Giardia and Cryptosporidium Infection in Childcare Centres in Western Australia

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I declare that this thesis is my own account of my research and contains no material which has been previously submitted for a degree at any other educational institution and contains no material previously published or written by any other person, except where due reference is made in the text of this thesis.

Jennifer Ann Walters Lymberry
To my father,

James Alan Walters

and my sons,

Hamish, Rowan and Samuel.
ABSTRACT

Giardia and Cryptosporidium are both recognised as important causes of infectious diarrhea in children worldwide, and childcare centres have been shown to be a major site of infection. The incidence of infectious diarrhea in children attending childcare centres has been estimated at between two to five times greater than in children cared for at home. Both Giardia and Cryptosporidium have a faecal-oral route of transmission that facilitates their spread in childcare environments, but can also be interrupted through the use of efficient hygiene protocols such as handwashing. Despite their importance as causes of infectious diarrhea, there are no data on the prevalence or transmission dynamics of these parasites in Australian childcare centres.

The present study was designed to determine the prevalence and incidence of both Giardia and Cryptosporidium in children attending childcare centres in Perth, Western Australia. Data were collected on asymptomatic infection, seasonal trends, the transmission dynamics of the parasites and risk factors for infection. The second part of the study involved the development, implementation and evaluation of a health intervention package designed to interrupt the transmission of causative organisms of infectious diarrhea in childcare centres. This intervention was based on appropriate and effective handwashing.

Over a period of 23 months, 1172 faecal samples were collected from non-toilet-trained children (n=306) attending 14 childcare centres in Perth, Western Australia. Where possible, family and contacts of infected children were also sampled to determine the
dynamics of infection in the community. Information on symptomology of infections and risk factors for infection was obtained by the administration of a questionnaire to parents of all the children in the study.

Over all the childcare centres in the study, 7.8% of children were positive for *Giardia* and 10.8% were positive for *Cryptosporidium*. Of these, 37.5% of the *Giardia*-positive children returned positive samples on two to four occasions, but not always consecutively, suggesting either continuous or repeated infection with the parasite. Only 12% of children who were *Cryptosporidium*-positive were infected for two consecutive months.

The major findings of this study included a significant seasonal peak in the prevalence of both *Giardia* and *Cryptosporidium*, with 50% of *Giardia* and 73% of *Cryptosporidium* infections occurring during the autumn months of March, April and May, and a high proportion of asymptomatic *Giardia* infections (45%), compared with only 13.5% of asymptomatic *Cryptosporidium* infections.

There was evidence for the transmission of both *Giardia* and *Cryptosporidium* infections to household contacts of infected children. Of the children who were found to be positive, faecal samples were also collected from 28 family members of those children with *Giardia* and from 14 family members of those with *Cryptosporidium*. Of these, 17.9% family members of the children with *Giardia* and 28.6% of family members of the *Cryptosporidium* children returned positive faecal samples. The only significant risk factor for *Giardia* infection was the number of adults living in the household, with infection more likely to occur in children who had a greater number
of adults in the household. Significant risk factors for Cryptosporidium infection included the age of the child: the mean age of the positive children (20.6 months) was higher than in the negative children (16.6 months), and the length of time enrolled at the centre. Children who were positive had attended for a longer time than those who were negative (11.2 and 7.8 months respectively).

These results have important implications for the control of infection with these organisms, both within and beyond childcare centres. Since these parasites can be readily transmitted by an asymptomatic carrier, the high percentage of asymptomatic cases in this study, particularly of Giardia, strengthens the argument for health interventions which are directed at interrupting the transmission of the parasite.

A health intervention programme was developed that focused on handwashing procedures and was targeted at the carers, the children and the parents of the children in the centres. It was designed to be a low-cost programme both financially, and in the time and effort required to implement the programme within the childcare centre, to enhance compliance with the intervention. The success of the programme in changing the knowledge, attitudes and practices of carers was evaluated through a pre- and post-test questionnaire. This showed that the programme successfully improved the knowledge of the carers in the test centres in several important areas of infection control. These included knowledge about specific organisms causing infectious diarrhoea in childcare centres, transmission of these by asymptomatic individuals and increased knowledge about effective handwashing technique. Because it has been repeatedly shown that increased knowledge does not always translate into improved practices, and that interventions are not always successful in
maintaining an improvement in the desired practices, a subjective evaluation was also performed. This was designed to determine how effective the intervention was perceived to be by the carers themselves, and whether they would continue to use the intervention over time. The results showed that the majority of the carers (>88%) found the intervention appropriate and useful in teaching both the carers and the children within the centres, the importance of handwashing. Twelve months after the intervention had first been implemented, 57% of the centres in the study were still using the intervention at least once per month and a further 29%, while using it less than this, still continued to use it occasionally. This is important information, since an intervention can only be useful if it is actually being used.
ACKNOWLEDGEMENTS

This thesis would never have been completed if not for the much valued assistance and support of several very special people.

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The development of The Supersoap Bag would not have occurred without the creative and artistic talents of Yvonne Treasure, Fiona Morgan, JoAnn Whalley, Rob Chambers and Doris Lymbery, and I cannot thank you all enough for your enthusiasm and willingness to take part in this study.

A very big and special thank you goes to Rowan and Samuel Lymbery, without whom neither Supersoap nor Gooey Germ would exist. Talented and creative children! I also appreciate the ideas and drawings provided by all the wonderful children at Bunbury Community School.

Without the assistance and co-operation of all the directors, carers, children and parents of the children in the childcare centres in this study, including those involved in piloting the questionnaires and health intervention, this study would not have been possible. I know it was not always easy to make the time necessary for participation and I am very grateful to you all. I hope you all thought it was worthwhile in the end.

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Finally, and certainly not least of all, to my long-suffering family and friends, especially my husband, Alan, my wonderful sons Rowan and Samuel, my parents-in-law, Doris
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thought it would never end. I can’t thank you all enough for the support, friendship,
patience and love.

And now….to my garden!
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Contents</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Declaration page</td>
<td>ii</td>
</tr>
<tr>
<td>Dedication</td>
<td>iii</td>
</tr>
<tr>
<td>Abstract</td>
<td>iv</td>
</tr>
<tr>
<td>Acknowledgements</td>
<td>viii</td>
</tr>
<tr>
<td>Table of Contents</td>
<td>xi</td>
</tr>
<tr>
<td>Thesis Overview</td>
<td>1</td>
</tr>
</tbody>
</table>

## PART ONE

## CHAPTER 1 INTRODUCTION

1.1 Childcare centres                          | 5    |
1.1.1 Increased numbers of children in childcare centres | 5    |
1.1.2 Children in childcare centres: greater susceptibility to infection | 6    |
1.2 Infectious diarrhoea in childcare centres  | 7    |
1.2.1 Causative organisms of infectious diarrhoea in childcare centres | 8    |
1.2.2 *Giardia*                                | 15   |
1.2.2a Transmission                            | 16   |
1.2.2b Clinical effects                        | 16   |
1.2.2c Prevalence in childcare centres 17
1.2.3 Cryptosporidium 17
1.2.3a Transmission 18
1.2.3b Clinical effects 19
1.2.3c Prevalence in childcare centres 20
1.2.4 Transmission to household/community contacts 20
1.2.5 The cost of infections acquired at childcare centres 21
1.3 Study objectives 22

CHAPTER 2 MATERIALS AND METHODS

2.1 Study population 23
2.2 Selection of childcare centres 24
2.2.1 Characteristics of childcare centres 28
2.2.2 Accreditation of childcare centres 31
2.3 What the study entailed for participants 32
2.3.1 For the centres 32
2.3.2 For children and parents 32
2.4 Collection of faecal samples 33
2.5 Laboratory analysis of faecal samples 36
2.6 Questionnaire development 37
2.7 Parent questionnaire 38
CHAPTER 3 RESULTS

3.1  *Giardia* and *Cryptosporidium* infections in childcare centres in Perth, Western Australia  43

3.2  Differences between childcare centres  44

3.3  Seasonal differences in *Giardia* and *Cryptosporidium* infections  45

3.4  Symptomatic and asymptomatic infections  49

3.5  Repeat and continuous infections  50

3.6  Transmission to family and household members  52

3.7  Risk factor analysis  53

CHAPTER 4 DISCUSSION

4.1  Introduction  59

4.2  Sample collection  60

4.3  *Giardia* and *Cryptosporidium* infections in childcare centres in Perth, Western Australia  61

4.4  Seasonal differences in infection rates of *Giardia* and *Cryptosporidium*  64
4.5 Risk factors 68
4.6 Symptomatic and asymptomatic infections 72
4.6.1 Asymptomatic infections and the value of exclusion policies 75
4.6.2 Costs to parents of ill children 77
4.7 Transmission beyond the childcare centre 78
4.7.1 Transmission of infectious disease to childcare centre carers 78
4.7.2 Transmission to family and household members 79
4.8 Conclusions 80

PART TWO

CHAPTER 5 INTRODUCTION

5.1 Introduction 83
5.2 Hand hygiene 84
5.3 Pioneers in infection control 85
5.4 Non-compliance with handwashing 87
5.4.1 Non-compliance within the healthcare system 87
5.4.2 Non-compliance within childcare centres 88
5.5 Barriers to compliance with handwashing 88
5.6 Handwashing technique 89
5.6.1 Resident and transient flora 89
5.7 Interventions to increase compliance with handwashing 91
5.7.1 Interventions within childcare centres 91
5.8 Study objectives 93

CHAPTER 6 MATERIALS AND METHODS

6.1 Characteristics of carers 95
6.1.1 Carer qualifications 96
6.2 Survey of childcare centres to determine infection control education needs 97
6.3 Health intervention 98
6.4 Components of health intervention 100
6.4.1 Hand puppets 100
6.4.2 Songs (on an audiotape) 102
6.4.3 Story booklet 102
6.4.4 Posters 102
6.4.5 Colouring-in sheets 103
6.4.6 Information sheets 103
6.4.7 Putting it all together 104
6.5 Implementation of the health intervention 105
6.6 Evaluation of the health intervention 106
6.6.1 Objective evaluation using pre- and post-test questionnaires 106
6.6.2 Subjective evaluation 107
6.7 Statistical analysis 107
CHAPTER 7 RESULTS

7.1 Characteristics of childcare centre carers 109
7.1.1 Differences between childcare centres 114
7.1.2 Differences between test and control groups 115
7.1.3 Relationship between carer characteristics and *Giardia/Cryptosporidium* infections in childcare centres 117
7.2 Evaluation of health intervention 120
7.2.1 Differences between the responses of test and control groups before and after the intervention 120
7.2.2 Subjective evaluation 121b

CHAPTER 8 DISCUSSION

8.1 Introduction 122
8.2 Risk factors for infectious diarrhoea in childcare centres 122
8.3 The importance of handwashing as a primary means of infection control in childcare centres 124
8.3.1 Previous infection control education of childcare centre staff 125
8.4 Health intervention package 126
8.4.1 Qualifications of childcare centre staff 126
8.4.2 Health education of pre-school children in childcare 129
8.4.3 Health education of families of pre-school children in childcare 131
8.5 Evaluation of health intervention 132
8.5.1 Objective evaluation of The Supersoap Bag 133
8.5.2 Subjective evaluation of The Supersoap Bag 135

