paperwork
971 Household paperwork
98 Other passive leisure, being a baby
99 Travel related to passive leisure

Table 2.4

Location Codes for the California Children's Activity Survey

Home	School/Childcare Location	Friend/Other's House	Stores, places for eating, shopping, errands	In-transit
1 Kitchen	251 School, Sch. daycare	3201 Kitchen	21 Office building (e.g., bank, post office)	51 Car
2 Living Rm., family rm., den	253 Childcare, house	3202 Living Rm., family rm., den	23 Grocery store	52 Pickup truck or van
3 Dining room, dinette	255 Childcare, commercial bldg., Church daycare	3203 Dining room, dinette	24 Shopping mall, other non-grocery store	53 Walking
4 Bathroom	259 Other school childcare location, not codeable above	3204 Bathroom	28 Restaurant	54 At bus, train ride, stop
5 Bedroom		3205 Bedroom	29 Bar, nightclub	55 On a bus
6 Study/office		3206 Study/office	33 Auto repair shop gas station, indoor parking area, car wash	56 On train, rapid transit
7 Garage		3207 Garage	36 Dry cleaners	57 Other kind of truck
8 Basement		3208 Basement	37 Beauty parlor, barbershop, hairdresser	58 Airplane
9 Utility/laundry room		3209 Utility/laundry room		59 Bicycle/skateboard, roller skates
10 Pool, spa OUTDOORS		3210 Pool, spa OUTDOORS		60 Motorcycle, motorscooter
11 Yard, patio, other OUTSIDE house		3211 Yard, patio, other OUTSIDE house		63 In stroller or carried by adult
12 Moving from room to room in the house		3212 Moving from room to room in the house		69 Other enclosed transit, not codeable above
13 Other house location, not codeable above		3213 Other house location		70 Other outdoor transit

Other location, not codeable above
22 Industrial plant, factory, warehouse
26 Public building (e.g., museum, library, theater)
27 Hospital, doctor's office, health care facility
30 Church, synagogue, temple, mosque
31 Indoor gym, sports/health club, any indoor recreation
34 Park, playground, any outdoor area
35 Hotel or motel
38 Amusement park
39 Other indoor location, not codeable above
40 Other outdoor location

Non-coded Responses
998 Don't know
999 Refused/Missing Data

descriptions of each activity directly into the computer, a feature that was particularly important for subsequent coding. Third, the CATI program made it relatively easy for respondents who had forgotten an activity to "jump back" and have that activity inserted in its proper place in the flow of the diary. Finally, the diary time entries were checked for consistency (both the sequence of begin and end times and the total number of minutes allocated (=1440) when the diary was initially completed and after any modifications of the diary entries (i.e., when the respondent wanted to "jump back" to insert or delete an activity).

All coding operations were reviewed periodically by the Coding Supervisor and the Principal Investigator. As a final check on coding procedures, all coding decisions were reviewed by ARB staff and Dr. John Robinson, an internationally-known expert on time diaries. Dr. Robinson conducted a systematic comparison between the codes and the verbal descriptions of activities and locations for a large sample of diary reports. Discrepancies found at this stage prompted a review of all activities and locations which had received such codes. Final codes were assigned after this stage and entered onto the data tape.

5. Overview of Training and Supervision

Prior to the briefing session concerned with procedures specific to the California Children's Activity Pattern Survey, all interviewers completed a training session in basic interviewing techniques as well as CATI training. As is true for all SRC studies, interviewers studied the briefing manual prepared especially for the study. This manual included: a description of the background and purpose of the study, instructions on how to obtain information in diary format, detailed instructions on how to handle each question in the interview, and instructions on how to handle common problems or ambiguities that could arise in the interview. The two-day briefings were held at the beginning of the spring and summer waves, April 19-20 and July 24-25. The briefing included a discussion of the objectives of the study, role-playing enumeration situations, and practice interviews. These role-playing exercises and practice interviews were used to instruct interviewers in procedures for handling general questions about the study, specific questions pertaining to items in the instrument, as well as to offer suggestions for handling any difficulties that might arise. Once the SRC supervisory staff were satisfied that interviewers understood study procedures, interviewing began.

During the early phase of data collection, supervisors closely monitored interviewer performance by listening in on the interviews and watching the interview progress on a video monitoring screen. These early interviews were carefully reviewed with each interviewer, with the supervisor pointing out those areas where interviewer performance could be improved. Throughout data collection, approximately fifty percent of the interviews were monitored by supervisory staff. Weekly reviews were conducted with each interviewer to ensure that proper procedures were followed and to provide an opportunity for the interviewer to raise questions. Diaries with fewer than fifteen activities were discussed with interviewers to make sure that adequate probing had occurred. The coding of diary activities was also reviewed.

All interviewers working on this study had previous interviewing experience. The initial interviewing staff consisted of six interviewers, two of whom had previously worked on the California Activity Patterns Study interviewing adults and children twelve and older. An additional seven interviewers were briefed for the summer wave, bringing the total number of interviewers to thirteen. Fall and winter waves were completed with nine interviewers, with four interviewers working on all four waves.

6. Field Results

a. Response Rates for Households and Eligible Children

As noted in section 3.b of this chapter, the penultimate stage of sampling telephone numbers resulted in 279 primary residential telephone numbers, each of which was used to generate 100 numbers by randomly varying the last two digits. Each set of 100 numbers was called, in random order, until a cluster size of 23 or 24 residences was obtained or until all 100 numbers were exhausted. Table 2.5 shows that 11,414 numbers were called, yielding 6,242 eligible sample units. Of these, 91.7% were successfully enumerated and 1,413 were identified as households containing at least one eligible child.

b. Outcomes for Children Selected as Subjects for the Survey

One child eleven years old or less was selected at random from each eligible household. As shown in Table 2.6, interviews were completed with 1,200 children and/or adult informants, giving an interview completion rate of 84.9%.

The overall response rate for the survey is calculated as the product of the interview completion rate and the rate of successful household enumeration that is, (0.917) times (0.849) = 77.9%. This calculation assumes that the

prevalence of households with eligible children is the same in non-enumerated and enumerated households.

Table 2.5

OUTCOME FOR HOUSEHOLDS

	Number	% of Total	% of Eligible
Total Selections	11414	100.0	
Ineligible for the Sample			
Not a residence*	4976	43.6	
Not English speaking	196	1.7	
Total ineligible	5172	45.3	
Eligible Sample Units	6242	54.7	100.0
Refused enumeration	367	3.2	5.9
Unresolved status**	249	1.3	2.4
Enumerated households			
No eligible children	4313	37.8	69.1***
One or more eligibles	1413	12.4	22.6
Total enumerated	5726	50.2	91.7

* Includes a few numbers never answered after at least 25 calls; most of those are disconnected business numbers, although a small proportion could be residential.

** Enumeration incomplete when data collection phase of project ended.

*** This fraction varied little between regions.

Table 2.6

OUTCOMES FOR CHILDREN SELECTED

	Number	% of Selected
Total Children selected	1413	100.0
Non-response		
Refusals	139	9.8
Respondent never home	54	3.8
Incomplete diary	20	1.4
Total non-response	213	15.1
Completed Interviews	1200	84.9

c. Characteristics of Persons Who Provided Interview and Diary Information

The questionnaire instrument for the California Children's Activity Survey was divided into three main parts: the adult sections, the children's section, and the daily time-diary. When the randomly selected child was eight years old or less, the preferred respondent for all sections of the questionnaire was the parent or guardian who spent the most time with the child on the diary day. In most cases the preferred adult respondent was also the actual respondent. Approximately 92% of the adult respondents were the parent or guardian who spent the most time with the selected child on the diary day. Nearly 98% of the adult respondents were either father, mother, step-father, or step-mother to the selected child. In fact, over three-quarters of the adult respondents were the children's mothers.

When the selected child was 9-11 years old, he or she was the preferred respondent for the children's and diary sections of the questionnaire. This occurred in about 85% (269 of a total of 316) of such cases. The diary and children's sections were completed by the adult informant in 931 of the 1200 interviews. Most (about 58%) of these proxy interviews were conducted with adults who had spent at least eight waking hours with the child on the diary day. Less than 1% of the proxy interviews were with adults who had spent less than one waking hour with the child on the diary day.

d. Interviewer Assessments of Diary Validity

Concern about the validity of the diary responses arises quite naturally because of the nature of the task of reconstructing the full range of activities and locations of the diary day, and because the diary information was collected from children and/or from proxy interviews with adults who may not have had full information. In order to make a subjective assessment of the validity of diary responses, the interviewers were asked to record their "confidence in the diary responses" after the diary section had been completed. In approximately 80% of the cases, interviewers said they had "complete confidence" in the

diary responses. Eighteen percent of the diaries inspired a "somewhat confident" rating. Less than 2% received a "not too confident" rating.

7. Comparison of Survey Estimates with Current Population Survey Data and School Enrollment Figures

Table 2.7 presents a comparison between estimates based on the California Children's Activity Pattern Survey and Current Population Survey (CPS) data for 1988. The estimates from the Children's survey pertain to the sample of adult respondents (i.e., the adult household member who spent the most time with the randomly selected child on the diary day) living in households which contained eligible children and to the sample of households that were enumerated to determine the presence or absence of eligible children. Although the CPS estimates pertain to somewhat different populations (e.g., to <u>all</u> adults 25 years or older in the case of years of education, not just to adults living in households with young children - see the notes to Table 2.7), these estimates do provide a rough basis for evaluating the representativeness of the Children's survey sample.

Table 2.7 suggests the possibility that groups of lower socioeconomic status may be underrepresented in the Children's survey sample. Both median household income and

Table 2.7
Comparison Between the California Children's Activity Pattern Survey and the 1988 Current Population Survey: Selected Socioeconomic Characteristics

Socioeconomic Characteristic	1988 CPS* California	Children's** Survey Sample
Unemployment[a] Rate	5.3%	7.9%
Median Household[b] Income (in $1,000's)	$30.2	$40.0
Mean Years[c] Education	12.6 years	13.3 years
Percentage of[d] Households with Children Under 18 years old	38.2%	33.5%

* Source: California State Census Data Center, Sacramento, CA., 1990.

** Data are weighted for variations in regional sampling fraction and number of phones.

[a] For the CPS, this is the percent of the California population, aged 16 and over, who were unemployed in March, 1988. For the ARB sample, this is the percent of adult respondents "looking for work" or layoff from work" among those who were "working", "looking for work" or "on layoff from work" (N = 796 adult respondents).

