

**Sleep and snoring in infancy:
Prevalence and effects on cognitive development, maternal
mental health and family functioning**

Alicia M Piteo

School of Psychology
University of Adelaide

November, 2010

TABLE OF CONTENTS

<i>ABSTRACT</i>	<i>X</i>
<i>DECLARATION</i>	<i>XII</i>
<i>ACKNOWLEDGEMENTS</i>	<i>XIII</i>
<i>LIST OF TABLES</i>	<i>XV</i>
<i>LIST OF FIGURES</i>	<i>XXI</i>
<i>PREFACE</i>	<i>1</i>
<i>Chapter 1: A literature review about the relationships between sleep, snoring and developmental outcome</i>	<i>3</i>
<i>1.1 Overview</i>	<i>3</i>
<i>1.2 Sleep in infancy</i>	<i>4</i>
<i>1.3 Definition of SDB</i>	<i>8</i>
<i>1.4 Prevalence of snoring in the population</i>	<i>8</i>
<i>1.5 Factors associated with symptoms of SDB</i>	<i>14</i>
<i>1.5.1 Ethnic differences in the reported prevalence of SDB</i>	<i>14</i>
<i>1.5.2 Gender differences in the reported prevalence of SDB</i>	<i>15</i>
<i>1.5.3 Socio-economic and environmental factors associated with snoring frequency</i>	<i>16</i>
<i>1.5.4 Physiological factors associated with snoring frequency</i>	<i>17</i>
<i>1.6 The consequences of disruption to sleep on behaviour and cognitive development</i>	<i>18</i>
<i>1.6.1 The relationship between sleep and developmental outcome in infancy</i>	<i>19</i>
<i>1.6.2 The relationship between sleep in infancy and subsequent development in later childhood</i>	<i>23</i>
<i>1.6.3 The relationship between sleep disruption and behavioural problems in pre-school children and school aged children</i>	<i>24</i>
<i>1.6.4 Cognitive functioning and sleep in pre-school and school-aged children</i>	<i>27</i>

1.6.4.1 Neuropsychological domains	27
1.6.4.2 The relationship between sleep and cognitive functioning.....	27
1.7 The consequences of SDB on daytime functioning in children	30
1.7.1 Excessive daytime sleepiness.....	30
1.7.2 Behavioural consequences of SDB.....	32
1.8 Neurocognitive deficits associated with SDB	34
1.8.1 Executive Functioning.....	39
1.8.2 Learning and school performance	41
1.8.3 Memory	42
1.8.4 Intelligence.....	43
1.8.5 The risk of SDB in the premature population	45
1.9 Treatment of Sleep Disordered Breathing	47
1.10 Mechanisms for causes of neurobehavioral deficits in SDB	49
1.10.1 Normal brain development.....	51
1.10.2 Evidence from animal studies.....	51
1.11 Summary of Chapter.....	52
 Chapter 2: A literature review of the relationships between children's sleep, parental sleep, postnatal depression and family functioning.....	 55
2.1 Overview	55
2.2 Definition of Postnatal Depression (PND)	56
2.3 Symptoms and clinical presentation of PND	56
2.4 Consequences of PND.....	58
2.4.1 Effects on child temperament.....	58
2.4.2 Effects on maternal-infant relationship and later social functioning	59

2.4.3	<i>Effects on developmental outcome</i>	61
2.4.4	<i>Effects on the child's development of psychiatric disorders in later childhood</i>	65
2.4.5	<i>Effects on family</i>	66
2.5	<i>Child sleep and maternal sleep</i>	67
2.6	<i>The relationship between maternal sleep disruption and maternal functioning</i>	68
2.6.1	<i>In older children</i>	68
2.6.2	<i>In infants</i>	69
2.7	<i>The relationship between child sleep and maternal depressive symptomology</i>	69
2.7.1	<i>In older children</i>	69
2.7.2	<i>In infants</i>	70
2.8	<i>Are child sleep problems predictors or a consequence of maternal mental health?</i>	71
2.9	<i>Methodological issues</i>	72
2.10	<i>Family functioning</i>	74
2.10.1	<i>Conceptual definition</i>	74
2.10.2	<i>The relationship between family characteristics and child developmental outcome</i>	76
2.11	<i>The relationship between family and children's sleep problems</i>	77
2.12	<i>The relationship between family and Sleep Disordered Breathing (SDB)</i>	79
2.13	<i>Summary of the literature</i>	82
<i>Chapter 3: Research methods</i>		85
3.1	<i>Overview</i>	85
3.2	<i>Method</i>	85
3.2.1	<i>Design</i>	85