CHAPTER NINE CONCLUSIONS 139

REFERENCES 145
# APPENDICES

| Appendix 1 | First contact letter to childcare centre directors, requesting their participation in the study | 168 |
| Appendix 2 | Consent form for childcare centres to participate in the study | 171 |
| Appendix 3 | Letter of explanation and consent form for parents | 172 |
| Appendix 4 | Letter of explanation and consent form for childcare centre employees | 175 |
| Appendix 5 | Western Australian Community Services (Child Care) Regulations 1988: Regulation No. 30: minimum staff requirements | 178 |
| Appendix 6 | Pre-test questionnaire for childcare centre employees | 180 |
| Appendix 7 | Post-test questionnaire for childcare centre employees | 191 |
| Appendix 8 | Questionnaire completed by parents of all children in the study | 198 |
| Appendix 9 | Short version of questionnaire completed by parents of all children in the study | 213 |
| Appendix 10 | Procedure for the microscopic examination of *Giardia* using the Zinc Flotation Method | 217 |
| Appendix 11 | Procedure for the Malachite Green Stain for the detection of *Cryptosporidium* | 218 |
| Appendix 12 | Letter to health professionals re validity testing of questionnaires | 219 |
| Appendix 13 | Survey to determine the needs of childcare centres and carers with regard to infection control | 220 |
Appendix 14  Photographs of the original *Supersoap* and *Gooey Germ* drawings  224
Appendix 15  Words to the songs on the audiotapes  225
Appendix 16  Story booklet  227
Appendix 17  Set of handwashing posters  228
Appendix 18  Information sheets for childcare centre carers  229
Appendix 19  Instructions/suggestions for using *The Supersoap Bag*  234
Appendix 20  Questionnaire for subjective evaluation of *The Supersoap Bag*  236
THESIS OVERVIEW

With the incidence of infectious diarrhoea shown to be two to five times greater in children attending childcare centres than in children cared for at home, and an increasing number of children attending out-of-home care in Australia and other developed countries, children are being increasingly exposed to infectious disease on a regular basis. Such infections are often spread to childcare staff, family members and other persons in the community.

Enteric protozoan parasites such as *Giardia* and *Cryptosporidium* are being increasingly recognised as important causes of infectious diarrhoea in children, and childcare centres are emerging as a major site of infection. Since both *Giardia* and *Cryptosporidium* share a common pattern of spread (person-to-person), transmission can be prevented or at least reduced, by implementing effective health education interventions.

This study was therefore conducted in two, interrelated parts. The first part involved the investigation of infection rates of *Giardia* and *Cryptosporidium* in children attending childcare centres in Perth, Western Australia, and the second part involved the development, implementation and evaluation of a health intervention package aimed at interrupting the transmission of these parasites in childcare centres.
In Part One of this thesis, the scene is set for the study in Chapter One, establishing that infectious diarrhoea continues to be a problem in childcare centres, discussing the reasons for this, the causative organisms, with specific reference to *Giardia* and *Cryptosporidium*, mechanisms of transmission and why children in childcare centres are particularly vulnerable. In Chapter Two, the procedures undertaken for determining the infection rates of *Giardia* and *Cryptosporidium* in randomly selected childcares in Perth, including collection of faecal samples, identification of the parasites and questionnaire development are detailed. In Chapter Three, the statistical analysis and results of the faecal sampling are set out, including infection rates with *Giardia* and *Cryptosporidium* and a comparison of rates between centres. Seasonal trends for infection, rates of asymptomatic infection and analysis of specific risk factors for infection are also outlined in Chapter Three. The importance of these findings is discussed in Chapter Four and compared with the results of similar studies, concluding with a discussion of the need for interventions in childcare centres designed to interrupt the transmission of these parasites.

In Part Two, Chapter Five, of the thesis, the importance of handwashing as a primary infection control strategy is discussed and the interesting history behind handwashing is explored. Despite its proven efficacy, and undoubted simplicity, overall compliance with handwashing protocols is poor. In Chapter Five some of the reasons for this are discussed and the need for interventions to improve and sustain compliance with handwashing protocols in childcare centres are highlighted. The procedures for the development of the intervention in this study, utilising a “needs survey” to try to involve
the end-users in its development, are set out in Chapter Six. Implementation and evaluation procedures are also discussed. Statistical analysis and results for this section of the study are set out in Chapter Seven. The results of both objective and subjective evaluations are presented, along with the results of how the risk factors of carers might impact on both the evaluation of the intervention package and infection rates with *Giardia* and *Cryptosporidium*. These results are discussed in Chapter Eight and compared with the results of similar studies. The risk factors for infectious diarrhoea in childcare centres are examined along with the difficulties involved with implementing infection control interventions in childcare centres, why the evaluation methods in this study were chosen and the importance of the results of these.

The thesis concludes with Chapter Nine, which draws the two parts of the study together. In this chapter, the strengths and limitations of the study are discussed and areas for further research are identified.
PART ONE

GIARDIA AND CRYPTOSPORIDIUM IN CHILDCARE CENTRES IN WESTERN AUSTRALIA
CHAPTER ONE
INTRODUCTION

1.1 CHILDCARE CENTRES

Childcare can be defined as arrangements other than parental care made for the care of children less than twelve years of age (ABS 1999) and may be formal or informal. Informal childcare is unregulated care such as that privately arranged between parents and unlicensed caregivers or relatives, while formal childcare is regulated care that takes place away from the child’s home (ABS 1996a). In Australia there is greater use of informal than formal childcare, but the use of formal childcare increases with the age of the child, from 8% of children less than one year old to 68% of children aged four years (Ochiltree and Edgar 1995; ABS 1996a). The main types of formal childcare for preschool children are childcare homes, where small groups of children (seven or less in Western Australia) are cared for in the caregiver’s own home, and Long Daycare Centres, or childcare centres, where larger groups of children are cared for and are usually separated into smaller groups based on age. In this study, only children attending childcare centres were studied.

1.1.1 Increased numbers of children in childcare centres

Until the 1960s, the majority of preschool children in developed countries were cared for in their own homes (Robinson 2001). In the last two to three decades however, there has been a dramatic increase in the number of children being placed in childcare (Alexander et al.)
1990; Collet et al. 1991; Thacker et al. 1992; Thompson 1994b). In the USA, the proportion of children less than six years old attending childcare centres is estimated to be between 16 and 22% (Barros 1999). Even higher proportions are found in countries that run large childcare programmes, such as Sweden, where it is estimated that 32% of all preschool children attend municipal childcare centres (Barros 1999).

More than one third of all Australian children less than five years of age currently receive some form of licensed or formal childcare (Ferson 1997). This figure has doubled since 1984, with the increased use greatest among children less than two years of age (ABS 1999). The increase in the use of childcare is mainly due to social and economic changes, with a return to the workforce of a large number of mothers, as well as the rise in the number of single parents who also choose or need to be in paid employment (Reves and Pickering 1992; Collet et al. 1994a; Thompson 1994b; Ferson 1997).

1.1.2 Children in childcare centres: greater susceptibility to infection

Children, especially those less than three years of age, who attend childcare centres experience more illness than those cared for at home (Ponka et al. 1991; Louhiala et al. 1997; Ferson 1997; Barros 1999; Cordell et al. 1999). Both respiratory illness and diarrhoea occur at least twice as much in children attending childcare centres compared with those who are cared for at home (Robinson 2001). This is thought to be because in childcare, large groups of children are congregated together in close physical contact for long periods of time and are therefore exposed to infectious illnesses, especially respiratory and gastrointestinal infections, at an earlier age (Ferson 1993; Collet et al. 1994a; Ferson
1997). Previously, many children would have had their first exposure to these infections when they began primary school at around age five, or from older siblings bringing infections home from school.

1.2 INFECTIOUS DIARRHOEA IN CHILDCARE CENTRES

Infectious diarrhoea has been shown to be second only to respiratory disease in causing illness among young children attending childcare centres (Sullivan et al. 1984; Jarman and Kohlenberg 1991; Ferson 1993, 1997; Cordell and Addiss 1994; Churchill and Pickering 1997; Barros 1999). It has been estimated that the incidence of infectious diarrhoea among children attending childcare centres is two to three times greater than those cared for at home (Bartlett et al. 1985; Ojembarrena Martinez et al. 1986; Alexander et al. 1990; Reves and Pickering 1992; Churchill and Pickering 1997; Pickering and Osterholm 1997; Robinson 2001). One longitudinal study carried out in France found that the risk of diarrhoea was around five times higher in children attending childcare centres, compared with those cared for at home (Collet et al. 1994b).

The incidence of infectious diarrhoea in childcare centres has consistently been found to be highest among toddlers less than three years of age (Reisenberg 1986; Crawford and Vermund 1987; Jarman and Kohlenberg 1991; Cordell and Addiss 1994; Thompson 1994a, 1994b), with those children still in nappies at greatest risk (Hillis et al. 1992; Osterholm et al. 1992). Attack rates greater than 50% in 13 to 24 month old children and up to 75% in children up to 12 months old have been reported over a 19 month period (Pickering et al. 1981). These are children who are usually not yet toilet-trained, have not learnt basic
hygiene and have a high level of mobility and personal interaction (Crawford and Vermund 1987; Ferson 1993; Cordell and Addiss 1994; Thompson 1994a, 1994b). As well, children in this age group still have immature immune systems and therefore are more susceptible to infections (Osterholm et al. 1992; Ferson 1993; Churchill and Pickering 1997).

1.2.1 Causative organisms of infectious diarrhoea in childcare centres

The majority of enteropathogens involved in infectious diarrhoea are acquired either via the faecal-oral route or through contaminated food or water (Pickering 1991). Within childcare centres, the most common route of transmission is person-to-person (Carson 1987; Churchill and Pickering 1997; Robinson 2001). Many organisms dependent on this mode of transmission have been identified in childcare centres, including Campylobacter (Bartlett et al. 1986), Shigella (Weissman et al. 1974; Pickering et al. 1981), Salmonella, Hepatitis A (Shapiro and Hadler 1990), viruses such as rotavirus (Pickering et al. 1981; Bartlett et al. 1988; Taylor et al. 1997) and cytomegalovirus (Pass et al. 1982; Pass et al. 1984; Hutto et al. 1985), and the enteric protozoan parasites Giardia (Black et al. 1977; Keystone et al. 1978; Pickering et al. 1981; Pickering et al. 1984; Rauch et al. 1990) and Cryptosporidium (CDC 1984, Diers and McCallister 1989; Overturf 1994).

The prevalence of infections of Cryptosporidium and Giardia among toddlers in childcare centres has been estimated to be approximately 2% and 11 to 26% respectively (Cordell 2002). These parasites share several epidemiological characteristics (Lindo et al. 1998) and are important highly infectious pathogens within childcare centres for the following reasons:
• They are a common cause of self-limiting gastroenteritis, but can also cause chronic illness (*Giardia*) or life threatening disease in immunocompromised people (*Cryptosporidium*).