[b] For the CPS, this is median household annual income for California households in 1987. For the ARB sample, this is the median household income in 1988 for adult respondents (N=1143 with complete data). This estimate is based on the weighted cumulative percentage of adult respondents in various income categories. 48.3% of these respondents reported household incomes below $39,000 per year and 50.9% reported incomes less than $41,000 per year. Therefore, the median is located at $40,000 in this sample.

[c] For the CPS, this is the average number of years of schooling completed for California residents age 25 years or older in 1988. For the ARB sample, this is the average number of years of schooling completed by adult respondents (N=1197 with complete data) at the time of interview.

[d] For the CPS, this is the percentage of all California households with children under 18 years old present in 1988. For the ARB sample, this is the percentage of all households enumerated (N=5726) that contained children under 18 years old at the time of interview.

mean years of education for adult respondents are higher than the corresponding CPS figures. The percentage of households with children under 18 is somewhat lower among the households enumerated in the children's Survey than in the CPS data, suggesting that the enumeration response rate (91.7% overall) may have been somewhat higher in households without children. The unemployment rate among adults is higher than the corresponding CPS figure, but this may be due to age differences between the samples or differences in the definition of unemployment.

Although the above differences may be due in part to differences in sampling frame between the Children's survey and the CPS, they are consistent with patterns of underrepresentation of lower income and education groups that have been observed in many telephone and personal interview surveys of adult respondents (Goyder, 1987). This fact should be kept in mind when attempting to generalize from the Children's Survey estimates to children 11 years and under in the state as a whole.

Table 2.8 compares Children's survey estimates and statewide public school enrollment figures for children in grades K through 6. Although the grade distribution for the 627 children in grades K through 6 in the Children's survey is not significantly different from the enrollment figures, the distribution of such children by race/ethnicity is

Table 2.8
Comparison Between the California Children's Activity Pattern Survey and School Enrollment Figures for California: Children in Grades K Through 6

Characteristic	California Public* School Enrollment 1989-1990 Grade K-6	Children's** Survey Sample N=627 Children in Grades K-6
Percentage		
1. Distribution by Grade		
Kindergarten	15.1%	17.2%
Grade 1	15.6	16.7
Grade 2	14.9	13.7
Grade 3	14.5	15.2
Grade 4	14.0	11.5
Grade 5	13.2	13.8
Grade 6	12.8	11.9
Total	****100.1%	****100.0
***Chi-squared statistic = 6.52, 6df, p < 0.50		
2. Distribution by Race Ethnicity		
White, Non-Hispanic	46.5%	68.0%
Black, Non-Hispanic	8.7	5.3
Hispanic	34.2	20.4
Asian	7.3	4.9
Other	3.3	1.3
Total	100.0%	****99.9%
***Chi-squared statistic = 118.4, 4df p < 0.001		

* Sources: The percentage distribution of children in grades K-6 by grade is for California children attending public schools. It is taken from Table 1 of California Department of Education, Enrollment Data: California Public Elementary and Secondary Schools, 1989-90. The distribution of children in grades K-6 by race/ethnicity is taken from Table 2 of California Department of Education, Racial and Ethnic Distribution of Staff and Students in California Schools, 1989-90. Sacramento, 1990. Private schools only account for 10% of the population in grades K through 12.

** Data are weighted to take into account variations in regional sampling fraction, number of telephones in the household, and number of eligible children in the household.

***The Chi-squared statistic tests the significance of the differences between ARB sample percentages and population percentages derived from the school enrollment data.

****The percentages sum to greater than 100% due to rounding error.

significantly different from the enrollment data. This suggests substantial underrepresentation of non-White and Hispanic children in the Children's Survey sample. These differences are due in part, to the exclusion of non-English-speaking households from the Children's survey sample. To a lesser extent, these differences may also be due to the exclusion of private schools from the enrollment data; private schools enrollment may consist of mostly white, Non-Hispanic students, but such schools comprise only 10% of elementary school enrollment. In addition, since race/ethnicity is also correlated with socioeconomic indicators, underrepresentation of certain race/ethnic groups may also be due to selection bias with respect to socioeconomic factors, as suggested by the differences in Table 2.7.

CHAPTER III: Methods of Data Analysis

This chapter describes the methods of data analysis used to produce the findings in Chapter IV of this report. It includes: a) an account of the methods and conventions used to generate measurements of times spent in proximity to potential pollution sources and times spent in various categories of activities and locations; b) the selection and definition of the "independent variables"---principally season and characteristics which identify different subpopulations of children; and c) the statistical procedures used in the analysis of the data.

1. Measurement of the Dependent Variables

a) Times spent in various activities and locations on the diary day. As noted in Chapter II, the diary responses were coded into a total of 113 activity categories and 63 location codes. Each of these codes can be used to define a variable of the form "minutes in activity X" or "minutes in location Y" on the diary day. (Indeed such variables have been created by aggregating the time spent in activities or locations with the same codes and they have been placed on the final data file.) To keep the analyses of these data within manageable proportions, we have constructed such variables in highly aggregated form. Thus we defined summary measures of time spent in <u>ten types of activities</u>

(work-related, household, childcare, obtaining goods and services, personal care, educational activities, organizational activities, entertainment and social activities, recreation, communication and passive leisure, and a residual category of don't know or uncodable responses) and seven types of locations (home, school or childcare facilities, friend's or other's house, stores/restaurants/shopping places, in-transit, other locations, and a residual category of don't know or uncodable responses). The detailed activities and locations under each major heading are listed in Tables 2.3 and 2.4 of Chapter II. Measures of time spent indoors, outdoors, in enclosed transit, and in outdoor transit, were also created. More precisely defined measures of activity or location are used only in Chapter V, where they were needed to make comparisons between the California Children's Activity Survey estimates and estimates drawn from previous time-diary surveys.

b) Measures of time spent in proximity of potential pollution sources on the diary day. The pre-diary section of the questionnaire included questions about the amount of time the child spent "yesterday at a gas station or in a parking garage or auto repair shop" and "how much time the child spent in a room(s) where a gas oven, range, or stove was turned on yesterday". The responses to these questions were used to create two potential exposure time measures for

the diary day: minutes spent in proximity to gasoline fumes (and gasoline engine combustion products) and minutes spent in proximity to gas oven fumes. In addition, since the diary included a question about the presence of tobacco smoke at each recorded location, minutes spent in proximity to environmental tobacco smoke on the diary day was constructed by summing the times in activities/locations where tobacco smoke was present.

c) Potential exposure to specific sources of air pollution on the diary day. Before the diary was administered, the adult informants were asked whether or not the child had been in proximity, on the diary day, to several sources of pollution commonly found in households. (Note that for most sources, no estimate of the duration of exposure was obtained from the adult informant.) Seven of these items were used to define variables for this report. Specifically, we defined dichotomous measures of potential exposure (1=potentially exposed, 0=unexposed on diary day) for the following sources of air pollution: glue, oil-based paints, solvents, pesticides, soaps and detergents, household cleaning agents, and personal care aerosols. Potential exposure to environmental tobacco smoke, gasoline fumes, and gas oven fumes were also represented as dichotomies, even though each was measured in terms of minutes in proximity to these potential pollution sources as well.

2. Selection and Definition of the Independent Variables

a) Season and Region. The season of interview (and therefore of the diary day) is potentially an important source of variation in daily activity patterns. For the purposes of analysis, seasons are defined as quarters of the year and labelled as follows: Winter (January through February); Spring (April through June); Summer (July through September), and Fall (October through December). The region variable is defined in terms of the sample strata; that is, Southern Coast, S.F. Bay Area, and Rest of State. (See section 3a of Chapter II for i) a definition of these regions in terms of the counties which comprise them and ii) Tables 2.1 and 2.2, which show the distribution of the sample by season and region.)

b) Characteristics of the randomly-selected child. We selected two basic variables to characterize the child: child's gender and child's age. Four age-groups were used in our analysis of the dependent variables: 0 to 2 years (n=313), 3 to 5 years (n=302), 6 to 8 years (n=269), and 9 to 11 years (n=316).

The interview portion of the survey included several other variables that can be used to define subgroups of children for further analysis of the dependent variables discussed in Section 1 of this chapter. Two of these, the child's race

or ethnicity (White/Caucasian, Black, Hispanic, Asian, and Other) and the adult respondent's level of education (in years of completed schooling) were used in preliminary multivariate analyses of potential exposures that are discussed briefly in Chapter V.

3. Methods of Data Analysis

a) Organization of the data tables. Tables are presented for summary measures of the three types of dependent variables: i) average time spent in each of the major activity and location categories, including average time spent indoors, outdoors, in enclosed transit, and in outdoor transit; ii) average time spent in proximity to environmental tobacco smoke (from diary), gasoline fumes (pgys, App.B, p.15), and gas oven fumes (gstm, App.B, p.19) on the diary day; and iii) proportion of the population potentially exposed to selected sources of air pollution on the diary day (glue, pnt1, solv, pest, pst2, ocln, aero, shwr, bath, App.B, pp.19-22). Each summary measure is shown separately for combinations of gender and age, for season, and for region. In a few cases (Tables 4.1 and 4.4), we include the percent who spent any time in an activity or location (% Doing), and the average minutes, median minutes, and maximum minutes for "doers".

b) Statistical tests. In this report, findings from the California Children's Activity Pattern Survey are presented in the form of average times (in minutes per day or hours per week) and proportions (e.g., of persons potentially exposed to sources of air pollution). Although these figures are reported separately for the different seasons and by region of residence, child's gender, and child's age, we present no formal statistical tests of the significance of the observed differences.

Because the distribution of times spent in various activities and locations and in proximity to potential pollution sources is often highly skewed, application of conventional methods of testing differences between mean values may be considered inappropriate. We nevertheless tried such methods --- based on analysis of variance --- when the sample sizes appeared to be sufficiently large to yield robust results even though the usual distributional assumptions were not satisfied. Although we used these preliminary results to guide our discussion of the observed differences, we acknowledge that additional study of the robustness of these procedures for Children's survey data is needed.

In addition, we explored multivariate analysis methods for potential exposure times and prevalence of proximity to

potential sources of air pollution on the diary day. These analyses are noted briefly in Chapter V.