3.2.2 Participants.....	87
3.2.2.1 Phase 1	87
3.2.2.2 Phase 2	87
3.2.2.3 Phase 3	88
3.2.3 Measures	89
3.2.3.1 Phase 1	89
3.2.3.1.1 Demographic Information.	89
3.2.3.1.2 Information about the Infant: Sleep Problems and Respiratory Infection.....	90
3.2.3.1.3 Information about the Parent: Sleep.....	91
3.2.3.1.4 Information about the Parent: Parental Wellbeing (The Edinburgh Postnatal Depression Scale).	92
3.2.4 Measures	93
3.2.4.1 Phase 2 and Phase 3	93
3.2.4.1.1 Demographic Information.	93
3.2.4.1.2 Developmental assessment (Bayley Scales of Infant and Toddler Development–Third Edition).....	94
3.2.4.1.3 Sleep Actigraphy.....	95
3.2.4.1.4 Sleep Diary.	96
3.2.4.1.5 Maternal IQ (National Test of Adult Reading –2nd Edition).....	99
3.2.4.1.6 Family Functioning (The Family Assessment Device).	99
3.2.5 Procedure.....	100
3.2.5.1 Phase 1	100
3.2.5.2 Phase 2	104
3.2.5.3 Phase 3	105
Chapter 4: Prevalence of snoring and associated factors when infants are 0-3-months-old	107

4.1 Overview.....	107
4.2 Background/Rationale	107
4.2.1 Aims.....	109
4.3 Method	110
4.3.1 Participants	110
4.3.2 Measures.....	110
4.3.3 Procedure	110
4.3.4 Statistical Analyses.....	111
4.4 Results.....	112
4.4.1 Sample Characteristics.....	112
4.4.2 Sleep patterns	115
4.4.3 Prevalence of snoring.....	118
4.4.4 The influence of snoring frequency on sleep patterns	120
4.4.5 Factors associated with Snoring.....	121
4.5 Discussion.....	125
<i>Chapter 5: Effects of sleep and snoring on developmental outcome at 6-months-</i> <i>old.....</i>	<i>135</i>
5.1 Overview.....	135
5.2 Introduction	135
5.2.1 Aims.....	138
5.2.2 Hypotheses.....	138
5.3 Methods.....	139
5.3.1 Participants	139
5.3.2 Measures.....	140
5.3.3 Procedure	141

5.3.4 Statistical Analyses	141
5.4 Results	144
5.4.1 Sample characteristics	144
5.4.2 Descriptive statistics for sleep and developmental outcomes for the entire sample	148
5.4.3. Descriptive statistics for sleep variables for each of the study groups.....	150
5.4.4. The association between snoring frequencies and associated factors.....	151
5.4.5 Relationships between snoring frequency and developmental outcomes	154
5.4.5.1 Hypothesis 1: Infants reported as habitual snorers (≥ 3 nights/week) will have poorer cognitive development, language development, motor development and social emotional development compared to controls	155
5.4.6 Relationships between sleep duration, sleep disruption and development..	157
5.4.7 The relationships between sleep duration and infant development at the 6 month assessment point for the entire sample	158
5.4.7.1 Hypothesis 2: Shorter sleep duration as measured will be associated with poorer developmental outcome.....	158
5.4.7.2 Hypothesis 3: Increased night waking will be associated with poorer developmental outcome	158
5.4.8 Infant sleep and development: subset of participants with actigraph data .	159
5.4.8.1 Descriptive statistics	159
5.4.8.2 Hypothesis 2: Shorter sleep duration will be associated with poorer developmental outcome	162
5.4.8.3 Hypothesis 3: Increased night waking will be associated with poorer developmental outcome	163
5.6 Discussion.....	164
Chapter 6: Effects of sleep and snoring on developmental outcome at 12-months-old	173