• Both are highly infectious enteric pathogens with low inoculums required for infection. *Giardia* has an infective dose of <10 to 100 cysts (Crawford and Vermund 1987; Jarman and Kohlenberg 1991; Ortega and Adam 1997) while *Cryptosporidium* infections may occur with as few as 10 oocysts (DuPont *et al.* 1995), and some infections have been reported with just one oocyst (Cordell and Addiss 1994; Pickering and Osterholm 1997; Weber and Rutala 2001).

• Both have a faecal-oral route of transmission that facilitates their spread in childcare environments (Thompson 1994b; Lindo *et al.* 1998; Thompson *et al.* 2000; Weber and Rutala 2001).

These parasites are both recognised as important causes of diarrhoea in children worldwide (CDC 1994; WHO 1996). Childcare centres have been shown to be a major site of infection, in cross sectional studies (Novotny *et al.* 1990; Addiss *et al.* 1991), prospective studies (Garcia-Rodriguez *et al.* 1990; Rauch *et al.* 1990) and in studies of outbreaks of diarrhoea (Steketee *et al.* 1989; Rodriquez-Hernandez 1996). In Table 1, those studies conducted over the past 30 years worldwide to determine the extent of *Giardia* and *Cryptosporidium* infections in childcare centres are listed. Some of these studies were conducted during outbreaks of diarrhoea, while others were longitudinal studies to determine the prevalence and or incidence of the parasite in apparently healthy children. These studies are discussed in detail in Chapter 4.
Table 1.1  Studies of the incidence and prevalence of *Giardia* and *Cryptosporidium* in childcare centres in the past 30 years

<table>
<thead>
<tr>
<th>Authors and year of publication</th>
<th>Country of study</th>
<th>Type of study</th>
<th>No. of children providing faecal samples</th>
<th>Age range</th>
<th>% of children <em>Giardia</em>-positive</th>
<th>% of faecal samples <em>Giardia</em>-positive</th>
<th>% of children <em>Cryptosporidium</em>-positive</th>
<th>% of faecal samples <em>Cryptosporidium</em>-positive</th>
<th>Other information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black <em>et al.</em> 1977</td>
<td>USA</td>
<td>outbreak</td>
<td>84</td>
<td>1-3½ yrs</td>
<td>44</td>
<td>N/A</td>
<td></td>
<td>Three childcare centres involved</td>
<td></td>
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<tr>
<td>Keystone <em>et al.</em> 1978</td>
<td>Canada</td>
<td>outbreak</td>
<td>327</td>
<td>6 wks-5 yrs</td>
<td>27</td>
<td>N/A</td>
<td></td>
<td>Most susceptible age 1-3 yrs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12% of household contacts and 7% of staff also <em>Giardia</em>+ve</td>
<td></td>
</tr>
<tr>
<td>Boreham &amp; Shepherd 1984</td>
<td>Australia</td>
<td>outbreak</td>
<td>71</td>
<td>&lt;5 yrs</td>
<td>19.7</td>
<td>N/A</td>
<td></td>
<td>Greatest prevalence in toddlers; 73% asymptomatic</td>
<td></td>
</tr>
<tr>
<td>Keystone <em>et al.</em> 1984</td>
<td>Canada</td>
<td>outbreak</td>
<td>900</td>
<td>3mths-10 yrs</td>
<td>7.8</td>
<td>N/A</td>
<td></td>
<td>Greatest prevalence in 6 yr olds; 22 childcare centres</td>
<td></td>
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<tr>
<td>Pickering <em>et al.</em> 1984</td>
<td>USA</td>
<td>cross-sectional</td>
<td>339</td>
<td>&lt;36 mths</td>
<td>21</td>
<td>N/A</td>
<td></td>
<td>Weekly samples collected for 18 mths</td>
<td></td>
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<tr>
<td>Pickering <em>et al.</em> 1984</td>
<td>USA</td>
<td>cross-sectional</td>
<td>261</td>
<td>&lt;36 mths</td>
<td>26</td>
<td>N/A</td>
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<tr>
<td>Pickering <em>et al.</em> 1984</td>
<td>USA</td>
<td>prospective</td>
<td>82</td>
<td>&lt;36 mths</td>
<td>33</td>
<td>N/A</td>
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<tr>
<td>Taylor <em>et al.</em> 1985</td>
<td>USA</td>
<td>outbreak</td>
<td>50</td>
<td>6-24 mths</td>
<td>36</td>
<td>36</td>
<td></td>
<td>72% of <em>Giardia</em> infections and 22% of <em>Cryptosporidium</em> infections asymptomatic</td>
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</tbody>
</table>
Table 1.1  Studies of the incidence and prevalence of *Giardia* and *Cryptosporidium* in childcare centres in the past 30 years