4. Use of Sampling Weights

In all analyses, the cases were weighted to take into account selection probability factors (number of eligible children in the household, region of the state (i.e., sample stratum), and number of telephone lines in the household) and adjustment for season and day of the week. The weight used is called "timewt" and is discussed in detail in the sampling report (Appendix D of this report).

CHAPTER IV: Major Findings

1. Time Spent in Different Activities

Table 4.1 shows how the 1440 minutes of the day are allocated across the 10 main headings of activity and the "don't know" category. The dominant category is for personal care, which totals 794 minutes (13.2 hours) or more than half the total time across the day. All 1200 child respondents in the study engaged in personal care activities. Because of this, the average time for doers is the same as the overall average. The main single activity in personal care is, of course, sleep.

The next most time-intensive set of activities (239 minutes per day or just under 4 hours per day) are found in the recreation category, with games and play activities being the major contributor to time in this category, along with sports and outdoor activities. Some 92% of child respondents engaged in at least one of these recreation activities, with an average daily time per participant of 260 minutes.

Just over three hours per day on average was spent in communication activities, in particular TV viewing. The percent participation figure, 93%, is virtually the same as

TABLE 4.1 Time Spent in Major Categories of Activity

Activity Category	Avg Minutes	% Doing	Avg. for Doers	Median Minutes for doers	Maximum Minutes for Doers	Detailed Activity with Highest Avg.Minutes (code)
Work-related**	10	25	39	30	405	Eating at work/school/daycare (06)
Household	53	86	61	40	602	Travel to household (199)
Childcare	< 1	< 1	83	30	290	Other child care (27)
Goods/Services	21	26	81	60	450	Errands (38)
Personal Care	794	100	794	770	1440	Night sleep (45)
Education	110	35	316	335	790	School classes (50)
Organizational	4	4	111	105	435	Attend meetings (60)
Entertain/Social	15	17	87	60	490	Visiting with others (75)
Recreation	239	92	260	240	835	Games (87)
Communication/ Passive Leisure	192	93	205	180	898	TV use (91)
Don't know/Not coded	2	4	41	15	600	____
All Activities*	1441					

* Column total may sum to 1440 due to rounding error
**Includes eating at school or daycare, an activity not grouped under the "education activities" (codes 50-59, 549).

for recreation activities, although the time per participant (205 minutes) is considerably lower.

Time spent on education is the next largest category of time expenditure, taking up a little less than 2 hours per day. Only about a third (35%) of child respondents reported school activities, so that the average time per participant was rather large (316 minutes per day).

The remaining sets of activities were distributed in order as follows: household work (53 minutes, about half of which was travel time), shopping for goods and services (21 minutes, mainly accompanying parents while they shop), social life (15 minutes, mainly visiting), work-related (10 minutes), organizational participation (4 minutes per day, mainly attending church) and childcare (less than 1 minute per day). Participation rates for these activities varied between 1% for child care (activity codes 20-29, e.g., "babysitting other children") and 86% for household activities.

The final row in Table 4.1 shows that time not coded into an activity category (mostly "don't know" responses) amounted to an average of 2 minutes per day, and that only 4% of respondents reported some missing activity time in their diaries. Those who did report missing time reported an average of 41 diary minutes of missing data.

a. Age-Gender Differences

Table 4.2 shows the basic differences in average time expenditures in these ten classes of activities by gender and by age. The first line of the table shows that on the average children aged 3-11 spend more than twice as much time in activities under the work-related category than children aged 0-2. Boys spend about as much time in these activities as girls.

There are differences by age, by gender and age-gender categories in time spent in household related activities. Girls spend more time doing such activities than boys and the time expenditure in home-related activities reaches a peak among 9-11 year olds. The pattern is more linear and monotonic among boys than among girls. Only 9-11 year old boys and girls report any time doing child care.

There are no sizable differences by age or gender with regard to shopping activities. Very large decreases are found in personal care activities (mainly sleeping) as children grow older. Older children spend much more time in school-related activity than do younger children, and the same is true for social life and for communication and passive leisure. Not all of these age differences in activities are smooth or monotonic -- as in the case of 3-5

TABLE 4.2

Average Number of Minutes Spent in Ten Activity Categories by Child's Age and Gender

Activity Category	Boys 0-2 yrs	Boys 3-5 yrs	Boys 6-8 yrs	Boys 9-11 yrs	Boys All Ages	Girls 0-2 yrs	Girls 3-5 yrs	Girls 6-8 yrs	Girls 9-11 yrs	Girls All Ages
Work-related	4	9	14	12	10	5	12	11	10	10
Household	33	45	55	65	48	58	44	51	76	57
Childcare	0	0	0	1	< 1	0	0	0	4	1
Goods/services	20	22	19	14	19	22	25	23	22	23
Personal care	914	799	736	690	792	906	816	766	701	797
Education	60	67	171	138	106	41	95	150	176	115
Organizational	1	3	7	6	4	6	1	4	6	4
Entertainment/ Social	3	15	5	34	13	5	16	9	36	17
Recreation	217	311	236	229	250	223	255	238	194	228
Communication/ Passive Leisure	187	166	195	250	197	171	173	189	213	186
Don't know/Not coded	1	4	1	1	2	3	1	< 1	3	2
All Activities*	1440	1441	1439	1440	1442	1440	1438	1441	1441	1440
Sample Sizes Unweighted N's	172	151	145	156	624	141	151	124	160	576

* The column totals may differ from 1440 due to rounding error.

year old boys, who spent the least time in communication activities. On the other hand, the 3-5 year old age group spends the most time in recreation (in games and play activities). Boys also spend more time in such play activity than girls, and the age patterns among boys are different than those found among girls.

b. Season and Region Differences

Table 4.3 shows differences in times spent in various activities by season of the year and by region of the state. In the first row, it can be seen that the average time spent in activities under the category of work varies between 6 minutes in summer months and 13 minutes in the fall. There are no large differences in work-related times by region.

Among the notable* seasonal variation in average times are the following:

1) The difference of 774 minutes in Spring vs. 815 minutes in Summer in personal care activity.
2) The difference of 49 minutes in Summer vs. 124-137 minutes in other seasons with respect to educational activities.

* These differences are statistically significant by t-test; however due to skewness of the distributions, we have refrained from discussing statistical findings. See p.42 above.

TABLE 4.3

Average Number of Minutes Spent in Ten Activity Categories by Season and by Region

Activity Category	Season: Winter (Jan-Mar)	Spring (Apr-June)	Summer (July-Sept)	Fall (Oct-Dec)	All Seasons	Region: So.Coast	Bay Area	Rest of State	All Regions
Work-related	10	10	6	13	10	10	10	8	10
Household	47	58	53	52	53	45	62	55	53
Childcare	< 1	1	< 1	< 1	< 1	< 1	< 1	1	< 1
Goods/services	19	17	26	23	21	20	21	23	21
Personal care	799	774	815	789	794	799	785	794	794
Education	124	137	49	131	110	109	115	109	110
Organizational	3	5	5	3	4	2	6	6	4
Entertainment/ Social	14	12	12	22	15	17	10	16	15
Recreation	221	243	282	211	239	230	241	249	239
Communication/ Passive Leisure	203	180	189	195	192	206	190	175	192
Don't know/Not coded	< 1	2	3	< 1	2	1	1	3	2
All Activities*	1442	1439	1441	1441	1441	1440	1442	1439	1441
Sample sizes (Unweighted N's)	318	204	407	271	1200	224	263	713	1200

* The column totals may not be equal to 1440 due to rounding error.

3) The difference of 22 minutes in Fall vs. 12-14 minutes in other seasons in social life and entertainment; and the difference of 282 minutes in Summer vs. 211-243 minutes in other seasons in recreation activities.
4) The difference of 203 minutes in Summer vs. 180 minutes in Spring in communication/passive leisure activities.

Seasonal differences in household activity, in childcare, in shopping, in organizational activity, in communication-passive leisure and in "don't know" time expenditures are relatively small.

Among the notable regional differences in average activity times are the following:

1) The 45-minute Southern Coast vs. 62-minute S.F. Bay Area difference in household activity.
2) The 230-minute Southern Coast vs. 249-minute other regions difference in recreational activity, and
3) The 206-minute Southern Coast vs. 175-minute rest of the state difference in communication and passive leisure activities.

Regional differences with respect to time for childcare, shopping, personal care, education, social life, recreation and "don't know" activities are small.

2. Time Spent in Different Locations

Table 4.4 shows the basic distributions of time across six main types of locations that were coded. By far the largest category is at home -- 1078 minutes or close to 18 hours per day. Almost all respondents (99%) spent at least some time at home. The main location at home was the bedroom, the site of sleeping -- the largest activity in terms of time expenditure in Table 4.1.

The second most time-intensive location for children's activities was the school, which was 109 minutes or per day. The participation rate of 33% meant that the average time for those who actually attended school was 330 minutes, or about 5.5 hours per day.

The next two most often visited locations were other people's homes (80 minutes) and in-transit locations (69 minutes). Some 83% of children used some means of travel on the diary day leading to an average in-transit time of 83 minutes for those traveling. The participation rate for being at another's home was 32% and the average time for doers, 251 minutes.

The least time-consuming locations were stores and other commercial establishments (24 minutes, or about $^1/_2$ hour).

TABLE 4.4 Time Spent in Major Location Categories

Location Category	Avg Minutes	% Doing	Minutes Avg. for Doers	Median Minutes for Doers	Maximum Minutes for Doers	Detailed Location with Highest Avg. Time
Home	1078	99	1086	1110	1440	Home - bedroom
School/Childcare	109	33	330	325	1260	School or daycare facility
Friend's/Other's House	80	32	251	144	1440	Friend's/Other's house - bedroom
Stores,Restaurants,Shopping places	24	35	69	50	475	Shopping mall
In-transit	69	83	83	60	1111	Traveling in car
Other Locations	79	57	139	105	1440	Park, Playground
Don't Know/Not Coded	< 1	1	37	30	90	_____
All Locations	1440					

These locations had about a 35% visitation rate, so that the average time for doers was 69 minutes per diary day. An average of 79 minutes per diary day was spent in "Other locations", mainly parks and playgrounds.

Finally, the "don't know" or missing location time average was less than 1 minute per day. Only 1% of respondents reported some missing location time, and the average time in "don't know" locations per such diary was about 36 minutes.

a. Age-Gender Differences

Table 4.5 shows differences in time spent in the basic location categories by gender and by age. In the first row of the table, it can be seen that there are sizable age differences in time spent at home. For boys, time at home decreases from 1157 minutes for those aged 0-2 years to 1020 minutes for those aged 9-11 years, a difference of more than two hours; for girls, the difference is even greater, from 1151 minutes for those aged 0-2 to 968 minutes for those aged 9-11.