6.1 Overview.....	173
6.2 Introduction	173
6.2.1 Aims.....	176
6.2.2 Hypotheses.....	176
6.3 Method	177
6.3.1 Participants	177
6.3.2 Measures.....	178
6.3.3 Procedure	179
6.3.4 Statistical Analyses.....	179
6.4 Results.....	182
6.4.1 Sample Characteristics	182
6.4.2 Descriptive statistics for sleep and developmental outcomes for infants at the 12 month assessment point for the entire sample	186
6.4.3 Descriptive statistics of sleep for each of the snoring and non-snoring groups.....	188
6.4.4 The associations between demographic, social and physiological factors and habitual snoring for infants reported to snore habitually at 6 and 12 months of age compared to non-snoring controls at 6 and 12 months of age	189
6.4.5 The associations between snoring and developmental outcome.....	192
6.4.5.1 Hypothesis 1: Infants reported as habitual snorers at 6-months-old will have poorer cognitive, language, motor and social-emotional development at 12 months of age compared to non-snoring control infants; this effect will be independent of their snoring status at 12-months-old.	192
6.4.6 Relationships between infant sleep duration, night waking and developmental outcomes.....	197
6.4.7 Relationships between infant sleep and development for the entire sample	198
6.4.7.1 Hypothesis 2: Shorter sleep durations as measured by parental- report at 6 and 12-month assessment points will be associated with poorer developmental outcomes at 12-months-old.	198

6.4.7.2 Hypothesis 3: Increased night wakings as measured by parental-report at 6 and 12 month assessment points will be associated with poorer developmental outcomes at 12-months-old.....	198
6.4.8 .Sleep and developmental outcome: subset of participants with actigraph data	199
6.4.8.1 Descriptive statistics.	199
6.4.8.2 Hypothesis 2: Shorter sleep durations as measured by objective recordings i.e. actigraphy at 6 month and 12 month assessment points will be associated with poorer developmental outcomes at 12-months-old.....	202
6.4.8.3 Hypothesis 3: Increased night wakings as measured by objective recordings i.e. actigraphy at 6 month and 12 month assessment points will be associated with poorer developmental outcomes at 12-months-old.....	204
6.5 Discussion	206
Chapter 7: Effects of snoring in infants on postnatal depression and maternal sleep	215
7.1 Overview	215
7.2 Introduction	215
7.2.1 Hypotheses	217
7.3 Method.....	218
7.3.1 Participants.....	219
7.3.1.1 Phase 1	219
7.3.1.2 Phase 2	219
7.3.1.3 Phase 3	219
7.3.2 Measures	220
7.3.3 Procedure.....	220
7.3.4 Statistical Analyses.....	221
7.4 Results	222

7.4.1 Parent sleep and postnatal depression (PND): Descriptive statistics	222
7.4.2 Factors associated with PND	225
7.4.3 The relationship between snoring in infancy and maternal concern about the child's breathing during sleep	230
7.4.4 The relationship between snoring in infancy and maternal sleep duration	230
7.4.5 The relationship between snoring in infancy and maternal sleep quality	231
7.4.6 The relationship between snoring in infancy and maternal postnatal depression (PND)	231
7.4.6.1 Additional analyses	235
7.5 Discussion.....	238
Chapter 8: Infant sleep, infant snoring, maternal sleep and family functioning	247
8.1 Overview.....	247
8.2 Background/Rationale	247
8.2.1 Hypotheses.....	250
8.3 Methods.....	251
8.3.1 Participants	252
8.3.2.1 Phase 2	252
8.3.2.2 Phase 3	252
8.3.3 Measures.....	253
8.3.4 Procedure	253
8.3.5 Statistical Analyses.....	254
8.4 Results	255
8.4.1 Descriptive statistics for family functioning scales; sleep variables and PND	255
8.4.2 Intercorrelations between infant sleep, maternal sleep, PND and family functioning	257

8.4.3 Hypothesis 1: PND and maternal sleep will mediate the relationship between infant sleep disruption and family functioning	260
8.4.5 The relationship between snoring and family functioning.....	264
8.5 Discussion.....	266
Chapter 9: Summary and Conclusions.....	271
9.1 Overview	271
9.2 The relationship between snoring and developmental outcome in infants	271
9.2.1 Overview of findings.....	271
9.2.2 Research implications	274
9.2.2.1 Prevalence of snoring and associated risk factors in infancy	274
9.2.2.2 The Mental Development Index, intelligence and life outcomes	275
9.2.2.3 The natural history of snoring.....	277
9.2.2.4 Confounding factors associated with cognitive development.....	277
9.2.2.5 Executive Functioning.....	279
9.2.2.6 Antenatal factors	279
9.2.2.7 Critical windows of development	280
9.2.3 Implications for clinical practice	281
9.3 The relationship between sleep duration and developmental outcome	285
9.3.1 Overview of findings.....	285
9.3.2 Research implications	286
9.3.3 Implications for clinical practice	287
9.4 The relationship between infant sleep, maternal sleep and Postnatal Depression (PND)	288
9.4.1 Overview of findings.....	288
9.4.2 Research implications	289