<table>
<thead>
<tr>
<th>Authors and year of publication</th>
<th>Country of study</th>
<th>Type of study</th>
<th>No. of children providing faecal samples</th>
<th>Age range</th>
<th>% of children <em>Giardia</em>-positive</th>
<th>% of faecal samples <em>Giardia</em>-positive</th>
<th>% of children <em>Cryptosporidium</em>-positive</th>
<th>% of faecal samples <em>Cryptosporidium</em>-positive</th>
<th>Other information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black <em>et al.</em> 1977</td>
<td>USA</td>
<td>outbreak</td>
<td>84</td>
<td>1-3½yrs</td>
<td>44</td>
<td>N/A</td>
<td></td>
<td>Three childcare centres involved</td>
<td></td>
</tr>
<tr>
<td>Keystone <em>et al.</em> 1978</td>
<td>Canada</td>
<td>outbreak</td>
<td>327</td>
<td>6 wks-5yrs</td>
<td>27</td>
<td>N/A</td>
<td></td>
<td>Most susceptible age- 1-3 yrs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12% of household contacts and 7% of staff also <em>Giardia</em> +ve</td>
<td></td>
</tr>
<tr>
<td>Boreham &amp; Shepherd 1984</td>
<td>Australia</td>
<td>outbreak</td>
<td>71</td>
<td>&lt;5yrs</td>
<td>19.7</td>
<td>N/A</td>
<td></td>
<td>Greatest prevalence in toddlers;</td>
<td></td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>73% asymptomatic</td>
<td></td>
</tr>
<tr>
<td>Keystone <em>et al.</em> 1984</td>
<td>Canada</td>
<td>outbreak</td>
<td>900</td>
<td>3mths-10yrs</td>
<td>7.8</td>
<td>N/A</td>
<td></td>
<td>Greatest prevalence in 6 yr olds;</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>22 childcare centres</td>
<td></td>
</tr>
<tr>
<td>Pickering <em>et al.</em> 1984</td>
<td>USA</td>
<td>cross-sectional</td>
<td>339</td>
<td>&lt;36 mths</td>
<td>21</td>
<td>N/A</td>
<td></td>
<td>Weekly samples collected for 18 mths</td>
<td></td>
</tr>
<tr>
<td>Pickering <em>et al.</em> 1984</td>
<td>USA</td>
<td>cross-sectional</td>
<td>261</td>
<td>&lt;36 mths</td>
<td>26</td>
<td>N/A</td>
<td></td>
<td>72% of <em>Giardia</em> infections and 22% of <em>Cryptosporidium</em> infections asymptomatic</td>
<td></td>
</tr>
<tr>
<td>Pickering <em>et al.</em> 1984</td>
<td>USA</td>
<td>prospective</td>
<td>82</td>
<td>&lt;36 mths</td>
<td>33</td>
<td>N/A</td>
<td></td>
<td>Weekly samples collected for 18 mths</td>
<td></td>
</tr>
<tr>
<td>Taylor <em>et al.</em> 1985</td>
<td>USA</td>
<td>outbreak</td>
<td>50</td>
<td>6-24 mths</td>
<td>36</td>
<td>36</td>
<td></td>
<td>72% of <em>Giardia</em> infections and 22% of <em>Cryptosporidium</em> infections asymptomatic</td>
<td></td>
</tr>
<tr>
<td>Authors and year of publication</td>
<td>Country of study</td>
<td>Type of study</td>
<td>No. of children providing faecal samples</td>
<td>Age range</td>
<td>% of children Giardia-positive</td>
<td>% of faecal samples Giardia-positive</td>
<td>% of children Cryptosporidium-positive</td>
<td>% of faecal samples Cryptosporidium-positive</td>
<td>Other information</td>
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<tr>
<td>Woo &amp; Paterson 1986</td>
<td>Canada</td>
<td>cross-sectional</td>
<td>97</td>
<td>2-5yrs</td>
<td>8.3</td>
<td>N/A</td>
<td></td>
<td></td>
<td>Survey of children in 2 areas of Ontario; 1982 &amp; 1983</td>
</tr>
<tr>
<td>Woo &amp; Paterson 1986</td>
<td>Canada</td>
<td>cross-sectional</td>
<td>147</td>
<td>2-5yrs</td>
<td>6.1</td>
<td></td>
<td></td>
<td></td>
<td>As above; in both studies all children reported asymptomatic</td>
</tr>
<tr>
<td>Heijbel et al 1987</td>
<td>USA</td>
<td>outbreak</td>
<td>142</td>
<td>&lt;5yrs</td>
<td>37</td>
<td>25</td>
<td></td>
<td></td>
<td>42% of Giardia infections and 23% of Cryptosporidium infections reported asymptomatic; 23% of household contacts and 21% of carers also Cryptosporidium +ve</td>
</tr>
<tr>
<td>Lacroix et al. 1987</td>
<td>France</td>
<td>outbreak</td>
<td>235</td>
<td>6-37 mths</td>
<td>N/A</td>
<td>3.8</td>
<td></td>
<td></td>
<td>2.2% of children reported asymptomatic</td>
</tr>
<tr>
<td>Crawford et al. 1988</td>
<td>USA</td>
<td>cross-sectional</td>
<td>9mths-4yrs</td>
<td>6</td>
<td>19</td>
<td></td>
<td></td>
<td></td>
<td>Only infants and toddlers found to be Cryptosporidium +ve</td>
</tr>
<tr>
<td>Grimmond et al. 1988</td>
<td>Australia</td>
<td>cross-sectional</td>
<td>178</td>
<td>≤ 6 yrs</td>
<td>10.7</td>
<td>N/A</td>
<td></td>
<td></td>
<td>All infected children aged 1-4 yrs. Aboriginal and non-Aboriginal children in study; prevalence highest in Aboriginal children</td>
</tr>
<tr>
<td>Walters et al. 1988</td>
<td>South Africa</td>
<td>outbreak</td>
<td>70</td>
<td>&lt;3 yrs</td>
<td>N/A</td>
<td>73</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Authors and year of publication</td>
<td>Country of study</td>
<td>Type of study</td>
<td>No. of children providing faecal samples</td>
<td>Age range</td>
<td>% of children Giardia-positive</td>
<td>% of faecal samples Giardia-positive</td>
<td>% of children Cryptosporidium-positive</td>
<td>% of faecal samples Cryptosporidium-positive</td>
<td>Other information</td>
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</tr>
<tr>
<td>Ish-Horowicz et al 1989</td>
<td>Israel</td>
<td>prospective</td>
<td>89</td>
<td>3mths-3yrs</td>
<td>37</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>3 specimens per child collected over 12 mths; infections mostly asymptomatic and prolonged</td>
</tr>
<tr>
<td>Steketee et al 1989</td>
<td>USA</td>
<td>outbreaks</td>
<td>115</td>
<td>0-6yrs</td>
<td>1=47</td>
<td>2=17</td>
<td>3=37</td>
<td>N/A</td>
<td>3 outbreaks of <em>Giardia</em> occurred during 19mths. Stool samples collected from children during these outbreaks. Most commonly found in toddlers (aged 18-23mths)</td>
</tr>
<tr>
<td>Bretagne et al 1990</td>
<td>France</td>
<td>outbreak</td>
<td>53</td>
<td>18-36mths</td>
<td>N/A</td>
<td>21</td>
<td>N/A</td>
<td>N/A</td>
<td>6mth prospective study carried out 3mths later-found 103 episodes of diarrhoea, 5% <em>Cryptosporidium</em> +ve</td>
</tr>
<tr>
<td>Garcia-Rodriguez 1990</td>
<td>Spain</td>
<td>cross-sectional</td>
<td>&lt;5yrs</td>
<td>18.7</td>
<td>4%</td>
<td>16</td>
<td>0.8</td>
<td>N/A</td>
<td>All infected children &lt;3yrs</td>
</tr>
<tr>
<td>Novotny et al. 1990</td>
<td>USA</td>
<td>cross-sectional</td>
<td>236</td>
<td>12-42 mths</td>
<td>16</td>
<td>0.8</td>
<td>N/A</td>
<td>N/A</td>
<td>9% and 0% control (non-childcare centre children) <em>Giardia</em> and <em>Cryptosporidium</em> +ve</td>
</tr>
<tr>
<td>Rauch et al. 1990</td>
<td>USA</td>
<td>prospective</td>
<td>82</td>
<td>1-24 mths</td>
<td>33</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Weekly stool samples collected over 15 mths; 70% of children asymptomatic; 37% had 2 or &gt; episodes of infection</td>
</tr>
<tr>
<td>Authors and year of publication</td>
<td>Country of study</td>
<td>Type of study</td>
<td>No. of children providing faecal samples</td>
<td>Age range</td>
<td>% of children Giardia-positive</td>
<td>% of faecal samples Giardia-positive</td>
<td>% of children Cryptosporidium-positive</td>
<td>% of faecal samples Cryptosporidium-positive</td>
<td>Other information</td>
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</tr>
<tr>
<td>Varga and Delage 1990</td>
<td>Canada</td>
<td>cross-sectional</td>
<td>75</td>
<td>6-65mths</td>
<td>23</td>
<td>N/A</td>
<td></td>
<td></td>
<td>Two cross-sectional surveys performed 6mths apart; Most infections appeared asymptomatic</td>
</tr>
<tr>
<td>Varga and Delage 1990</td>
<td>Canada</td>
<td>cross-sectional</td>
<td>75</td>
<td>6-65mths</td>
<td>12</td>
<td>N/A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Addiss et al. 1991</td>
<td>USA</td>
<td>prospective</td>
<td>292</td>
<td>≤3yrs</td>
<td>7.2</td>
<td>2.7</td>
<td></td>
<td></td>
<td>3 specimens/child collected over 12 mths Age range of children Giardia +ve 3mths-3yrs Age range of children Cryptosporidium +ve 12-27mths</td>
</tr>
<tr>
<td>Ferson and Young 1992</td>
<td>Australia</td>
<td>outbreak</td>
<td>36</td>
<td>≤2yrs</td>
<td>14</td>
<td>28</td>
<td></td>
<td></td>
<td>Only half +ve children symptomatic</td>
</tr>
<tr>
<td>Cody et al 1994</td>
<td>USA</td>
<td>cross-sectional</td>
<td>80</td>
<td>2-3yrs</td>
<td>16</td>
<td>N/A</td>
<td></td>
<td></td>
<td>Prevalence varied with age: 5% &lt;12mths; 33%&lt;23mths. No Cryptosporidium 22% of children with Giardia asymptomatic</td>
</tr>
<tr>
<td>Ginsberg et al 1994</td>
<td>USA</td>
<td>cross-sectional</td>
<td>63</td>
<td>≤2yrs</td>
<td>18-32 in 3 centres</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Franco and Cordeiro 1996</td>
<td>Portugal</td>
<td>cross-sectional</td>
<td>310</td>
<td>2-60mths</td>
<td>13.5</td>
<td>6.4</td>
<td></td>
<td></td>
<td>Giardia infection greatest in 2yr olds; Cryptosporidium infection greatest in 7-12mth old children</td>
</tr>
<tr>
<td>Ferson et al. 1997</td>
<td>Australia</td>
<td>cross-sectional</td>
<td>178</td>
<td>0-36 mths</td>
<td>6</td>
<td>N/A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Authors and year of publication</td>
<td>Country of study</td>
<td>Type of study</td>
<td>No. of children providing faecal samples</td>
<td>Age range</td>
<td>% of children Giardia-positive</td>
<td>% of faecal samples Giardia-positive</td>
<td>% of children Cryptosporidium-positive</td>
<td>% of faecal samples Cryptosporidium-positive</td>
<td>Other information</td>
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</tr>
<tr>
<td>Nunez et al 1999</td>
<td>Cuba</td>
<td>cross-sectional</td>
<td>365</td>
<td>≤4</td>
<td>20</td>
<td>N/A</td>
<td></td>
<td>Over 18mth period: 51% children never infected; 40% infected 1-2 times; 9% infected in most or all of the study period</td>
<td></td>
</tr>
<tr>
<td>Oberhelman et al 2001</td>
<td>Mexico</td>
<td>prospective (over 12 mths)</td>
<td>78</td>
<td>2-48mths</td>
<td>3</td>
<td>0</td>
<td></td>
<td>Monthly sample collection</td>
<td></td>
</tr>
<tr>
<td>Cheng-Ng et al. 2002</td>
<td>Venezuela</td>
<td>cross-sectional</td>
<td>82</td>
<td>11 mths-6yrs</td>
<td>45.1</td>
<td>N/A</td>
<td></td>
<td>Single-sample study to determine prevalence of Giardia</td>
<td></td>
</tr>
<tr>
<td>Guimaraes &amp; Sogayar 2002</td>
<td>Brazil</td>
<td>cross-sectional</td>
<td>147</td>
<td>0-6yrs</td>
<td>63.3</td>
<td>N/A</td>
<td></td>
<td>Three separate stool samples collected from each child</td>
<td></td>
</tr>
<tr>
<td>Millet et al 2003</td>
<td>Venezuela</td>
<td>cross-sectional</td>
<td>301</td>
<td>&lt;6yrs</td>
<td>21</td>
<td>89</td>
<td></td>
<td>Children sampled five times over one month</td>
<td></td>
</tr>
</tbody>
</table>

**Key:** outbreak = centre surveyed during an outbreak of diarrhoea; all other survey were in centres with apparently healthy children  
N/A = not assessed
1.2.2 *Giardia*

*Giardia* is one of the most common pathogenic intestinal parasites affecting humans worldwide (Farthing 1993; Thompson 1994a; Thompson 2000), with a prevalence varying between 2 and 7% in Europe, USA, Canada and Australia, and over 40% in developing countries (Thompson 1998). In the USA, *Giardia* is considered to be the most common intestinal parasite of people (Polis *et al.* 1986), and it is the most frequently isolated intestinal parasite in the United Kingdom (Woo and Paterson 1986) and Australia (Meloni *et al.* 1993; Richards and Crotty 1995), and the most commonly notified waterborne disease in New Zealand (Hoque *et al.* 2001).

Children are infected with *Giardia* far more commonly than adults (Bartlett *et al.* 1991; Thompson 1998; Nunez *et al.* 1999), with the highest prevalence found in preschool children (Boreham *et al.* 1981; Boreham and Phillips 1986; Farthing 1993), probably related to the increased use of childcare facilities (Thompson 1998). *Giardia* has been found to be the most commonly identified pathogen in diarrhoea outbreaks and in sporadic diarrhoea in infants and toddlers (Bartlett *et al.* 1991).

Relatively few studies have been published on the prevalence of *Giardia* in the Australian population. Available data, however, are consistent with overseas studies which show that it is most common in the one to five year age group and is more prevalent in children who attend some form of pre-school care (Thompson 1994b).
1.2.2a Transmission

Transmission of *Giardia* commonly occurs through direct person-to-person contact and contaminated water or food (Boreham and Phillips 1986; Harley 1988; Farthing 1993; Thompson 1994a). Zoonotic transmission has been suspected but the evidence is not conclusive (Thompson 1998) and it is unlikely that this constitutes a major mode of transmission in humans.

Giardiasis is often associated with overcrowding, poor sanitary conditions and contaminated water sources, especially in undeveloped countries (Thompson 1994a). In more developed countries, faecal-oral contamination is the primary route of transmission (Thompson *et al.* 2000).

1.2.2b Clinical effects

*Giardia* can cause a large range of symptoms from acute self-limiting diarrhoea with intestinal malabsorption, abdominal pain and rapid weight loss to chronic intermittent diarrhoea (Crawford and Vermund 1987; Guerrant *et al.* 1990). Continual or repeat infection with *Giardia* may be responsible for retarded growth and development in children (Islam 1990; Farthing 1993; Thompson 1994a). Asymptomatic infection is also common (Crawford and Vermund 1987; Rauch *et al.* 1990).
1.2.2c Prevalence in childcare centres

*Giardia* is considered a serious problem in childcare centres, where it is one of the most commonly identified enteropathogens (Keystone *et al*. 1984; Pickering *et al*. 1984; Polis *et al*. 1986; Jarman and Kohlenberg 1991; Thompson 1994b; CDC 1994; WHO 1996). An Australian study found a significantly higher prevalence of *Giardia* (12%) in children aged one to five years attending childcare than in those not attending any form of childcare (7%) (Boreham and Phillips 1986). Within childcare centres in the USA, the prevalence of *Giardia* infection varies from 17-90% (Overturf 1994).