There are large age differences in average time spent in educational settings such as schools and daycare facilities. Time in such settings increases from about 87 minutes for

TABLE 4.5

Average Number of Minutes Spent on Six Locations
Categories by Age and Gender

Location Category	Boys 0-2 yrs	Boys 3-5 yrs	Boys 6-8 yrs	Boys 9-11 yrs	All Boys	Girls 0-2 yrs	Girls 3-5 yrs	Girls 6-8 yrs	Girls 9-11 yrs	All Ages
Home	1157	1134	1044	1020	1094	1151	1099	1021	968	1061
School/ childcare	86	88	144	120	108	59	102	133	149	111
Friend's/ other's house	67	73	77	109	80	56	47	125	102	80
Stores, Restaurants, Shopping places	21	25	22	15	21	23	35	27	26	28
In-transit	54	62	61	62	59	76	88	53	93	79
Other Locations	54	58	92	114	77	73	68	81	102	81
Don't Know/Not Coded	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
All Locations*	1439	1440	1439	1440	1439	1438	1440	1440	1440	1440
Sample sizes (Unweighted N's)	172	151	145	156	624	141	151	124	160	576

* The column totals may not sum to 1440 due to rounding error.

boys aged 0-5 to 120-144 minutes for boys aged 6-11, and from 59 minutes for girls aged 0-2 to 149 minutes for girls aged 9-11.

A similar pattern is found for average times at other residences. Such time reaches a peak for boys at aged 9-11 (109 minutes per day) and for girls at ages 6-8 (125 minutes per day). There are also age differences in time spent in stores and other commercial establishments, but they are not strictly increasing with age, reaching a peak for 3-5 year old boys and girls and then declining for older children. At all ages, girls spend more time than boys in stores, restaurants, and other shopping places.

In general, girls spend more time in transit (79 minutes per day) than boys do (59 minutes per day). This is true at all ages except among the 6-8 year old girls, where in-transit time average is lowest at 53 minutes per day.

Finally, there is a steady increase in time spent in "other" locations for both boys and girls with increasing age.

b. Season and Region Differences

Differences in location time by season and region are shown in Table 4.6. The most noteworthy feature in the tables is the lack of any large differences by region of the state.

TABLE 4.6

Average Number of Minutes Spent in Six Locations
by Season and by Region

Location Category	Season					Region			
	Winter (Jan-Mar)	Spring (Apr-June)	Summer (July-Sept)	Fall (Oct-Dec)	All Seasons	So.Coast	Bay Area	Rest of State	All Regions
Home	1091	1042	1097	1081	1078	1078	1078	1078	1078
School/ childcare	119	141	52	124	109	113	103	108	109
Friend's/ other's house	69	75	108	69	80	73	86	86	80
Stores, Restaurants, Shopping places	22	21	30	24	24	26	23	23	24
In-transit	75	75	60	65	69	71	73	63	69
Other Locations	63	85	93	76	79	79	76	81	79
Don't Know/Not Coded	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
All locations*	1439	1439	1440	1439	1439	1439	1440	1440	1439
Sample sizes (Unweighted N's)	318	204	407	271	1200	224	263	713	1200

* The column totals may not sum to 1440 due to rounding error.

There are relatively large differences by season, however. Not surprisingly, time spent at school locations declines in the Summer months, while time spent in the residences of other families, and in stores and other commercial establishments increases.

3. Indoor vs. Outdoor Location Time

Table 4.7 shows average times spent in four basic types of locations: indoors, outdoors, enclosed transit, and outdoor transit.

a. Gender-Age Differences

In general, girls spent slightly less time than boys in indoor and outdoor locations and slightly more time in transit. These gender differences, however, are considerably smaller than variations according to age group. For both boys and girls, time spent indoors decreases steadily with age, while time outdoors tends to be higher among older as compared with younger children. There are also age differences in time spent in enclosed transit, but these do not show a regular pattern by age for either boys or girls. Time spent in outdoor transit is highest among 9-11 year olds.

TABLE 4.7

Average Number of Minutes Indoors, Outdoors, in Enclosed Transit and in Outdoor Transit by Age and Gender of Child

Location	All Children	Boys 0-2 yrs	Boys 3-5 yrs	Boys 6-8 yrs	Boys 9-11 yrs	Boys All Ages	Girls 0-2 yrs	Girls 3-5 yrs	Girls 6-8 yrs	Girls 9-11 yrs	Girls All Ages
All locations											
Indoors	1230	1297	1227	1212	1193	1235	1274	1229	1229	1170	1225
Outdoors	141	88	151	167	185	145	90	122	158	177	136
Enclosed Transit	61	48	58	54	45	52	73	80	45	79	70
Outdoor Transit	8	6	3	7	17	8	4	9	8	14	9
Don't Know		< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Total*	1440	1439	1439	1440	1440	1440	1441	1440	1440	1440	1440
Sample Sizes (Unweighted N's)	1200	172	151	145	156	624	141	151	124	160	576

* The column totals may not sum to 1440 due to rounding error.

Among the children sampled, approximately 85% of the average diary day (1230 minutes) was spent in indoor locations. A little over two hours (141 minutes) was spent in outdoor locations. The remaining time (69 minutes) was spent in transit, and of this, the majority was in enclosed transit (mostly automobile travel).

b. Season-Region Differences

Table 4.8 shows differences in indoor-outdoor times by season and by region. There are no major differences in average times by region, although residents of the South Coast spent somewhat less time outdoors than do residents of other two parts of the state.

There are, not surprisingly, large seasonal differences in time spent indoors and outdoors, with indoor times being highest in the winter and lowest in the summer. Time spent by children outdoors is twice as high in the summer months (181 minutes per day) as in the winter (89 minutes). Average times per diary day in transit were highest in the winter and spring months (75 minutes per day), with lower average travel times in the summer and fall (60 and 65 minutes, respectively). Seasonal differences in enclosed transit times follow the same pattern.

TABLE 4.8

Average Number of Minutes Indoors, Outdoors, in Enclosed Transit, and in Outdoor Transit by Season and Region

Location	Season					Region			
	Winter (Jan-Mar)	Spring (Apr-June)	Summer (July-Sept)	Fall (Oct-Dec)	All Seasons	So.Coast	Bay Area	Rest of State	All Regions
All locations									
Indoors	1276	1207	1199	1238	1230	1234	1224	1229	1230
Outdoors	89	157	181	136	141	134	142	148	141
Enclosed Transit	66	68	54	55	61	65	62	55	61
Outdoor Transit	9	7	6	10	8	7	11	8	8
Don't Know	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Total*	1440	1439	1440	1439	1440	1440	1439	1440	1440
Sample Sizes (Unweighted N's)	318	204	407	271	1200	224	263	713	1200

* The column totals may not sum to 1440 due to rounding error.

4. Time Spent in Potential Exposure Situations:

Tables 4.9 and 4.10 show the average potential exposure times for three pollutants that all of the sampled children may have been in proximity to on the diary day --- tobacco smoke, gasoline fumes and gas oven fumes. Average time spent in proximity to tobacco smoke was approximately 77 minutes per diary day, seven times the average minutes near gas oven fumes, and nearly forty times the average minutes near gasoline fumes. Among the 38% of all children who were in proximity to tobacco smoke on the diary day, the average duration of potential exposure was about 202 minutes per day. The proportions of children who were potentially exposed to these pollutants are presented in Table 4.11.

a. Gender-Age Differences

Boys' potential exposure times to tobacco smoke were slightly higher than for girls (82 vs. 73 minutes per day), but that was mostly accounted for the single relatively high figure of 115 minutes per day for boys under the age of 3. Except for this unusually high figure, the average times for the other age groups of boys and girls range from 66 to 76 minutes per day. Over all age-gender groups, average times in proximity to gasoline fumes vary between 1 and 4 minutes per day; and for gas oven fumes, the average times vary between 7 and 14 minutes per day.

TABLE 4.9

Average Potential Exposure Times (Minutes on Diary Day)
by Age and Gender
(Sample = All children)

Minutes Potentially Exposed to:	All Children	Boys 0-2 yrs	Boys 3-5 yrs	Boys 6-8 yrs	Boys 9-11 yrs	All Boys	Girls 0-2 yrs	Girls 3-5 yrs	Girls 6-8 yrs	Girls 9-11 yrs	All Girls
Tobacco Smoke	77	115	76	66	66	82	77	68	71	74	73
Gasoline Fumes	2	2	1	1	4	2	1	1	3	1	1
Gas Oven Fumes	11	10	15	12	11	12	12	10	10	7	10
Sample Sizes (Unweighted N's)	1166*	168	148	144	150	610	140	147	122	147	556

* Respondents with missing data were excluded.

b. Season and Region Differences

Table 4.10 shows the difference in potential exposure times by season and by region. There are differences in average times near environmental tobacco smoke with respect to both season and region. The seasonal difference contrasts Summer (99 minutes per day) to Winter (61 minutes per day), with spring and fall months being roughly in the middle. The regional difference is almost as large, showing a contrast between 62 minutes in the Southern Coast and 98 minutes in the rest of the state.

Differences by season are also found for potential exposure to gasoline fumes (4 minutes in the Summer vs. 1 minute in the rest of the year) and for potential exposure to gas oven fumes (15 minutes in the Spring vs. 9 minutes in the Summer and Fall).

5. Proportion in Proximity to Selected Pollution Sources

The proportions of children who were in proximity to 10 different potential pollutant sources on the diary day are shown in Table 4.11.

TABLE 4.10

Average Potential Exposure Times (Minutes on Diary Day)
by Season and Region
(Sample = All children)

1. Season

Minutes Potentially Exposed to:	Winter (Jan.-Mar.)	Spring (April-June)	Summer (July-Sept.)	Fall (Oct.-Dec.)	All Seasons
			Seasons		
Tobacco Smoke	61	72	99	77	77
Gasoline Fumes	1	1	4	1	2
Gas Oven Fumes	11	15	9	9	11
Minimum Sample Sizes (Unweighted N's)	307	196	398	265	1166*

2. Region

Minutes Potentially Exposed to:	South Coast	Bay Area	Rest of State	All Regions
			Region	
Tobacco Smoke	62	74	98	77
Gasoline Fumes	1	2	2	2
Gas Oven Fumes	12	11	9	11
Minimum Sample Sizes (Unweighted N's)	219	254	693	1166*

* Respondents with missing data were excluded.