9.4.2.1 Family factors that contribute to poor maternal sleep	289
9.5 The relationships between infant sleep, maternal sleep, postnatal depression and family functioning.....	290
9.5.1 Overview of findings	290
9.5.2 Research implications.....	291
9.5.2.1 Effects of family functioning and sleep on development in later childhood.....	291
9.6 Infant snoring, maternal sleep, postnatal depression and family functioning	293
9.6.1 Overview of findings	293
9.6.2 Research implications.....	294
9.6.2.1 Effects of poor maternal sleep on daytime functioning.....	294
9.6.2.2 Effects of different spectra of SDB on parent "s daytime functioning	295
9.6.2.3 Effects on family and parent	295
9.7 Infant sleep, infant snoring, maternal PND, maternal sleep and family functioning.....	296
9.7.1 Clinical implications	296
9.8 Limitations of the present study and methodological considerations for future studies	299
9.9 Conclusions	302
Appendix 1: Infant and parent sleep questionnaire at 0-3-months-old	303
Appendix 2: Infant and parent sleep questionnaire at 6-months-old.....	310
Appendix 3: Infant and parent sleep questionnaire at 12-months-old.....	315
Appendix 4: Baby sleep wake chart	319
Appendix 5: Family Assessment Device-Version 3	322
Appendix 6: Information sheet and consent when infants are 0-3 months old.....	328
Appendix 7: Information sheet and consent form when infants were 6 and 12-months-old	332

Appendix 8: Demographic details for participants at 6-months-old (Table A1) and for participants at 12-months-old (Table A2) 336

Appendix 9: Path estimates for the measurement model maternal sleep with 5 variables.....337

Appendix 10: Regression analysis results.....333

References.....339

Abstract

Background and aims

This thesis was designed to deepen the understanding of the role of snoring and sleep in infants on cognitive development, maternal mental health and family functioning. Firstly it aimed to determine the prevalence of snoring in a community sample of infants aged 0-3-months-old and to examine the factors associated with snoring in this young age group. Secondly, it aimed to assess the impact of snoring and sleep duration in infants on developmental outcome at 6-months-old and 12-months-old. Thirdly, it aimed to examine whether snoring in infants places the mother at an increased risk of postnatal depression (PND), by disrupting her sleep. Finally, it aimed to assess the role of sleep disruption and snoring in infants on family functioning.

Methods

Initially, parents of 457 infants (45% male) aged 1-13.9-weeks-old completed the Edinburgh Postnatal Depression Scale (EPDS) and infant and parent sleep questionnaires. From this initial study, 117 full term infants (49% male; 88 controls; 10 infrequent snorers (snoring 1 to 2 nights a week); 19 habitual snorers (snoring 3 or more nights a week in the absence of a cold) were assessed at 6-months-old using the Bayley Scales of Infant and Toddler Development Edition III. In addition to infant sleep, parent sleep, parent mental health, family functioning and maternal IQ were assessed. 113 infants (48% male; 78 controls; 5 infrequent snorers and 14 habitual snorers) were followed-up with the same measures at 12-months-old. A subset of infants at 6-months-old ($n = 59$) and 12-months-old ($n = 41$) wore actigraphs and only parents of these infants completed a 7-day sleep diary.

Results

Overall, 9 % of infants aged 0-3-months-old were reported to snore 3 or more nights in the absence of a cold. Habitual snorers at 6-months-old scored significantly lower in cognitive ability compared to controls and infrequent snorers at both 6 and 12-months-old. Children reported to snore since birth and also reported to snore habitually had significantly lower scores in cognitive ability compared with control children at both 6 and 12-months-old. At 6-months-old and 12-months-old mothers of habitual snorers compared to controls had higher PND scores, more concern about their child's breathing during sleep and less sleep duration. At 12-months-old but not 6-months-old, infant sleep effected family functioning through maternal sleep and PND. There were no significant differences between snoring and non-snoring groups for family functioning scores.