1.2.3 *Cryptosporidium*

*Cryptosporidium* is also a significant pathogen in humans, primarily as a cause of acute diarrhoea. It came to prominence with the AIDS epidemic (Hoepelman 1996; Molbak 2000), and was first reported as a human pathogen in 1976 (Nime *et al*. 1976). Prior to this, *Cryptosporidium* was recognised as an important veterinary pathogen in a wide range of animals (Guerrat *et al*. 1990), while in humans it was considered to be the result of an opportunistic pathogen outside its normal host range (Molbak 2000). *Cryptosporidium* is now, however, a well-recognised cause of gastroenteritis in both immunocompromised and immunocompetent individuals (Guerrat 1997; Weber and Rutala 2001) in over 40 countries (Kosek *et al*. 2001). The incidence of *Cryptosporidium* infection is highest in immunocompetent young children aged between one and five years (Ferson 1993; Mosier and Oberst 2000), and it is considered to be the most significant of all parasites causing diarrhoea in young children (Current and Garcia 1991).
As with *Giardia*, *Cryptosporidium* is a ubiquitous organism with a widespread distribution (Hoepelman 1996, Iqbal *et al.* 1999, Molbak 2000). Data from more than 100 geographically-based surveys show that *Cryptosporidium* is becoming one of the significant pathogens causing diarrhoea worldwide, especially in children (Current 1994; Current and Garcia 1991; Checkley *et al.* 1998). Although it has a higher prevalence in Asia, Africa, Central and South America, accounting for up to 20% of diarrhoea in these areas (Richards and Crotty 1995; Mosier and Oberst 2000), it remains a significant pathogen in more industrialized areas of the world such as Europe and North America (Soave and Armstrong 1986; Molbak 2000)

*Cryptosporidium* is one of the few parasitic infections of humans that is becoming more prevalent (MacKenzie *et al.* 1995) and is recognised as an ‘emerging infectious disease threat’ (CDC 1994; Juranek 1995; Guerrant 1997). In developing countries, it is a major cause of diarrhoea in malnourished children living in impoverished and unsanitary conditions (Newman *et al.* 1994; Checkley *et al.* 1997), while in developed countries, the increased use of childcare centres is an important factor in the increase in cryptosporidial infections (Longbottom 1997).

**1.2.3a Transmission**

*Cryptosporidium* is transmitted by the ingestion of oocysts excreted in the faeces of infected humans or animals (Juranek 1995). By the time the oocysts are excreted, they are fully developed and very infectious, and can therefore readily be spread by person-to-person contact (Juranek 1995; Dilligham *et al.* 2002). Infection with *Cryptosporidium* has been
linked to contaminated food and water, for example the Milwaukee waterborne outbreak in
the USA in 1993, where more than 400,000 residents were affected (MacKenzie et al.
1995), recreational water activities (swimming pools, lakes, rivers) and contact with
animals (Hoepelman 1996; Weber and Rutala 2001).
Although human cryptosporidiosis was initially though to be a zoonotic disease, with
human infection only resulting from contact with animal hosts (Tzipori et al. 1980), in
many cases no animal contact could be traced, and person-to-person contact has since
frequently been documented (Casemore and Jackson 1984; MacKenzie et al. 1995; Neill et
and animal isolates of Cryptosporidium suggested that human cryptosporidiosis was not
primarily a zoonotic disease. Zoonotic transmission, however, may be still an important
factor in infections in children living in developing countries where contact with domestic
and agricultural animals is very close, and hygiene conditions are poor (Molbak 2000). The
consensus from recent molecular epidemiological studies is that there are at least two
species of Cryptosporidium that affect humans, C. parvum, which is zoonotic, and C.
hominis, which may be contracted by humans only (Xiao et al. 2004; Xiao and Ryan in
press).

1.2.3b Clinical effects

Since the early 1980s, Cryptosporidium has been increasingly recognised as a cause of
severe, protracted, and often life-threatening diarrhoea in immunocompromised patients,
especially those with HIV/AIDS (Current et al. 1983; Navin and Juranek 1984;
Cruickshank et al. 1988; Guerrant 1997). In immunocompetent persons, however, the
disease is often short and self-limiting and manifests as an acute diarrhoeal illness with flu-like symptoms lasting 7-14 days, often accompanied by nausea, abdominal cramps and a low grade fever (Fayer and Ungar 1986; Cruickshank \textit{et al.} 1988; Cordell and Addiss 1994; Juranek 1995). \textit{Cryptosporidium} oocysts are resistant to most common disinfectants, including chlorine (Fayer and Ungar 1996), and there are currently no effective drugs for treatment or prophylaxis (Juranek 1995; Guerrant 1997; Petri 2000).

1.2.3c \textbf{Prevalence in childcare centres}

\textit{Cryptosporidium} infection is becoming an increasingly common cause of diarrhoea in young, immunocompetent children and has been associated with both sporadic and epidemic diarrhoea in childcare settings (Table 1) (Heijbel \textit{et al.} 1987; Garcia-Rodriguez \textit{et al.} 1990; Cordell & Addiss 1994; Hanna and Brooks 1995; Rodriguez-Hernandez \textit{et al.} 1996). Non-toilet-trained children who are still wearing nappies are at highest risk (Juranek 1995).

1.2.4 \textbf{Transmission to household contacts/community}

Infectious diarrhoea in childcare centres is a public health problem because of the potential for spread to other children and families and then to the wider community (Reves and Pickering 1992; Juranek 1995; Churchill and Pickering 1997). Both \textit{Giardia} and \textit{Cryptosporidium} infections are often spread to childcare staff, with those caring for children still in nappies most at risk (Cordell and Addiss 1994), as well as family and household contacts and others in the community (Hannah and Riordan 1988; Reves and
Pickering 1992; Cordell and Addiss 1994; Ferson 1997). This should not be surprising, given that infected individuals may excrete oocysts for up to five weeks after their disease symptoms have resolved (Jokipii and Jokipii 1986; Stehr-Green et al. 1987). While reports of the transmission of infectious diarrhoea from childcare centre children to families have ranged between 10 and 71% (Combee et al. 1986; Pickering and Engelkirk 1990; Pickering and Hadler 1991; Reves and Pickering 1992), studies have shown transmission of Giardia to family members ranging between 10 and 47% (Black et al. 1977; Pickering et al. 1981; Polis et al. 1986; Harley 1988). Transmission of Cryptosporidium infection to an immunocompromised contact could have a potentially serious outcome (Cordell and Addiss 1994).

1.2.5 Costs of infections acquired at childcare centres

The only major study on costs associated with infections in childcare centres found that more than US$1.8 billion was spent in the USA each year on illnesses associated with out-of-home childcare (Haskins 1989). Further studies have shown that at least 50% of these costs are due to work days missed to take care of an ill child kept home from childcare, or because of employee absenteeism due to illness contracted from a child in childcare (Avendano et al. 1993; Hardy et al. 1994; Cordell et al. 1997; Carabin et al. 1999).

Illness of children in childcare has an impact on the parents’ ability to work, the income of the childcare centre and the health of other centre children and of family members (Bartlett et al. 1985). Costs can therefore be defined in terms of health costs (to children, carers, families and the greater community) as well as financial costs (loss of income to parents,
medical costs, possible loss of income to the childcare centre and cost of replacing sick staff) (Haskins 1989; Hardy et al. 1994; Carabin et al. 1999). There is also a cost in terms of stress/worry of parents over sick children and how best to care for them, balanced with the risks of job loss if time is taken off work.

1.3 STUDY OBJECTIVES

The present study was designed to determine the prevalence and incidence of both Giardia and Cryptosporidium in children attending childcare centres in Perth, Western Australia. Despite an extensive search of the literature, no previous Australian studies could be found that had set out to do this. From the resultant data, information was collated on the prevalence of asymptomatic infection, the transmission dynamics of the parasites, whether there were any seasonal differences in the prevalence of the parasites, and the risk factors for infection with these parasites in childcare centres. The objectives of this study were therefore:

- To determine the prevalence and incidence of both Giardia and Cryptosporidium infection in apparently healthy children attending randomly selected childcare centres in Perth, Western Australia over 12 months (extended to 23 months).
- To determine how often these infections were transmitted from the infected children to other family and household members.
- To determine any seasonal trends in the prevalence of both parasites.
- To determine the levels of asymptomatic infection for both parasites.
- To determine the risk factors for Giardia and Cryptosporidium infection in the children in this study.
CHAPTER TWO

MATERIALS AND METHODS

2.1 STUDY POPULATION

The study population (n=583) comprised 382 children aged between 0 and 5 years of age who attended Long Daycare Centres (referred to in this study as childcare centres) in Perth, Western Australia, and 201 childcare workers who were employed in these centres. In the original study design, it had been intended to include childcare centres from rural areas in Western Australia to allow a rural-urban comparison, but this was not possible for several reasons:

- Time and labour constraints prevented the collection of samples from centres that were remote from Perth.
- Many childcare centres in small rural towns had insufficient enrolment numbers from which to sample.
- Of the centres that were of sufficient size and were close enough to Perth to permit collection of samples (n=8), only one (in Bunbury, approximately 200 kms south of Perth) agreed to participate.
2.2 SELECTION OF CHILDCARE CENTRES

A list of childcare centres throughout the Perth Metropolitan Area and southwest of Western Australia was obtained from the Child Care Services Board of Western Australia. This list provided information on the address, phone number, whether the centre was Long or Home Day care, and the number of children each centre was licensed to accommodate.

Prior to random selection of childcare centres for the study, centres with less than 45 child places were removed from the list. The size of the centre was set at this minimum to make collection feasible, and was an important factor in determining eligibility for the study. Being licensed for 45 children does not necessarily mean that a centre will have 45 children attending at any particular time, and of these, only a percentage will be in the non-toilet-trained age group (see Chapter 2.3.2). All the childcare centres in this study were therefore Long Daycare Centres since Home Daycare Centres had too few children enrolled to be included in the study. Those metropolitan childcare centres outside of a 25km radius of Murdoch University were also excluded because of the time required to collect samples from all the centres each month. Consequently, 106 centres remained, which were distributed across postcode districts covering a variety of socio-economic regions of the Perth metropolitan area (ABS 1996).

In March 1998, 30 centres from this list were randomly selected. These centres were contacted by letter (Appendix 1), with follow-up telephone contact two weeks later to determine whether they would be prepared to take part in the study. A total of 12 centres
(40%) consented to participate. Of these, in eight centres there was a sufficient positive response from parents (greater than five in each centre) to warrant sample collection from the children. In four centres, too few parents (less than five in each centre) consented and it was not considered feasible to collect from these. These centres instead assisted with the piloting of questionnaires (Section 2.7.2). The reasons given by childcare centre directors for not taking part in the study, included:

- The centre employees (carers) were too busy.
- The centre was in the process of being examined for accreditation (Section 2.2.2).
- The centre felt they received too many requests to take part in research.
- They did not believe the study was necessary.
- The centre director was agreeable but the parents were not.

Because of low sample collection in all eight centres (falling from 52 samples in June 1998 to only 31 samples in November 1998), in December 1998 after six months of sampling, another 25 centres were selected based on the initial selection criteria. Of these, eight (32%) agreed to participate in the study, however, only seven continued to participate once sampling had commenced (see below).

Difficulties with recruitment of childcare centres into research programmes are not unusual (Laborde et al. 1993; Carabin et al. 1999). In a similar prospective study by Bartlett et al. (1985), six out of 22 randomly selected centres refused to participate because they felt their carers were already too busy, and during the course of the two year study, one of the centres ceased to operate, two withdrew from the study because of owner or director changes, and
three withdrew because the staff found it too time-consuming to continue with the survey activities. In the present study, one of the original eight dropped out of the study after only three months because of major changes in the administration of the centre, and another from the second sampling set, discontinued after only two months because staff refused to cooperate with sample collection, citing time constraints.