TABLE 4.11

Proportion of Children Potentially Exposed to Selected Potential Air Pollution Sources on Diary Day By Gender and Age

Potential Source of Air Pollution	All Children	Boys					Girls				
		0-2 yrs	3-5 yrs	6-8 yrs	9-11 yrs	All Ages	0-2 yrs	3-5 yrs	6-8 yrs	9-11 yrs	All Ages
Tobacco Smoke	38	38	34	33	37	35	28	42	48	45	41
Gasoline Fumes	11	11	8	8	18	11	12	9	12	11	10
Gas Oven Fumes**	32	32	38	37	31	35	25	29	36	28	29
Glue	12	2	16	14	19	13	3	8	14	18	11
Oil-based Paint	2	1	2	< 1	4	2	3	2	< 1	1	2
Solvents	3	1	3	2	4	3	5	3	1	5	4
Pesticides	6	5	7	2	12	6	2	4	12	7	6
Soaps/Detergents	84	84	87	89	77	84	82	86	94	71	83
Cleaning Agents	24	19	23	23	35	25	27	18	21	29	24
Personal Care Aerosols	37	28	30	36	40	33	31	34	36	60	40
Minimum Sample Sizes (Unweighted N's)	1188*	169	146	144	152	615	140	149	123	157	570

* Respondents with missing data were excluded.

**These percentages refer to children who were in a room where an oven, range, or stove was turned on (variable gstv) and where the oven, range, or stove was gas burning (variable gore).

a. Gender-Age Differences

In general, these comparisons yield only a few notable differences. The older children, particularly 9-11 year olds, tend to have higher rates of potential exposure to several pollution sources --- this is true for gasoline fumes (as well as other sources of air pollution that may be found near gas stations, parking garages, and auto repair shops) and pesticides among the older boys, and for glues, cleaning agents and aerosols for both boys and girls. In the case of aerosols, potential exposures increase regularly with age for boys and girls, and reach a peak prevalence at 60% among girls 9-11 years old. The prevalence of potential exposure to tobacco smoke is typically higher for girls than boys, except for infant girls for whom the prevalence is lowest at 28%. The prevalence of potential exposure to gas oven fumes is consistently high (51-60%) for all age-gender groups. The remaining comparisons do not reveal large or systematic differences.

b. Season and Region Differences

Table 4.12 shows estimates of the prevalence of potential exposure to pollution sources by season and by region. With the exception of potential exposure to aerosols, which was substantially higher in the Southern Coast region than

TABLE 4.12 Percentage of Children Potentially Exposed to Selected Potential Air Pollution Sources on Diary Day By Season and Region

Potential Source of Air Pollution	Season					Region			
	Winter (Jan-Mar)	Spring (Apr-June)	Summer (July-Sept)	Fall (Oct-Dec)	All Seasons	So.Coast	Bay Area	Rest of State	All Regions
Tobacco Smoke	34	41	40	37	38	36	40	39	38
Gasoline Fumes	6	10	15	11	11	9	14	11	11
Gas Oven Fumes	63	63	50	57	58	57	63	56	58
Glue	11	9	12	14	12	13	11	11	12
Oil-based paint	1	0	2	4	2	2	2	1	2
Solvents	3	1	3	5	3	3	3	3	3
Pesticides	6	6	7	4	6	8	5	4	6
Soaps/Detergents	82	83	84	86	84	84	84	84	84
Cleaning Agents	25	22	27	24	24	26	20	24	24
Personal Care Aerosols	34	37	34	42	37	44	27	34	37
Minimum Sample Size* (Unweighted N's)	313	200	403	267	1188	221	260	704	1188

* Respondents with missing data were excluded.

elsewhere (at 44%), the regional comparisons did not reveal major differences.

There were seasonal variations in prevalence with respect to potential exposures to several pollution sources. Potential exposure to gasoline fumes appear to be most common in the Summer months. On the other hand, potential exposures to gas oven fumes were lowest in the Summer and uniformly higher in the rest of the year. Potential exposures to glue, oil-based paints, solvents and personal care aerosols were most prevalent in the Fall months.

6. Comparison with Estimates Derived for Other Time-Diary Surveys

a. Comparisons with the ARB Adult Survey

With the exceptions noted below, the data from the survey of children's activity patterns can be compared directly with the data from the ARB adult survey conducted in 1987-88. Both studies used comparable statewide probability samples and were conducted across an entire year. The two-year time interval separating the two studies should not introduce significant problems in comparisons.

Before proceeding to these comparisons in Table 4.13, several differences in coding procedures that were

introduced into the child study need to be described. The main change involved passive, "being with" or "watching" activities that children (or their adult surrogates), reported in their diary accounts. These were designated with the code 8 in the second digit of the activity code. Children reported being with or watching adults and other children as these other people worked (code 08), did housework (code 18), cared for children (code 28), did shopping or errands (code 38), engaged in personal care for themselves (code 48), did educational activity (code 58), did organizational activity (code 68), visited or engaged in social life (code 78), were involved in sports or recreational activities (code 88) and talked or used the mass media (code 98); the 98 code was also used to identify most activities of infants under 2 years of age. This second digit 8 code had no counterpart in the adult activity codes.

Travel activity was also coded somewhat differently in the child study in that all "return" trips to the respondent's home were coded as 199 and not according to the main purpose of the trip (i.e., a return trip from work to home was not coded as 09 or a return trip from school as 59 as in the Adult Survey). This, of course, resulted in a very large number of trips being coded into this residual 199 category. Distributing these code 199 trips in equivalent proportion to the "to" portion of the trip may give a rough estimate of

how these travel numbers in the two surveys could be made equivalent. Thus, trips to recreation (code 89), personal care (code 49) and shopping (code 39) activities are the largest categories in the designated travel codes (-9) and should therefore also be the major origin points for the code 199 trips home.

Among some of the other major differences in the children's "coding" scheme were:

1) All paid or volunteer work done by children was coded as 05 (that is as a "second job") and the 01 code used for adult work time was not used at all. Codes 07 and 08 for ancillary activities at work were not used.
2) Code 06 for meals at work (or school) in the adult study mainly consisted of meals at school or daycare facilities for the child sample.
3) Code 18 for pet and animal care in the adult study was changed to code 19 in the child study (to maintain consistency with the -8 codes described above).
4) Code 28 for being at the dry cleaners in the adult study was changed to code 301 in the child study.
5) Codes 52 and 57 were not used in the adult study, but they were used to code daycare-related activities in the child study.

6) Code 60 was used to code <u>all</u> organizational activity in the child study, and was not differentiated into code 61 through 68 as in the adult study.

7) Code 80 in the child study included more active forms of play and "roughhouse" activities of children -- such as climbing trees, playing on swings, or riding on a rollercoaster. These would have been coded as play or outdoor activities in the adult study.

8) Adult code 87 for indoor games in the child study included all of the miscellaneous and general play activities of children, including some reading activity of children under 5.

In addition, there were some other streamlining or minor changes in coding procedures, but these should not affect the overall difference in results.

Table 4.13 shows the average minutes per day per activity for the Adult and Children's Surveys. Where possible, we have used the adult activity codes to represent the activities of both adults and children. Children's activity codes with no adult counterpart are given in parentheses. The entry "NC" in a row means that the corresponding activity code pertains to adults only or to children only. A zero entry in this table (and in Table 4.14 below)

TABLE 4.13: ACTIVITY DIFFERENCES BETWEEN ARB ADULT AND ARB CHILD STUDIES

(Average time in minutes per day)

00-49 NON-FREE TIME	Adult 1987-88	Child 1989-90
00-09 PAID WORK		
n =	(1579)	(1200)
00 (not used)		
01 Main job	205	NC
02 Unemployment	1	0
03 Travel during work	7	0
05 Second job	3	0
06 Eating	5	8
07 Before/after work	1	NC
08 Breaks	2	NC
(08) Watch adult work	NC	1
09 Travel to/from work	26	1
10-19 HOUSEHOLD WORK		
10 Food preparation	30	3
11 Meal cleanup	11	1
12 Cleaning house	22	5
13 Outdoor cleaning	9	2
14 Clothes care	8	1
15 Car repair/maintenance (by Respondent)	5	0
16 Other repairs (by Respondent)	9	1
17 Plant care	3	1
18 Animal care	3	7
19 Other household	7	5
(199) Travel to home	NC	28
20-29 CHILD CARE		
20 Baby care	3	0
21 Child care	6	0
22 Helping/teaching	2	0
23 Talking/reading	1	0
24 Indoor playing	2	0
25 Outdoor playing	2	0
26 Medical care - child	0	0
27 Other child care	2	0
28 At Dry cleaners	1	0
29 Travel, child care	3	0
30-39 OBTAINING GOODS AND SERVICES		
30 Everyday shopping	8	2
31 Durable/house shop	18	4
32 Personal services	1	0
33 Medical appointments	3	0
34 Govt/financial service	3	0
35 Car repair services	1	0
36 Other repair services	0	0
37 Other services	2	0
38 Errands	1	8
39 Travel, goods and services	24	6
40-49 PERSONAL NEEDS AND CARE		
40 Washing, etc.	20	19
41 Medical care	4	0
42 Help and care	4	0
43 Meals at home	47	66
44 Meals out	27	14
45 Night sleep	480	628
46 Naps/day sleep	17	43
47 Dressing, etc.	24	18
48 Not Ascertained activities	2	2
49 Travel, personal care	21	6

50-59 FREE TIME	Adult 1987-88	Child 1989-90
50-59 EDUCATION AND TRAINING		
n =	(1579)	(1200)
50 Students' classes	8	72
51 Other classes	1	0
(52) Unspecified day care	NC	19
54 Homework	8	9
55 Library	0	0
56 Other education	1	4
(57) Hanging out	NC	2
59 Travel, education	2	4
60-69 ORGANIZATIONAL ACTIVITIES		
60 Professional/union	0	
61 Special interest	0	
62 Political/civic	0	
63 Volunteer/helping	1	
64 Religious groups	1	
65 Religious practice	5	4
66 Fraternal	0	
67 Child/youth/family	1	
68 Other organizations	2	
69 Travel, organizations	2	1
70-79 ENTERTAINMENT/SOCIAL ACTIVITIES		
70 Sports events	2	1
71 Entertainment, events	4	2
72 Movies	2	2
73 Theatre	1	0
74 Museums	1	0
75 Visiting	25	4
76 Parties	6	1
77 Bars/lounges	4	0
78 Other social	0	1
79 Travel, events/social	13	2
80-89 RECREATION		
80 Active sports	13	50
81 Outdoor	3	22
82 Walking/hiking	5	52
83 Hobbies	1	0
84 Domestic crafts	4	0
85 Art	0	10
86 Music/drama/dance	3	3
87 Games	5	90
88 Computer use	3	NC
(88) Watching others recreate	NC	2
89 Travel, recreation	5	11
90-99 COMMUNICATION		
90 Radio	2	0
91 TV	139	135
92 Records/tapes	2	1
93 Read books	6	4
94 Reading magazines/other	17	6
95 Reading newspaper	14	0
96 Conversations	15	8
97 Writing	9	0
98 Think, relax	9	NC
(98) Being a baby	NC	34
99 Travel, communication	4	3
*All Activities	1435	1439

* The totals are less than 1440 minutes due to rounding error.