Conclusions

This thesis confirmed that snoring early in life has detrimental consequences on an infant's cognitive development during a critical period of maximal brain growth and development. This indicates that early intervention is necessary. Larger studies replicating these results using objective measures of breathing during sleep are warranted. This thesis also demonstrated that sleep in infants influences maternal sleep, maternal PND and family functioning. Therefore, identifying ways to manage factors that are related to PND such as infant sleep problems are important because this could potentially reduce the impact on parents, children and family.

Declaration

NAME: Alicia M. Piteo

PROGRAM: PhD

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

I give consent to this copy of my thesis when deposited in the University Library, being made available for loan and photocopying, subject to the provisions of the Copyright Act 1968.

I also give permission for the digital version of my thesis to be made available on the web, via the University's digital research repository, the Library catalogue, the Australasian Digital Theses Program (ADTP) and also through web search engines, unless permission has been granted by the University to restrict access for a period of time.

SIGNATURE:

DATE:

Acknowledgements

I would like to thank my supervisor Dr Rachel Roberts, for the time you spent reading my draft chapters, the advice that you have made throughout my dissertation and for the encouragement to persevere and persist when I was distressed.

I would also like to thank my supervisor A/Professor Declan Kennedy for your enthusiasm, encouragement and many useful comments you have provided on my draft chapters and papers.

I would also like to thank my supervisor Professor Ted Nettelbeck for the time you have taken to read through my draft chapters, the recommendations you have made throughout my dissertation and for always encouraging me throughout the process.

I would also like to acknowledge the support of A/Professor Kurt Lushington, although not an official supervisor; took time to read through my draft chapters and provided me with alternative suggestions of how to present and analyse my results.

Thanks must also go to Dr Cameron van den Heuvel, Dr Yvonne Pamula and Dr James Martin who have offered advice throughout this project, for your expertise and knowledge in the area.

I would also like to acknowledge Dr Mark Kohler and Dr Sarah Biggs who have taken time to read drafts and provided me with suggestions with how to analyse data and most importantly how to persist and manage in difficult times.

Thanks must also go to A/Professor Nick Burns and Bob Willson who have given much advice and help with statistical analyses.

I would also like to thank all other staff and students from the Sleep Disorders Unit, especially Margaret Heddle, Fiona Futo, Chris Clift, Scott Coussens, Marisa Kathriner and Diana Cicua Navarro, who have provided me with much support and have always been ready to listen to me.

Thanks must go to the Child and Family Health Nurses who distributed my surveys, the staff in the maternity wards at Women's and Children's Hospital, Lyell McEwin Hospital, Burnside War Memorial Hospital, North Eastern Community Hospital, Ashford/Flinders Medical Private Hospital, Mount Barker and Mount Gambier Hospital for distribution of information sheets.

I would like to thank all of my close friends, especially Jasmine, Clare, and Fr Matthew, for the cups of tea, chats, encouragement and support you have given me throughout this time. Also, to Nadja Klafke and Angela Moffa who edited drafts at the end.

Thanks especially to all the parents and infants who participated in this study, without your support this project would not have been possible.

Finally, to my family who have supported me when I have been tired, frustrated, and preoccupied. I would like to thank you for the emotional support and encouragement you have given me throughout this experience.

List of Tables

Table 1.1 <i>Methods and results of studies reporting prevalence of snoring in children.....</i>	11
Table 1.2 <i>Methodology and results of studies examining neurocognitive functioning in children with Sleep Disordered Breathing (SDB).....</i>	35
Table 2.1 <i>Studies examining the effect of maternal depression and anxiety in pregnancy and postpartum on developmental outcome.....</i>	63
Table 3.1 <i>The time that each hospital included information sheets in parent packs.....</i>	100
Table 3.2 <i>The time that questionnaires were distributed by Child and Family Health nurses for each region.....</i>	102
Table 3.3 <i>Original Items and Revised item after piloted with parents.....</i>	102
Table 4.1 <i>Demographic details for participants.....</i>	114
Table 4.2 <i>Means and Standard Deviations (SD) for sleep variables in each age group.....</i>	116
Table 4.3 <i>Proportion (%) of infants reported to have a cold or nasal discharge for snoring and non-snoring groups.....</i>	118
Table 4.4 <i>Proportion (%) of infants reported to have colds for snoring and non-snoring groups for each of the seasons.....</i>	119
Table 4.5 <i>Means (SD) for sleep variables for each snoring frequency.....</i>	121
Table 4.6 <i>Frequencies (%) for infant demographic variables according to snoring group with Chi-square or F-value results.....</i>	122
Table 4.7 <i>A summary of regression co-efficients for each variable predicting snoring frequency.....</i>	124