Therefore, children from seven centres were sampled from June 1998 to June 1999 inclusive. Nine centres (including two from the first sampling group) were sampled from February 1999 to April 2000 inclusive. The geographical distribution of the 14 childcare centres can be seen in Figure 2.1.
Figure 2.1: Distribution of childcare centres taking part in the study, in Perth, Western Australia
Each centre was visited and the study was explained in more detail to the director of the centre. This included clarification of what involvement would entail for the centre and the short and long term benefits the centre would derive from involvement in the study. The short term benefits included being provided with knowledge about the levels of parasite infection within the centre on a monthly basis, and the long term benefits included receiving a summary of study findings at the completion of the study, as well as a copy of the health education programme developed during the study (detailed in Chapter 6) to supplement the resources already available at the centres. Any queries were answered, and a childcare centre consent form (Appendix 2) as well as explanatory letters for parents (Appendix 3) and employees (Appendix 4) with attached consent forms were then left at each centre for distribution. The centres were contacted again two weeks later, and the letters were sent out again to any parents who had not responded to the initial letter.

2.2.1 Characteristics of childcare centres

There were 14 childcare centres in this study, ranging in child population size from 45 to 125, (the maximum number of children each centre was licensed to care for) with a mean size of 64 children. The majority of the centres (86%) enrolled children aged from 0 to 6 years, with two centres taking children aged 0 to 12 years. All of the centres were open from Monday to Friday only, with the earliest opening time being 6.30am and the latest closing time, 6.30pm.
Most centres were private-profit centres (nine) with two being Government-run-profit centres, two community-run non-profit and one private-non-profit. The minimum number of carers employed at any of the centres was eight, while the maximum was 24, with a mean number of 15. In all but one centre, more than 50% of the carers were employed full time; in one centre only 50% of the staff were full time (Table 2.1). The Western Australian Community Services Child Care Regulations (1988), regulation no. 30 (Appendix 5) states the minimum staff to children ratios required for each age group. All childcare centres registered in Western Australia are required to adhere to these regulations.

<table>
<thead>
<tr>
<th>Childcare centre</th>
<th>Number children licensed for</th>
<th>Number carers</th>
<th>Number full-time carers</th>
<th>Number part-time carers</th>
</tr>
</thead>
<tbody>
<tr>
<td>U 1</td>
<td>61</td>
<td>17</td>
<td>10 (59%)</td>
<td>7</td>
</tr>
<tr>
<td>U 6</td>
<td>70</td>
<td>18</td>
<td>13 (72%)</td>
<td>5</td>
</tr>
<tr>
<td>U 7</td>
<td>59</td>
<td>15</td>
<td>10 (67%)</td>
<td>5</td>
</tr>
<tr>
<td>U 8</td>
<td>100</td>
<td>24</td>
<td>24 (100%)</td>
<td>0</td>
</tr>
<tr>
<td>U 9</td>
<td>48</td>
<td>10</td>
<td>6 (60%)</td>
<td>4</td>
</tr>
<tr>
<td>U10</td>
<td>92</td>
<td>21</td>
<td>18 (86%)</td>
<td>3</td>
</tr>
<tr>
<td>U13</td>
<td>60</td>
<td>16</td>
<td>13 (81%)</td>
<td>3</td>
</tr>
<tr>
<td>U14</td>
<td>47</td>
<td>14</td>
<td>7 (50%)</td>
<td>7</td>
</tr>
<tr>
<td>U15</td>
<td>125</td>
<td>21</td>
<td>14 (67%)</td>
<td>7</td>
</tr>
<tr>
<td>U16</td>
<td>51</td>
<td>10</td>
<td>8 (80%)</td>
<td>2</td>
</tr>
<tr>
<td>U41</td>
<td>45</td>
<td>13</td>
<td>11 (85%)</td>
<td>2</td>
</tr>
<tr>
<td>U42</td>
<td>45</td>
<td>12</td>
<td>11 (92%)</td>
<td>1</td>
</tr>
<tr>
<td>U52</td>
<td>45</td>
<td>8</td>
<td>7 (88%)</td>
<td>1</td>
</tr>
<tr>
<td>R 1</td>
<td>52</td>
<td>8</td>
<td>6 (75%)</td>
<td>2</td>
</tr>
</tbody>
</table>
All of the centres in this study separated children into different groups by age, with no mixing of these groups during the day. The centres all differed in their age separations (Table 2.2) but the children were generally grouped into babies, toddlers and preschool children. In all centres, individual staff members only looked after one age group during the day.

Table 2.2 The age separation groups for each childcare centre

<table>
<thead>
<tr>
<th>Childcare centre</th>
<th>Babies (months)</th>
<th>Toddlers (months)</th>
<th>Preschoolers (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U 1</td>
<td>0-21</td>
<td>22-32</td>
<td>2½+</td>
</tr>
<tr>
<td>U 6</td>
<td>0-17</td>
<td>17-30</td>
<td>2½-3 and 3-5</td>
</tr>
<tr>
<td>U 7</td>
<td>0-12</td>
<td>12-24</td>
<td>2-3 and 3-6</td>
</tr>
<tr>
<td>U 8</td>
<td>0-12</td>
<td>12-19 and 20-30</td>
<td>2½-3; 3-4; 4-6</td>
</tr>
<tr>
<td>U 9</td>
<td>6-24</td>
<td>24-36</td>
<td>3-6</td>
</tr>
<tr>
<td>U10</td>
<td>0-18</td>
<td>18-28 and 29-36</td>
<td>3-4 and 4-6</td>
</tr>
<tr>
<td>U13</td>
<td>0-12</td>
<td>12-30</td>
<td>2½-3½ and 3½-6</td>
</tr>
<tr>
<td>U14</td>
<td>0-18</td>
<td>18-36</td>
<td>3-5+</td>
</tr>
<tr>
<td>U15</td>
<td>0-12</td>
<td>12-24</td>
<td>2-3 and 3-6</td>
</tr>
<tr>
<td>U16</td>
<td>0-16</td>
<td>16-24</td>
<td>2-3 and 3-5</td>
</tr>
<tr>
<td>U41</td>
<td>0-24</td>
<td>24-36</td>
<td>3-5</td>
</tr>
<tr>
<td>U42</td>
<td>0-24</td>
<td>24-36</td>
<td>3-6</td>
</tr>
<tr>
<td>U52</td>
<td>0-24</td>
<td>24-36</td>
<td>3+</td>
</tr>
<tr>
<td>R 1</td>
<td>0-24</td>
<td>24-36</td>
<td>3-5</td>
</tr>
</tbody>
</table>

All the centres provided some kind of in-service education on hygiene for carers, attendance at which was compulsory in 50% of the centres. All the centres had a written hand-washing policy, with eight using their own policy, and the remaining six using the Staying Healthy in Childcare Guidelines (Roberts 1997). Nine of the centres used liquid soap only, two used solid soap only and three used both. Ten of the centres used disposable paper towels,
one used continuous cloth and three used a combination of both for drying hands. All the centres provided disposable gloves for the carers to use when changing nappies.

All the centres stated that they followed a strict exclusion policy for children with diarrhoea. The centres all stated that they contacted parents to collect the child if he/she developed diarrhoea while at the centre, and most of the centres then separated the child from the other children until collected by the parents.

2.2.2 Accreditation of childcare centres

Australia is the first country to introduce a national childcare quality improvement process that culminates in accreditation and which is directly linked to the government’s financial support paid to centres on behalf of families (Ochiltree and Edgar 1995). Although involvement in the accreditation process is voluntary, the Commonwealth Government’s Childcare Assistance is only available to childcare centres if they are registered with the National Childcare Accreditation Council (NCAC) and are accredited or making satisfactory progress towards the standards required for accreditation. Accreditation can be granted for one, two or three years between reviews, with one year meaning the centre meets all the basic standards required, through to three years for those who have excelled in all areas. This system was developed so that national standards of childcare could be achieved (Ochiltree and Edgar 1995). All of the centres in this study had attained three-year accreditation.
2.3 WHAT THE STUDY ENTAILED FOR PARTICIPANTS

2.3.1 The childcare centres

Involvement in this study by the childcare centres required a long-term commitment on the part of the centre. The carers were required to collect faecal samples from children once a month for 12 months (in two centres the carers collected for 23 months). They were also asked to distribute and collect questionnaires on a regular basis from parents in the study. As well, carers were asked to complete a pre- and post-test questionnaire (Appendices 6 and 7) and for those in the test centres, to trial a health education package centred on handwashing (Chapter 6).

2.3.2 The children and parents

Parents who consented to having their children included in the study were requested to complete one comprehensive questionnaire (Appendix 8), requiring approximately 10-15 minutes to complete, and at least two more short versions of the same questionnaire (Appendix 9), requiring only 5-10 minutes to complete, during the course of the study. Participation in the study did not require any active role from the children since carers would collect their faecal samples during a normal nappy change. Children in the test group of centres were exposed to the health education package, which involved them participating in singing songs, drawing and colouring pictures, and learning about handwashing (Chapter 6).
It had initially been planned to also collect faecal samples from the parents, siblings and pets of children in the study, and from employees in the centres, to assist in determining the transmission dynamics of the parasites. There was, however, a very negative response to this from parents and employees, with a strong reluctance on the part of adults to provide faecal specimens. It had also been proposed that faecal samples would be collected from children aged five years and under. Unfortunately the carers showed a great resistance to collecting samples from toilet-trained children. The main reasons given were that it would be an invasion of privacy for the child, and that for many children who have just learnt to use the toilet, it might jeopardise their toilet-training progress. The carers refused to consider the use of potties or collection items such as ice-cream containers placed inconspicuously under the toilet seat. Since this was a widespread feeling in all centres, faecal samples were collected only from non-toilet-trained children.

2.4 COLLECTION OF FAECAL SAMPLES

Faecal samples were collected once a month from the children of consenting parents in each centre, regardless of whether the children had diarrhoea. Faecal collection for each month was carried out over a period of one week, Monday to Friday. The sampling period for the month was carried out over one week rather than one day to increase the likelihood of getting samples from each child, because some children attend childcare part time, children are often absent due to illness, and many do not defaecate every day at the centre.
Each centre was given a code number (eg U1; U=urban centre; R=rural centre) and children were given a code that included their centre’s code (eg U1C1; C=child). A list of all participating children for that particular centre, including their code numbers, was given to each centre each month. Participating centres were all supplied with an ice-box, three ice packs, pre-coded faecal sample collection containers, disposable gloves, plastic bags and a marking pen. This was all delivered to each centre on the Friday prior to each sampling week.

Carers in the centres were requested to collect one faecal sample from each child, usually while changing a nappy or toileting the child. One sample per child was less than ideal, since it is accepted that for *Giardia* at least, a minimum of three separate samples are required due to the intermittent shedding of the parasite (Thompson 1994a). Unfortunately in this study I was constrained by the preparedness of the staff in centres to collect samples, and the number of samples that could be examined in the laboratory each month.

Once the sample was collected, the carer wrote the child’s code number on the collection container. The samples were then put into a plastic bag in the esky, with ice packs to keep the samples chilled. Samples were collected from each centre two to three times during the week and taken to Murdoch University, where they were kept in a cool room at 4°C. Microscopic examination of the samples usually occurred within one week of collection.