Note: "NC" means that the codes for the adult and children's surveys were not comparable.

indicates that the average time was less than $^1/_2$ minute per day. The total time for all activities differs from 1440 minutes due to rounding error.

Keeping in mind the instances of coding differences between the Adult and Children's Surveys, we note the following similarities and contrasts between the two samples:

Activities: Table 4.13 shows that the work-related times of this children's sample are very small, averaging less than a half minute per day for paid (second) jobs and about a minute per day for work-related travel. The time young children spent eating in school cafeterias (8 minutes per day) is about the same overall as what adults report for eating meals at the workplace (and at school, if they take classes).

Children's time on household chores is much lower than for adult respondents. The one exception is for pet and animal care (7 minutes per day) -- which is larger for the child sample than for the adult sample (3 minutes per day).

Children also spend much less time than adults caring for (other) children in the household and less time as well doing shopping and obtaining personal services. Children spend as much time accompanying or watching adults on

errands (8 minutes per day) as they do shopping for themselves on their own (about 6 minutes per day).

Time on washing and personal hygiene is about the same for adults and children, but time spent dressing is slightly less for children. Children spend more time eating meals at home but less time eating meals away from home. Children spend much more time sleeping than adults, both at night and in the form of naps during the day.

Not surprisingly, children spend much more time in school and day care activities than adults -- although that figure (72 minutes per day) is still less than half the amount of overall time than adults spend doing paid work (205 minutes per day).

Children also spend less than a third as much time as adults in organizational activities (4 minutes per day vs. 10 minutes per day). Most of this children's time is spent at religious services and church-related activities. Children further spend much less time visiting and socializing <u>per se</u> than adults -- that is <u>not</u> as part of playing with other children. (Table 4.14 shows that children do spend more time in other people's homes than do adults.) Children spend only a little less time than adults going out to sports events, movies and other forms of social entertainment.

Table 4.14: AVERAGE MINUTES SPENT IN DIFFERENT LOCATIONS

Variable	1. Mean Adults+Teens (1762)	2. Mean Children (1200)	Label
WC01	74	46	In Kitchen
WC02	196	233	In Living Room
WC03	21	21	In Dining Room
WC04	33	19	In Bathroom
WC05	524	674	In Bedroom
WC06	7	0	In Study
WC07	9	2	In Garage
WC08	0	0	In Basement
WC09	3	0	In Utility Room
WC10	1	1	Pool, Spa
WC11	27	62	In Yard
WC12	22	18	Room To Room
WC13	3	1	Other HH Room
WC01-13	921	1078	Total At Home
WC21	70	2	At Office
WC22	35	0	At Plant
WC23	12	5	At Grocery Store
WC24	34	11	At Shopping Mall
WC25	40	109	At School
WC26	13	3	Other Public Place
WC27	14	3	At Hospital
WC28	28	6	At Restaurant
WC29	8	0	At Bar-Nightclub
WC30	6	6	At Church
WC31	4	3	At Indoor Gym
WC32	61	80	At Other's Home
WC33	11	0	At Auto Repair
WC34	12	49	At Playground
WC35	7	3	At Hotel-Motel
WC36	0	0	At Dry Cleaners
WC37	2	0	At Beauty Parlor
WC38	2	4	At Varying Locations
WC39	12	3	Other Indoor
WC40	33	5	Other Outdoor
WC21-40	405	293	Total Away
WC51	73	43	In Car
WC52	18	13	In Van
WC53	10	6	Walking
WC54	1	0	At Bus Stop
WC55	4	3	On Bus
WC56	1	0	On Rapid Train
WC57	1	0	Other Travel
WC58	1	0	On Airplane
WC59	1	1	On Bicycle
WC60	1	0	On Motorcycle
WC63	0	1	Stroller
WC69	0	1	Other
WC51-69	111	69	Total In Travel
	1440	1440	TOTAL
	73	141	Outdoors
	1253	1230	Indoors
	111	69	In-transit
	2	0	Location not known

The largest difference in free time activities shows up for playing sports and games, with children spending three times as much time as adults engaged in sports and other vigorous activities and more than 15 times as much time in simple play activities. For children in this culture, of course, such play may represent their "work" time.

TV time is about the same for children as for adults, while children's reading time is lower -- especially for periodicals like magazines and newspapers. Conversation and correspondence times are also far lower for children.

To recapitulate the major differences, then, children spend much <u>more</u> time than adults sleeping, playing sports and games, going to school and day care facilities and in general passive leisure. Children spend far <u>less</u> time doing paid work, housework, child care, shopping, organizational activity, visiting, reading periodicals, conversation and correspondence.

<u>Locations</u>: Differences between the adult/teen sample and the child sample in time spent in locations are shown in Table 4.14. Unlike Table 4.13, the "adult" entries in the table include the data for adolescents (persons less than 18 years of age) as well. Nonetheless, the overall trends tend

to mirror most of the activity differences shown in Table 4.13.

For example the larger times spent by children in bedrooms reflect the great sleep time for children in Table 4.13 and the greater play times of children are reflected in the greater times spent in yards, in playgrounds and at other people's homes; and, of course, the greater time children spend in schools and day care centers reflect their greater educational activity.

In the home environment, children spend <u>less</u> time than older people in the kitchen, in the bathroom, in the study, in the garage and in "other" rooms in the house. Children spend much less time at work locations, stores and other commercial environments -- including bars and nightclubs and auto repair facilities. Children also spend less time in travel modes than adults -- except on buses, on bicycles and in strollers.

As shown in the aggregate figures at the bottom of Table 4.14, children spend slightly less time in all indoor locations than adults (1230 vs 1253 minutes per day). They also spend less time in transit (69 minutes vs 111 minutes). Both of those discrepancies are made up by the greater time spent outdoors, which is almost double that for adults (141 minutes vs 73 minutes). Thus, while children run less risk

of being in motor vehicles and in indoor environments like kitchens, bathrooms, bars-nightclubs, and auto-repair facilities, they do spend more than a hour more per day in outdoor environments than do adults.

b. Comparison with 1981 National Survey

To our knowledge, only two prior studies of young children's daily time use have been conducted. One of these was a 1981 national sample of 229 children aged 3-11 conducted by the University of Michigan's Survey Research Center (Timmer, Eccles and O'Brien, 1985). A second even smaller-scale survey of 169 children aged 0-18 was conducted by PEI Associates in 1985 in Cincinnati, Ohio (Johnson, 1989). In this section, we compare the 1981 national study and the ARB Children's Survey with respect in time devoted to selected activities.

The Michigan study was a small pilot study that mainly demonstrated that time-diary data could be collected for young children and that new activity codes needed to be developed for child samples. It was conducted in two periods of 1981: February through April and September through October. As in the ARB study, older children completed their own diaries, children aged 6-8 helped one of their parents complete the diary and children 5 and younger had their activities reported on fully by a main caretaking parent. The sample was not fully representative in that it

consisted only of children of adult respondents who had initially been interviewed six years earlier (in the Fall of 1975) and who had stayed in the panel study across the four subsequent re-interviews. The overall adult sample, then, consisted of less than 30% of the original probability sample and may be of limited generalizability for that reason.

Nonetheless, this pioneering study did generate detailed quantitative diary data from a broad cross-section of young respondents in this survey, who came from all regions and areas of the country. Data were collected for a weekday and a weekend day for each respondent. There are some complications raised by the different codes than those used in the ARB child study as will be noted, but many of the comparisons seem straightforward enough. In order to make the data as comparable as possible and to achieve maximum sample sizes given the small number of respondents interviewed, the data published in the University of Michigan volume of study results (Juster et al, 1985, p.366-369) have been aggregated by day of the week and converted into hours and tenths of hours per week in Table 4.15. Not all activities are described because several were not presented in this Michigan publication of results. These are shown with ARB codes at the bottom of Table 4.15, and include all travel, child care and shopping among other activities.