Table 5.1 <i>Descriptive statistics for demographic variables for each snoring frequency</i>	145
Table 5.2 <i>Demographic details for children reported to snore since early life and who were reported to snore habitually a 0-3-months-old and 6-months-old (labelled “early life”) and controls</i>	147
Table 5.3 <i>Means, Standard Deviation (SD) and Range for developmental outcomes for males and females and for the entire sample</i>	149
Table 5.4 <i>Means, Standard Deviations and Range for sleep variables for each gender</i>	149
Table 5.5 <i>Correlations between developmental outcomes and demographic variables for the entire sample (N = 117)</i>	149
Table 5.6 <i>Means and standard deviations of sleep variables for each group</i>	150
Table 5.7 <i>Frequencies for socio-economic, environmental and physiological factors according to snoring and non-snoring groups</i>	152
Table 5.8 <i>Summary of hierarchical regression analysis for independent variables (episodes of wheezing, maternal asthma, maternal eczema, maternal allergies and length of breastfeeding) predicting snoring frequency</i>	154
Table 5.9 <i>Correlation coefficients for developmental outcome and snoring frequency and snoring duration</i>	155
Table 5.10 <i>Means and Standard Deviations (SD) for each of the groups for developmental outcomes (N = 117)</i>	155
Table 5.11 <i>Summary of hierarchical regression analysis for snoring frequency after controlling for family functioning</i>	156

Table 5.12 <i>Means and Standard deviations (SD) for developmental outcomes for children reported to snore since early life and were also currently reported to snore frequently (labelled “early life”) and controls</i>	157
Table 5.13 <i>Correlations between parental-reported infant sleep items and developmental outcomes</i>	159
Table 5.14 <i>Correlations between developmental outcomes and demographic variables for the sample with actigraphs (n = 59)</i>	159
Table 5.15 <i>Means (SD) for Actigraph and sleep diary recordings in minutes</i>	160
Table 5.16 <i>Correlations between developmental outcome and sleep variables from actigraph and sleep diary (n = 59)</i>	163
Table 5.17 <i>Summary of hierarchical regression analysis for sleep duration and sleep efficiency</i>	163
Table 6.1 <i>A summary of the descriptive statistics for demographic variables for each snoring frequency at 6 months of age</i>	183
Table 6.2 <i>Demographic details for children reported to snore since early life and also reported to snore habitually at both 0-3-months-old and 6-months-old (labelled “Early life”) and Controls</i>	185
Table 6.3 <i>Means, Standard Deviations and Range for sleep variables for each gender at 12 month assessment point</i>	187
Table 6.4 <i>Means, Standard Deviation and Range for developmental outcomes for males and females</i>	187
Table 6.5 <i>Correlations between developmental outcomes and demographic variables for the entire sample (N = 113)</i>	187
Table 6.6 <i>Means (SD) for sleep variables for each snoring frequency at 6-months-old and 12-months-old</i>	189

Table 6.7 <i>Socio-economic, environmental and physiological factors associated with habitual snoring at both 6 and 12-months-old</i>	191
Table 6.8 <i>Correlations between snoring frequency at 6-months-old and snoring duration and developmental outcomes at 12-months-old</i>	192
Table 6.9 <i>Means (SD) of 12 month developmental outcomes for infants categorised controls; infrequent snorers and habitual snorers at 6-months-old for the entire sample (N = 113)</i>	193
Table 6.10 <i>Summary of hierarchical regression analysis for snoring frequency at 6-months-old predicting cognitive ability at 12-months-old after controlling for breastfeeding duration and family functioning</i>	194
Table 6.11 <i>Means and Standard deviations (SD) for developmental outcomes for children reported to snore from early in life and were also reported to snore habitually at 0-3-months and 6-months-old (labelled “early life”) and controls</i>	195
Table 6.12 <i>Means and Standard deviations (SD) for developmental outcomes for children reported to snore since early in life and were also reported to snore habitually at 0-3-months and 6-months-old and 12-months-old (labelled “early life”) and controls</i>	196
Table 6.13 <i>Correlations between 12-month-old developmental outcomes and parental-reported sleep variables at 12-months-old and parental-reported sleep variables at 6-months-old</i>	199
Table 6.14 <i>Correlations between developmental outcomes and demographic variables for the sample with actigraphs (n =41)</i>	200
Table 6.15 <i>Means (SD) for Actigraph and Sleep diary recordings in minutes</i>	200