If a sample was found to be positive for *Giardia* or *Cryptosporidium*, the centre coordinator was notified immediately. She was asked to notify the parent/s, who usually gave
permission for a contact telephone number to be passed on. The parent/s were then contacted, told of the results and given advice on how to act. This was generally to seek further advice from their General Practitioner. Any questions the parent/s had were answered and information sheets about both *Giardia* and *Cryptosporidium* were available to be mailed out to the parents at their request.

Information was elicited from these parents with regard to whether the child and any family members had had any recent symptoms of gastroenteritis, particularly with regard to changes in bowel habits, and the parent/s were asked questions relating to potential sources of infection, for example contact with anyone suffering from an infectious gastrointestinal disease, recent contact with animals, visits to a farm or overseas travel. Parents were also asked if they would be prepared to supply faecal samples from themselves, siblings of the infected child, other persons in the household and any household pets, especially cats or dogs. If the parents agreed to this, sample collection containers were available at the centre and the child’s code number with an identification such as “Mum”, “Dad” “dog 1”, “dog 2” or the first name of a sibling was added. Providing the child’s code number was on the container, this was sufficient to identify household contacts without breaching confidentiality. Parents were notified as soon as possible of the results of any further samples provided and also of the sample results for their child for the following collection month/s, until the child returned a negative sample.

The parents were asked if they would complete a short version (Appendix 9) of the original comprehensive questionnaire (Appendix 8), which would take approximately five minutes
to complete (see Section 2.6). A copy of this questionnaire was either mailed to the parent/s along with any relevant information sheets as requested with a reply-paid, return-address envelope, or left at the centre for the parent to collect, again with an envelope for return.

2.5 LABORATORY ANALYSIS OF FAECAL SAMPLES

*Giardia* cysts and *Cryptosporidium* oocysts in faeces may be identified using several different techniques, all of which vary in effectiveness, sensitivity, cost and ease of use. These include direct staining of faecal smears (microscopy), indirect immunofluorescence, polymerase chain reaction (PCR) genetic marker analysis, enzyme-linked immunosorbent assay (ELISA) and flow cytometry (Lindo *et al.* 1998; Tzipori 1998). Of these methods, microscopy is by far the simplest and the cheapest. In this study, microscopy was used to identify *Giardia* cysts and *Cryptosporidium* oocysts in all samples. The same experienced microscopist examined all the samples throughout the study.

Microscopy has been criticised in the diagnosis of *Cryptosporidium* on the grounds that it is unreliable in the hands of an inexperienced operator (Current and Garcia 1991), and that differentiation between *Cryptosporidium* and other organisms may be difficult (Casemore *et al.* 1985; Kehl *et al.* 1995; Morgan and Thompson 1998). These problems have been largely overcome by the use of the malachite green stain. Elliot *et al.* (1999) compared this stain with three other commonly used staining techniques. They found that the malachite green stain was the most reliable and the fastest method of identifying *Cryptosporidium*
oocysts, with the other methods tested proving to be more time-consuming, unreliable and lacking sensitivity. They concluded that even relatively inexperienced microscopists could use this method accurately. In this study, the zinc sulphate flotation method (Zajac 1992) was used to allow microscopic identification of *Giardia* cysts (Appendix 10) and the malachite green stain was used to identify *Cryptosporidium* oocysts (Appendix 11).

### 2.6 QUESTIONNAIRE DEVELOPMENT

Questionnaires are a useful means for collecting information, and should be kept as simple as possible, without jeopardising the amount and quality of information gathered, to optimise respondent cooperation. There is often a conflict between collecting enough information necessary for the objectives of the study and keeping the questionnaire to an acceptable length. Response rates appear to be reduced by questionnaires of more than 12 pages in length (Armstrong *et al.* 1994).

The major objectives in the design of questionnaires for this study were to:

- Ensure ease of use by the respondents, since the questionnaires were designed to be self-administered.
- Maximise the usefulness of the information gathered through careful choice of questions.
- Ensure the questionnaires would not be difficult to process and analyse.
Two questionnaires were developed for this study. The first was for completion by the parents or legal carers of children involved in the study (Appendices 6 and 7). The second was for the carers working in the childcare centres (Appendices 8 and 9), and was used to evaluate the effectiveness of a health education intervention (Chapter 6). Armstrong et al. (1994) suggest that it is preferable to use or modify questionnaires previously used by others in similar studies, not only because it can make the process of questionnaire design much easier, but also because they will usually have been tested for reliability and/or validity and they use the expertise of others in the field. Despite a comprehensive search of the literature, however, no questionnaires were found which would be suitable for this study, so the questionnaires were specifically developed with the needs of this study in mind.

2.7 PARENT QUESTIONNAIRE

This questionnaire, which the parents/carers of each child in the study were asked to complete, was comprehensive and included questions which would provide demographic data about the child and his/her family, information about potential risk factors (for example contact with animals, farm visits and recent overseas travel) and questions to determine the knowledge level of parents about gastrointestinal parasites. Two versions of this questionnaire were used. The first included all the questions and was completed at the child’s inclusion into the study by all consenting parents (Appendix 6). The second was a shortened version of this, and was completed by parents if their child had a positive faecal sample (Appendix 7). It was also distributed to all other parents for completion twice
during the sampling period of the study to ensure that there were non-infected controls with which to compare the responses of those who were infected.

2.7.1 Validity Testing

Once the questionnaires had been developed, they were sent to five health professionals with a covering letter explaining the objectives of the study and the purpose of the questionnaires (Appendix 12), and asking them to specifically consider the following:

- Do the questions have relevance to the objectives of the study?
- Are the questions clear and easy to understand or might they be open to misinterpretation?
- Is the format of the questionnaire appropriate or could it be improved?
- Are there any other questions that should have been included to achieve the objectives?

Some changes to the questionnaires were made following this and the questionnaires were again sent out, this time to only two of the original health professionals, for a final examination. No further changes were required.

2.7.2 Reliability Testing

Pre-testing any questionnaire, but especially one which is newly designed and untried,
is a necessary part of questionnaire development (Armstrong et al. 1994). It is essential to identify and remove or alter any questions that are poorly understood, ambiguous or which might evoke inappropriate responses.

The parent questionnaire was piloted at two childcare centres that did not participate in the study, and the questionnaire for childcare centre carers was piloted at three centres not in the study. Following this, a small number of questions were removed from the questionnaires, but no new ones were added. Questions were removed where respondents had consistently either misinterpreted the question, answered inappropriately, or where they had made adverse comments about a particular question, and the question was not deemed by the researcher to be vital to the objectives of the study. Some minor changes were made to the wording of some questions, where the respondents had indicated that the original text was potentially confusing.

2.8 STATISTICAL ANALYSIS

All data from faecal sample surveys and questionnaires were entered into excel spreadsheets. Data entries were verified against raw values (independently by at least two people) prior to any analyses.

Infection rates with *Giardia* and *Cryptosporidium* were calculated both as a percentage of positive samples, and a percentage of positive children. Associations between categorical variables were analysed by Fisher’s exact test or Chi-square test using Yates’ correction for
continuity where appropriate, and associations between continuous variables by Pearson’s product moment correlation.

Time series analysis was used to identify any systematic patterns in infection rates with *Giardia* and *Cryptosporidium* over time. Autocorrelation functions were calculated for different time lags and spectral density plotted against period frequency. Fisher’s Kappa statistic was used to test for a significant periodic component to the pattern. Risk factors for parasite infection were tested first by univariate analyses (Chi-square or one way analysis of variance), then by multivariate analysis.

Logistic-normal multiple regression was used to create a multivariate model. Only variables significant at $P \leq 0.25$ in the univariate analyses were considered eligible for inclusion in the logistic multiple regression (Hosmer and Lemeshow 1989; Frankena and Graat 1997). Dummy variables were generated for any categorical variable with more than two levels. Backward elimination was used to determine which factors could be dropped from the multivariable model (Hosmer and Lemeshow 1989). The likelihood-ratio test statistic was calculated to determine the significance at each step of the model building. The level of significance for a factor to remain in the final model was set at 0.10. All statistical tests were two-tailed. Two-way interaction terms among the explanatory variables were examined after identification of the reduced set of main effects. Each interaction was added to the model and the significance assessed in the same way as for the explanatory variables.
Statistical comparisons were performed using JMP version 4 (SAS, Cary, North Carolina), Statistix for Windows (Analytical Software, Tallahassee, Florida) and Egret for Windows (Cytel Software Ver 2.0.31). Prior to any analyses assuming normal distributions, variables were tested for normality and transformed if necessary. Where multiple tests of the same hypothesis were performed, a Bonferroni correction was used to obtain an experiment side-error rate of 0.05.

2.9 ETHICS APPROVAL

Ethics approval for this study was received from the Human Research Ethics Committee, Division of Research and Development, Murdoch University. Confidentiality for all participants was assured by the use of code numbers rather than names to identify questionnaires and faecal samples. All printed identifying material, for example, signed consent forms, was kept in locked filing cabinets, with access available only to the principal researcher in this study, while all computer files with any identification of individuals were protected with passwords, again known only to the principle researcher in this study.
CHAPTER THREE

RESULTS

3.1. GIARDIA AND CRYPTOSPORIDIUM INFECTIONS IN CHILDCARE CENTRES IN PERTH, WESTERN AUSTRALIA

During 23 months of sampling, 1169 faecal samples were collected from 306 children. Seventy six (20%) children in the study did not have a faecal sample collected from them at all during the sampling period.

Of the samples, 40 were found to be positive for Giardia (3.4%) and 37 were positive for Cryptosporidium (3.2%). Only one sample was positive for both Giardia and Cryptosporidium. The number of children positive for Giardia during the collection period was 24 (7.8%) and for Cryptosporidium, 33 (10.8%). These originated from 11 (79%) and 12 (86%) childcare centres respectively.

Six faecal samples were positive for parasites other than Giardia or Cryptosporidium. Four of these contained another protozoan parasite, Entamoeba coli, one contained Enterobius vermicularis (pinworm) and one contained Trichostrongylus eggs.
3.2 DIFFERENCES BETWEEN CHILDCARE CENTRES

The percentage of samples positive for *Giardia* and *Cryptosporidium* in each childcare centre over the sampling period is shown in Table 3.1. There was a significant difference between childcare centres in the number of samples positive for *Giardia* ($\chi^2_{13} = 23.3, P=0.04$), but not for *Cryptosporidium* ($\chi^2_{13} = 16.2, P=0.24$). In three childcare centres no faecal samples were positive for *Giardia* at all during the sampling period, and in those where *Giardia* was detected, between 0.7% and 9.8% of samples were positive. Faecal samples positive for *Cryptosporidium* were found in all but two childcare centres, with the range of positive samples in the remaining 12 centres being 1.1% to 6.7%.