TABLE 4.15: Comparisons of ARB Children's Data with those from 1980-81 University of Michigan National Study of Time Use
(Data are shown in hours per week)

	AGED 3-11				AGE (Boys and Girls Combined)							
	Boys		Girls		3-5		6-8		9-11		TOTAL	
	National (n=118)	Cal (n=452)	National (n=111)	Cal (n=442)	National (n=67)	Cal (n=335)	National (n=69)	Cal (n=278)	National (n=93)	Cal (n=281)	National (n=229)	Cal (n=894)
Paid work(05,08)	1.4	0.2	0.1	0.1	0	0.1	1.3	0.1	1.0	0.3	0.8	0.2
Housework(10-19)	2.5	3.2	3.2	3.6	1.7	2.1	2.2	3.6	3.0	4.7	2.8	3.4
Eating(43,44,06)	9.4	9.1	9.3	9.2	9.5	10.3	9.4	9.0	8.7	7.9	9.4	9.2
Sleeping(45)	69.5	71.7	69.8	72.7	73.6	74.1	71.0	72.7	65.5	69.3	69.6	72.2
Other personal care (40,41,42,47,48)	5.0	4.3	5.3	4.7	5.0	4.9	5.6	5.0	4.8	3.6	5.1	4.5
School (50,51,52,53,56,57,58)	21.0	12.3	21.6	14.0	11.4	8.8	24.3	16.3	26.3	15.3	21.3	13.2
Studying(54,55)	1.3	1.4	1.6	1.5	0.2	0.2	0.7	2.0	2.8	2.4	1.4	1.5
Church (60)	2.3	0.5	2.4	0.3	2.2	0.2	2.6	0.6	2.5	0.6	2.3	0.4
Visiting(75-78)	2.1	0.7	2.0	1.2	1.5	0.5	1.5	0.4	1.3	2.0	1.4	0.9
Sports(80)	3.2	8.2	1.8	5.9	0.5	4.6	3.0	7.9	3.2	9.2	2.5	7.0
Outdoors(81,82)	1.8	8.6	1.4	7.8	0.6	10.2	1.7	8.3	2.0	5.7	1.6	8.2
Hobbies(83-84)	0.3	0.1	0.5	0.1	0.1	0.0	0.3	0.2	0.3	0.2	0.4	0.1
Art activities(85-86)	0.5	1.6	0.5	2.2	0.6	2.4	0.5	1.8	0.4	1.5	0.5	1.9
Playing indoors (87,875-879)	17.3	10.3	18.5	8.9	31.5	13.9	15.3	7.8	8.5	6.3	17.9	9.6
TV(91,914,915)	19.1	19.8	14.7	18.6	13.0	16.3	12.8	18.9	18.3	23.1	16.9	19.2
Reading or Being read to (93,94,95,937,949)	1.2	1.4	0.9	1.4	0.9	1.2	0.9	1.6	1.1	1.4	1.3	1.4
Conversation(96)	1.3	1.3	1.2	0.9	*	1.4	*	1.0	*	0.9	1.3	1.1
Other passive leisure (98)	1.3	0.5	1.6	0.8	1.0	0.5	0.4	0.6	0.4	0.9	1.4	0.7
Not ascertained(1)	2.5	0.2	3.1	0.1	4.2	0.3	1.4	0.1	2.4	0.2	2.8	0.2
**Other activities	5.0	12.1	8.5	13.7	*	15.6	*	10.1	*	12.4	6.9	12.9

* Not available for National Survey.

** Not strictly comparable. For ARB survey, includes the following codes:

Travel 09,29,39,49,59,69,79,89,99,199
Childcare 20-27
Shopping 30-38
Naps 46
Entertainment 70-74,711
Watching others recreate 88
Radio, records, letters 90,92,97

Table 4.15 first shows a number of close correspondences in overall time expenditures for children aged 3-11 -- for housework, eating, sleeping, personal care, studying, TV viewing, reading, and conversation.

The ARB data show higher average times than in the 1980-81 national study in terms of time spent in active sports, in outdoor activities and in arts-related activities. Many of these differences appeared in comparing the ARB and national data for adult respondents.

On the other hand, the ARB data are notably lower than the national figures in the times spent in indoor play activities, in work activities, in school activities, at church and religious services, and in visiting. The ARB data are also lower in missing time periods, that is, in time spent in activities that were not reported.

These differences in sports, outdoors and play activities may be resolved by the following comparison of all the related activity codes:

	National	California	California-National
Sports	2.5	7.0	+5.5 hrs
Outdoors	1.6	8.2	+6.6 hrs
Play	17.9	9.6 (indoor only)	-8.3 hrs
	22.0	24.8	+2.8 hrs

The table suggests that the Michigan coding conventions, which put roughhouse and hard play activities into play rather than sports and which also code outdoor play as play, may have had much to do with this apparent discrepancy in results. Taking this into account, the net difference in all sports, outdoors, and play activities then becomes only about 3 hours per week. The fact that physical education classes were classified under education (and not as sports as in the ARB study) probably explains most of the remaining difference of 3 hours.

Gender: In Table 4.15, many of same gender differences for the 3-11 age group can be seen in the California as in the national data. These include the greater times that boys spend at work, playing sports, in outdoor activities, TV viewing, and conversation. Girls, on the other hand, spend more time in both samples doing housework (although not as much more than boys that might be expected), personal grooming, in school activities, and resting. Unlike the national data, girls in California spend more time visiting and in art activities. Boys have more missing time periods than girls.

Age: As in the national survey, older children in California spent more time in paid work, doing housework, going to school, studying, playing sports, and watching TV. On the other hand, younger children in both surveys spent

more of their time eating, sleeping, doing art and other expressive activities, and playing in general.

Nonetheless the overall tendency in Table 4.15 is toward far more convergences than divergences -- both in terms of general time allocations for children and in terms of pattern of association between gender and age and activity times.

CHAPTER V: Conclusions

1. Summary of Principal Findings

a. Field Results

One of the most important findings is that surveys such as the California Children's Activity Survey are clearly feasible and can provide data of acceptable quality. The response rate for this survey was considerably higher than the 70% standard normally used in the survey field. There were fewer than average refusals, and in general, the survey respondents found the interview experience enjoyable and experienced little difficulty in answering the questions. The uncodable and "don't know" responses on the diary accounted for an average of only 2 minutes per diary day for the activity responses and less than 1 minute per diary day for the location responses. In the vast majority of cases, we were able to interview the adult in the household who had spent the most time with the selected child on the diary day, and furthermore, most of these adults (58%) had spent at least 8 waking hours with the child on the diary day. The interviewing staff rated their confidence in the diary responses as reasonably confident or better in all but a small number of instances.

b. Findings with Respect to Time Spent in Various Activities and Locations

The field results show wide diversity in individual activity patterns, as was observed in the adult study. That is, the percentage of doers and their time spent in a location or activity varied widely. Therefore, when analyzing these data, distinctions must be drawn between the entire sample and just the doers. The following findings refer to those based on the entire sample, unless stated otherwise.

As expected, there were pronounced differences in activity and location patterns between age groups. Sizable age differences in average times spent (in minutes per diary day) were observed for eight of ten major activity categories and for five of seven major location categories. Time spent indoors decreased systematically with age, suggesting that air pollution in indoor microenvironments may be a particularly relevant concern for infants. Differences in location and activity patterns for boys and girls were generally not large, though boys show slightly higher outdoor times than girls except among infants.

Seasonal differences are observed for five of ten activities and four of seven major locations. Most of these differences are of the form Summer vs. other seasons. As expected, children's outdoor time is higher in the summer

months, although trends toward year-round school sessions may alter this activity pattern in the future. In contrast, there are few large regional differences in time spent in the major activities and locations.

c. Findings with Respect to Potential Exposures to Sources of Air Pollution

Average diary-day potential exposure times for environmental tobacco smoke, gasoline fumes, and gas oven fumes showed few large differences by gender or age (Table 4.9). However, in comparisons between potentially exposed and unexposed children (Table 4.11), the percentage in proximity to environmental tobacco smoke was somewhat higher for girls, except for a relatively low prevalence among infant girls. Similarly, the percentage in proximity to personal care aerosols was somewhat higher for girls, especially in the 9-11 year old group. Furthermore, there were age differences in favor of higher potential exposure rates for older children to glue, pesticides, household cleaning agents, and personal care aerosols. Region was generally not related to potential exposure prevalence (except for higher rates of proximity to personal care aerosols among girls living in the Southern Coast). Rates of potential exposure to gasoline fumes were elevated in the Summer months, while potential exposure to gas oven fumes was highest in the Winter and Fall.

d. Findings with Respect to Comparisons with Other Surveys

Although the rules for coding activities in the survey of children's activity patterns were somewhat different than those used for the ARB adult survey conducted in 1987-88, it is possible to make broad comparisons between activity and location patterns reported in the two surveys. Comparisons between adult and children's surveys revealed the following differences: 1) with respect to activities, children spend much more time than adults sleeping, playing sports and games, going to school and day care facilities and in general passive leisure. Children spend far less time doing paid work, housework, child care, shopping, organizational activity, visiting, reading periodicals, conversation and correspondence; 2) with respect to locations, children spend slightly less time in all indoor locations than adults (1230 vs 1253 minutes per day). They also spend less time in transit (69 minutes vs 111 minutes). Both of those discrepancies are made up by the greater time spent outdoors, which is almost double that for adults (141 minutes vs 73 minutes). Thus, while children run less risk of being in motor vehicles and in indoor environments like kitchens, bathrooms, bars-nightclubs, and auto-repair facilities, they do spend more than an hour more per day in outdoor environments than do adults.

A comparison between the children's activity pattern survey and a 1981 national sample of children aged 3-11 revealed similarities in the general allocation of time over activities and in the pattern of association between activity times and age and gender. The major differences between the surveys - greater time in sports and outdoor activities among California children than among the national sample - appear to result from differences in the conventions used for coding various kinds of play activities.

2. Directions for Future Research

The California Children's Activity Survey is one of the few, large-scale, probability-based surveys of children's activity and location patterns in existence. It is the first survey of its kind to use computer-assisted telephone interviewing (CATI) to implement a 24-hour time diary for a large, representative sample of young children. The relatively high response rate for this survey, the fact that most questions, including the diary component, were answered with little difficulty (and very little missing data), and that most of the adult informants spent enough time with the selected child on the diary day to provide reliable answers, suggest strongly that studies of this kind can produce data of acceptable quality. Indeed, we believe that the California Children's Activity Survey establishes a

methodology and a standard of performance against which future surveys of children's activity patterns should be evaluated.

This report gives only a preliminary analysis of this very rich source of data on children's activity patterns and exposures to sources of air pollution. In what follows, we indicate some directions for future work with these data, focussing on opportunities for additional data analysis.

a. Characterization of Time Spent in Different Micro-environments

The California Children's Activity Survey was designed to provide estimates of time spent in a large number of microenvironments and of potential exposure to sources of air pollution found in such environments. Our preliminary analysis focused on broad classes of activities and locations, aggregating over 115 uniquely coded activities and 62 locations to produce 10 activity categories, 6 location categories, and 6 indicators of time spent indoors and outdoors. The same kind of analysis can be conducted for much more detailed activities and locations, or for different ways of combining activities and locations to create aggregate measures. The choice of level of detail and of rules for combining activities and locations depends on the purpose to be served. Since the data are given in

detailed (i.e., disaggregated form) on the data tape supplied to the Air Resources Board, this choice can be made by the final user.