Table 6.16 <i>Correlations between 12-month-old sleep variables from Actigraph and sleep diary and 12-month-old developmental outcome and 6-month-old sleep variables from Actigraph and 12-month-old developmental outcome</i>	203
Table 6.17 <i>Summary of hierarchical regression analysis for day sleep efficiency and night motor activity at 6-months-old predicting language development at 12-months-old after controlling for family functioning and PND at 12-months-old (n = 58)</i>	204
Table 6.18 <i>Summary of hierarchical regression analysis for snoring frequency at 6-months-old and objectively recorded sleep duration at 6-months-old predicting cognitive ability at 12-months-old after controlling for breastfeeding duration and PND at 6-months-old (n = 58)</i>	205
Table 7.1 <i>Descriptive statistics for parent sleep variables and Postnatal Depression (PND) scores when infants were aged 0-3-months-old, 6-months-old and 12-months-old</i>	224
Table 7.2 <i>Mean (SD) Postnatal Depression scores for parent sleep variables and infant sleep variable</i>	226
Table 7.3 <i>Correlations between infant sleep variables and postnatal depression scores</i>	228
Table 7.4 <i>Standardised Beta Coefficients (β) of predictors for maternal postnatal depression when infants are aged 0-3-months-old, 6-months-old and 12-months-old</i>	229
Table 7.5 <i>PND scores, proportion of mothers concerned about their child "sbreathing during sleep, watching their child sleep afraid they would stop breathing, maternal sleep duration and maternal sleep quality for the three study groups (Non-snorers; Infrequent</i>	

<i>snorers (snoring 1-2 nights/week) and Habitual snorers (snoring \geq 3nights/week).....</i>	<i>233</i>
<i>Table 7.6 Frequency (%) of sleep behaviour for parents of habitual snorers for mother "s concerned about their child"sbreathing during sleep and mother not concerned about their child"sbreathing during sleep.....</i>	<i>236</i>
<i>Table 7.7 Frequency (%) of sleep behaviour for mothers of non-snorers for mother concerned about their child"sbreathing during sleep and mothers not concerned about their child"sbreathing during sleep</i>	<i>237</i>
<i>Table 8.1 Means (standard deviations) and range for each of the subscales of the Family Assessment Device, maternal sleep and infant sleep variables at 6 and 12-months-old.....</i>	<i>252</i>
<i>Table 8.2 Correlations between infant (I) sleep variables, maternal (M) sleep variables, PND and family functioning variables at 6-months-old and 12-months-old.....</i>	<i>255</i>
<i>Table 8.3 Means and Standard deviations for each of the family functioning variables for controls, infrequent snorers and habitual snorers when infants were aged 6 and 12-months-old.....</i>	<i>261</i>

List of Figures

<i>Figure 3.1.</i> The recruitment procedure.....	86
<i>Figure 3.2.</i> An example of a 7 day sleep diary used by mothers for children.....	98
<i>Figure 4.1.</i> Sleep position (%) for infants for each age group.....	117
<i>Figure 4.2.</i> Sleep location (%) for infants for each age group.....	117
<i>Figure 4.3.</i> Proportion of infants (%) snoring for each age group and snoring frequency.....	120
<i>Figure 5.1.</i> Bland-Altman Plots for agreement between sleep diaries and actigraphy for daytime sleep (upper) and night time sleep (lower).....	161
<i>Figure 6.1.</i> Bland-Altman Plots for agreement between sleep diaries and actigraphy for night time sleep (upper) and daytime sleep (lower).....	201
<i>Figure 7.1.</i> Recruitment and assessment.....	218
<i>Figure 7.2</i> Postnatal depression scores for mothers of infants who remained controls and habitual snorers throughout the first year of life.....	232
<i>Figure 8.1.</i> Hypothesised Model to be tested in this study.....	250
<i>Figure 8.2.</i> Recruitment and assessment.....	251
<i>Figure 8.3.</i> Model to be tested.....	261
<i>Figure 8.4.</i> Path analysis linking infant sleep (IS) to family functioning (FF) through maternal sleep (MS) and PND.....	263