There are at least two principles that can be used to guide the construction of aggregate activity and location measures: (1) a priori rules for grouping detailed activities and locations that combine those with similar potential for exposures to particular sources of air pollution (e.g., time traveling in gasoline-powered vehicles), and (2) combinations derived from the associations between activities and locations -- that is, grouping activities and locations that "cluster" in the diary day. The latter procedure is essentially one of defining an empirical rule for grouping activities and locations based on the correlations between them in the sampled population. Such a rule can be derived from application of cluster analysis algorithms available in most mainframe statistical software packages (e.g., SPSS and SAS). Actually, these procedures can be done in tandem, first defining groups of activities and locations on an a priori basis, then using cluster analysis to find additional groupings within broadly defined classes of activities and locations.

b. Analysis of the Relation Between Potential Exposures and Selected Independent Variables

The findings presented in Chapter IV of this report indicate that there are significant differences among various subpopulations of California children with respect to time-spent indoors and outdoors, time-exposed to environmental tobacco smoke and gas oven fumes, and prevalence of potential exposure to common sources of air pollution. Our analysis can be extended by incorporating additional independent variables (e.g., family size, urban vs. rural location, household income, employment status of the adult informant) in a multivariate analysis. For example, it would be of interest to provide a sociodemographic "profile" of the population subgroups most commonly exposed to each potential source of air pollution covered by the survey. This can be done, via ordinary regression analysis and/or logistic regression, by noting which groups (e.g., younger children vs. older children, girls vs. boys, urban vs. rural, high income vs. low income, etc.) appear to have elevated exposures as judged by the pattern of values of the regression coefficients for each of the subgroups. Our preliminary experiments with the use of multivariate analysis of potential exposure times (for tobacco smoke and gas oven fumes) suggest that care should be taken in applying regression techniques due to the skewed nature of the distributions. It is necessary to make allowance for

the large number of zero potential exposure times by conducting separate analyses of a) the prevalence of potential exposure (potentially exposed vs unexposed, using logistic regression methods) in the total sample and b) potential exposure times in the subsample of children with non-zero exposure times. In addition, it may be advisable to experiment with transformations of raw data before applying multivariate techniques.

c. "Internal" Comparisons Relevant to the Reliability and Validity of Survey Responses

Like all survey responses, answers to questions about children's activity patterns are subject a variety of errors: for example, omissions due to forgetfulness or lack of information, deliberate distortion in order to make the reporting task easier or to avoid "socially undesirable" responses, etc. Verification of such reports against an external standard is at best very expensive and at worst not feasible at all. Thus it is desirable to include in the survey instrument itself some items that allow for an assessment of data quality.

The California Children's Activity Survey included a few items that may be useful in identifying bias in reports about children's activities on the diary day. These were a) the amount of time the adult informant spent with the

selected child on the diary day, and b) an interviewer assessment of "confidence" in the diary responses. Although, as we have noted above, interviewers were generally confident in the diary responses and most adult informants had first-hand knowledge of the child's activities on the diary day, it would be useful to explore the relation between these indicators and i) the number of activities and locations reported and ii) the number of minutes unaccounted for in the diary reports. A reasonable a priori hypothesis is that adults who spent more time with the child also reported more activities, more potential exposures, and fewer unaccounted minutes. Such a finding would suggest that underreporting is most acute when the adult informant has the least first-hand information about the child's activities.

If preliminary analysis suggests that underreporting is likely in some cases, it may be worth examining the relationship between the adult informant's time spent with the child and such variables as exposures on the diary day and time spent in specific locations and activities. In addition, time spent with the child on the diary day can be routinely included as an independent variable in multivariate studies of selected dependent variables (such as potential exposure times and potentially exposed/not exposed). The predictive power of "time spent with child"

would give a rough measure of the importance of its effect on underreporting, controlling on other independent variables (e.g., gender, age, race/ethnicity, etc.).

REFERENCES

Allen, C., "Photographing the TV Audience," *Journal of Advertising Research*, 1968,8(1):2-8.

ARB, (Air Resources Board), **Activity Pattern Study of California Residents.** ARB Contract No. A6-177-33 with University of California, Berkeley. Sacramento, CA, Research Division, 1987.

ARB, (Air Resources Board), **Request for Proposals, Study of Children's Activity Patterns.** Sacramento, CA, Research Division, February, 1988.

Bechtel, R., Achepohl, C., and Akers, R., "Correlates Between Observed Behavior and Questionnaire Responses in Television Viewing" in E.A. Rubenstein, G.A. Comstock, and J.P. Murray, (eds.), **Television and Social Behavior, Reports and Papers.** Vol.4: **Television in Day-to-Day Life: Patterns and Use.** Washington, D.C.: U.S. Government Printing Office, 1972.

Beschen, D.A., **Nationwide Personal Transportation Study: Transportation Characteristics of School Children, Report No. 4.** Washington, DC., U.S. Department of Transportation, Federal Highway Administration, 1972.

Burdach, S., Wechselberg, K., "Gesundhertsschaden in der schule," *Forstchr. Med.*, 1986,98:379-384. As cited in WHO, 1985.

Carpenter, C.J., Huston-Stein, A., "Activity structure and sex-typed behavior in preschool children," **Child Development** 1980, 51:862-872.

Carpenter, C.J., Huston, A.C., Spera, L., "Children's use of time in their everyday activities during childhood," in M. Block and A. Pellegrini (eds.), **The Ecological Context of Children's Play**, Ablex Publishing Co., New Jersey, 1988.

DeGrazia, S., **Of Time, Work, and Leisure.** New York: Twentieth Century Fund, 1962.

EPA (U.S. Environmental Protection Agency), **Air Quality Criteria for Lead, Final Draft.** EPA-600/8-83/028 (a-d)F. Research Triangle Park, NC, 1986.

Goyder, J., **The Silent Minority: Nonrespondents on Sample Surveys.** Cambridge, U.K.: Polity Press, 1987.

Harvey, A. and Elliott, D., **Time and Time Again.** Ottawa-Hill, Canada: Employment and Immigration Commission, 1983.

Helwig, H. "Wie ungefahrlich ist formaldehyde?" *Deut. Med. Wochenschr* 1977,102:1612-1613. As cited in WHO, 1985.

Hill, D., "Implications of Home Production and Inventory Adjustment Processes for Time-of-Day Demand for Electricity" in F. Thomas Juster and Frank Stafford, (eds.), **Time, Goods, and Well-Being.** Ann Arbor, Michigan: Institute for Social Research, The University of Michigan, 1985.

IPCS (International Programme on Chemical Safety), **Environmental Health Criteria 59: Principles for Evaluating Health Risks from Chemicals During Infancy and Early Childhood: The Need for a Special Approach.** Geneva, World Health Organization, 1986.

Johnson, T., **Human Activity Patterns in Cincinnati, Ohio.** EN-6204 for Research Project 940-6. Palo Alto, CA.: Electric Power Research Institute, 1989.

Juster, F. T. and Stafford, F.P. (eds.), **Time, Goods and Well-Being.** Ann Arbor, Michigan: Institute for Social Research, University of Michigan, 1985.

Juster, F. T., "The Validity and Quality of Time Use Estimates Obtained from Recall Diaries" in F. Thomas Juster and Frank P. Stafford (eds.), **Time, Goods, and Well-Being.** Ann Arbor, Michigan: Institute for Social Research, The University of Michigan, 1985.

Medrich, E.A., Roizen, J., Rubin, V., Buckley, S., **The Serious Business of Growing Up: A Study of Children's Lives Outside School.** Berkeley, CA.: University of California Press, 1982.

Michelson, W.M., **From Sun to Sun: Daily Obligations and Community Structure in the Lives of Employed Women and Their Families.** Totowa, NJ.: Rowman and Allanheld, 1985.

NRC, (National Research Council), **Environmental Tobacco Smoke: Measuring Exposures and Assessing Health Risks.** Washington, D.C., National Academy Press, 1986.

Ott, W.R., **Human Activity Patterns: A Review of the Literature for Estimation of Exposure to Air Pollution, Draft Report.** Washington, D.C., U.S. EPA, 1982.

Robinson, J.P., **How Americans Use Time: A Social-Psychological Analysis of Everyday Behavior.** New York: Praeger, 1977. (Further analyses were published in **How Americans Used Time in 1965-66.** Ann Arbor: University Microfilms, Monograph Series, 1977.)

Robinson, J.P., "The Validity and Reliability of Diaries versus Alternative Time Use Measures," in F. T. Juster and F. Stafford (eds.), **Time, Goods, and Well-Being.** Ann Arbor, Michigan: Institute for Social Research, University of Michigan, 1985, pp. 33-62.

Robinson, J., and Holland J., "Trends in Time Use" in **Technology and the American Economic Transition,** Washington, D.C.: Office of Technology Assessment, U.S. Congress (OTA-TET-283), 1988.

Robinson, J.P., Personal communication, August, 1990.

Sandler, D.P., Everson, R.B., Wilcox, A.J., Browder, J.P., "Cancer risk in adulthood from early life exposure to parents' smoking," *Am. J. Public Health* 1985,75:467. As cited in Wallace, 1987, p.104.

Sexton, K. and Ryan, P.B., "Assessment of human exposure to air pollution: methods, measurements, and models,." in Watson, A., Bates R.R., Kennedy, D. (eds.), **Air Pollution, the Automobile, and Public Health: Research Opportunities for Quantifying Risk.** Washington, D.C.: National Academy of Sciences Press, 1987.

Stjernfeldt, M., Berglund, K., Lindsten, J., Ludvigsson, J., "Maternal smoking during pregnancy and risk of childhood cancer," *Lancet* 1986, June 14:1350-1352.

Szalai, A. (ed.), **The Use of Time: Daily Activities of Urban and Suburban Populations in Twelve Countries.** Mouton, The Hague: 1972.

Timmer, S.G., Eccles, J., O'Brien, K., "How children use time," in Juster and Stafford, 1985, Ch. 14.

Waksberg, J., Sampling Methods for Random Digit Dialing," *Journal of the American Statistical Association,* 1978,73:40-46.

Wallace, L., **The Total Exposure Assessment Methodology (TEAM) Study. Summary and Analysis: Volume 1.** EPA/600/6-87/002A. Washington, DC.: U.S. EPA, 1987.

WHO (World Health Organization), **Air Quality Guidelines: Indoor Air Pollutants, Third Draft.** Working Group on Indoor Air Quality, Radon and Formaldehyde, Dubrovnik, August 26-30. Geneva, Regional Office for Europe, 1985.

Wiley, J. and Robinson, J.P, **Activity Patterns of California Residents.** ARB Contract No. A6-177-33 with University of California, Berkeley. Sacramento, CA: Air Resources Board, 1991.