<table>
<thead>
<tr>
<th>Childcare centre (code no)</th>
<th>Total samples collected from each centre</th>
<th>Percentage of positive <em>Giardia</em> samples (95% CI)</th>
<th>Percentage of positive <em>Cryptosporidium</em> samples (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U 1</td>
<td>60</td>
<td>0</td>
<td>6.7 (0.4-13.0)</td>
</tr>
<tr>
<td>U 6</td>
<td>95</td>
<td>0</td>
<td>1.1 (0.0- 3.1)</td>
</tr>
<tr>
<td>U 7</td>
<td>82</td>
<td>7.3 (1.7-13.0)</td>
<td>2.4 (0.0- 5.8)</td>
</tr>
<tr>
<td>U 8</td>
<td>105</td>
<td>5.7 (1.3-10.2)</td>
<td>3.8 (0.1- 7.5)</td>
</tr>
<tr>
<td>U 9</td>
<td>79</td>
<td>2.5 (0.0- 6.0)</td>
<td>5.1 (0.2- 9.9)</td>
</tr>
<tr>
<td>U10</td>
<td>53</td>
<td>5.7 (0.0-11.9)</td>
<td>3.8 (0.0- 8.9)</td>
</tr>
<tr>
<td>U13</td>
<td>69</td>
<td>4.3 (0.0- 9.2)</td>
<td>5.8 (0.3-11.3)</td>
</tr>
<tr>
<td>U14</td>
<td>77</td>
<td>1.3 (0.0- 3.8)</td>
<td>1.3 (0.0- 3.8)</td>
</tr>
<tr>
<td>U15</td>
<td>144</td>
<td>0.7 (0.0- 2.1)</td>
<td>5.6 (1.8- 9.3)</td>
</tr>
<tr>
<td>U16</td>
<td>70</td>
<td>2.9 (0.0- 6.8)</td>
<td>2.9 (0.0- 6.8)</td>
</tr>
<tr>
<td>U41</td>
<td>137</td>
<td>4.4 (1.0- 8.2)</td>
<td>2.2 (0.0- 4.6)</td>
</tr>
<tr>
<td>U42</td>
<td>131</td>
<td>4.6 (1.0- 8.2)</td>
<td>0</td>
</tr>
<tr>
<td>U52</td>
<td>41</td>
<td>9.8 (0.7- 8.8)</td>
<td>4.9 (0.0-11.5)</td>
</tr>
<tr>
<td>R 1</td>
<td>26</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1169</td>
<td>3.4 (2.4- 4.5)</td>
<td>3.2 (2.2- 4.2)</td>
</tr>
</tbody>
</table>
3.3 SEASONAL DIFFERENCES IN GIARDIA AND CRYPTOSPORIDIUM INFECTIONS

In Figure 3.1 the proportion of positive samples of Giardia and Cryptosporidium for all the childcare centres for each month of the sampling period is illustrated. The number of positive samples for Giardia ($\chi^2_3 = 10.04, P=0.018$) and Cryptosporidium ($\chi^2_3 = 35.6, P<0.0001$) were significantly different between seasons. Fifty percent of Giardia and 73% of Cryptosporidium infections occurred during the autumn months of March, April and May (Table 3.2). This peak occurred in the first autumn of sampling, but was not repeated in the second autumn.

No long-term periodicity in infection rates for Giardia or Cryptosporidium was able to be identified using time series analysis. Positive autocorrelations between infection rates in different months were seen only with time lags of one month. Neither series differed significantly from that expected if the values were drawn from a normal distribution (for Giardia, Fisher’s Kappa = 2.65, $P=0.62$; for Cryptosporidium, Fisher’s Kappa = 2.91, $P=0.48$).
Fig. 3.1 Percentage of positive samples for *Giardia* (black bars) and *Cryptosporidium* (white bars) for all the childcare centres for each month of the sampling period.
<table>
<thead>
<tr>
<th>Season</th>
<th>Number of samples positive for <em>Giardia</em></th>
<th>% (95% CI)</th>
<th>Number of samples positive for <em>Cryptosporidium</em></th>
<th>% (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer</td>
<td>7</td>
<td>17.5 (5.7-29.3)</td>
<td>5</td>
<td>13.5 (2.5-24.5)</td>
</tr>
<tr>
<td>Autumn</td>
<td>20</td>
<td>50 (34.5-65.5)</td>
<td>27</td>
<td>73 (58.7-87.3)</td>
</tr>
<tr>
<td>Winter</td>
<td>8</td>
<td>20 (7.6-32.4)</td>
<td>5</td>
<td>13.5 (2.5-24.5)</td>
</tr>
<tr>
<td>Spring</td>
<td>5</td>
<td>12.5 (2.3-22.7)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>100</td>
<td>37</td>
<td>100</td>
</tr>
</tbody>
</table>

Weather data, including the mean maximum and mean minimum temperatures, mean relative humidity and rainfall for the period of this study, for Perth Western Australia, are presented in Figure 3.2. There were significant differences between seasons in the mean maximum temperature ($F_{3,19}=33.5$, $P<0.0001$), mean minimum temperature ($F_{3,19}=32.1$, $P<0.0001$), mean relative humidity ($F_{3,19}=20.3$, $P<0.0001$) and rainfall ($F_{3,19}=7.8$, $P=0.001$). None of these weather parameters, however, were significantly related to the number of positive samples of *Giardia* (for mean maximum temperature $r^2=0.03$, $P=0.41$; for mean minimum temperature $r^2=0.02$, $P=0.55$; for mean relative humidity $r^2=0.00$, $P=0.99$; for rainfall $r^2=0.01$, $P=0.56$) or the number of positive samples of *Cryptosporidium* (for mean maximum temperature $r^2=0.03$, $P=0.61$; for mean minimum temperature $r^2=0.01$, $P=0.29$; for mean relative humidity $r^2=0.00$, $P=0.99$; for rainfall $r^2=0.03$, $P=0.45$).
Figure 3.2  The percentage of positive samples for *Giardia* (black bars) and *Cryptosporidium* (white bars) in each month, plotted against monthly values for (a) mean maximum temperature, (b) mean minimum temperature, (c) mean relative humidity and (d) rainfall.
3.4 SYMPTOMATIC AND ASYMPTOMATIC INFECTIONS

Of the 40 faecal samples found to be positive for *Giardia*, 18 (45%) were from children who were symptomatic, for example suffered from diarrhoea and/or stomach cramps, at the time of sample collection or during the two weeks prior to collection, while 22 (55%) were from children who had shown no signs or symptoms of giardiasis. Only five (13.5%) of 37 *Cryptosporidium*-positive samples were from asymptomatic children, with the remaining 32 (86.5%) all from children reporting signs and symptoms of the disease, with parents usually reporting that the child had had diarrhoea, stomach cramps, anorexia and was generally unwell.

Analysis of children who were never positive for *Giardia* found that 34% had had some signs or symptoms of gastroenteritis during the study, compared to 50% of those who were found positive at least once. Although this difference was not statistically significant ($\chi^2 = 2.36, P = 0.12$), there was a trend for more positive than negative children to have been symptomatic. Sixty five percent of the children who had at least one positive sample for *Cryptosporidium*, had some signs or symptoms of gastroenteritis during the study, compared with 32% of the children who were never positive. This difference was statistically significant ($\chi^2 = 13.76, P = 0.0001$). Positive children were 3.7 times (95% CI, 1.8-8.0) more likely to show signs of gastroenteritis than were negative children.
3.5 REPEAT AND CONTINUOUS INFECTIONS

Fifteen (62.5%) of the 24 children found to be positive for *Giardia* during this study returned positive samples for only one month (their faecal samples were negative in the following sampling month), with the remaining nine (37.5%) returning positive faecal samples for two (four children), three (three children) and four months (two children), but not always consecutively (Table 3.3). One child returned positive faecal samples for *Giardia* over a period of five months and another over seven months, but neither had samples collected consecutively every month during these periods.

A total of 33 children were found to be positive for *Cryptosporidium*. Twenty nine (88%) of these returned positive samples for only one month, while four (12%) were infected for two consecutive months (Table 3.3).
Table 3.3  Sampling history of children whose faecal samples were positive for *Giardia/Cryptosporidium* more than once. The sample in the month prior to the first identified positive sample is shown. Thereafter, sampling history each month is shown until either no more positive samples were identified, or no more samples were collected from the child.

<table>
<thead>
<tr>
<th>Child</th>
<th>Infection (Giardia or Cryptosporidium)</th>
<th>Sample in month prior to first positive sample</th>
<th>Sample history from first positive sample until sample negative for Giardia/Cryptosporidium</th>
</tr>
</thead>
<tbody>
<tr>
<td>U41C2</td>
<td>Giardia</td>
<td>NS</td>
<td>+ve</td>
</tr>
<tr>
<td>U42C26</td>
<td>Giardia</td>
<td>-ve</td>
<td>+ve</td>
</tr>
<tr>
<td>U42C30</td>
<td>Giardia</td>
<td>-ve</td>
<td>+ve</td>
</tr>
<tr>
<td>U52C4</td>
<td>Giardia</td>
<td>NS</td>
<td>+ve</td>
</tr>
<tr>
<td>U7C10</td>
<td>Giardia</td>
<td>NS</td>
<td>+ve</td>
</tr>
<tr>
<td>U13C11</td>
<td>Giardia</td>
<td>-ve</td>
<td>+ve</td>
</tr>
<tr>
<td>U8C32</td>
<td>Giardia</td>
<td>-ve</td>
<td>+ve</td>
</tr>
<tr>
<td>U8C40</td>
<td>Giardia</td>
<td>-ve</td>
<td>+ve</td>
</tr>
<tr>
<td>U10C11</td>
<td>Giardia</td>
<td>NS</td>
<td>+ve</td>
</tr>
<tr>
<td>U7C14</td>
<td>Cryptosporidium</td>
<td>-ve</td>
<td>+ve</td>
</tr>
<tr>
<td>U13C9</td>
<td>Cryptosporidium</td>
<td>-ve</td>
<td>+ve</td>
</tr>
<tr>
<td>U15C4</td>
<td>Cryptosporidium</td>
<td>NS</td>
<td>+ve</td>
</tr>
<tr>
<td>U41C22</td>
<td>Cryptosporidium</td>
<td>NS</td>
<td>+ve</td>
</tr>
</tbody>
</table>

**Key:**
- **-ve** negative sample
- **+ve** positive sample
- **NS** no sample was obtained from the child during that collection month
- **NFS** no further samples obtained from this child
3.6 TRANSMISSION TO FAMILY AND HOUSEHOLD MEMBERS

Of the children who were found to be positive for *Giardia* or *Cryptosporidium* during this study, it was possible to collect faecal specimens from 28 family members (parents and/or siblings) of 12 children (50%) with *Giardia* and of 14 family members of five children (15%) with *Cryptosporidium*. Of these, five (17.9%) family members of three of the 12 children with *Giardia* returned *Giardia*-positive faecal samples, while four (28.6%) family members of the five children with *Cryptosporidium* returned *Cryptosporidium*-positive faecal samples. Two of the family members of a *Cryptosporidium*-positive child had provided faecal samples to their doctor, but not to this study, and these had also returned a positive result. The family of a child with a *Giardia*-positive sample had all been treated with Metronidazole before providing samples in this study, all of which were found to be negative for *Giardia*. All four members of this family (two parents and two pre-school children) were symptomatic for gastroenteritis. Information received from the parents of children found to be either *Giardia*- or *Cryptosporidium*-positive, indicated that in three (12.5%) and 16 (48.5%) of these families respectively, at least one other family member reported having diarrhoea, whereas in families without *Giardia*-positive or *Cryptosporidium*-positive children, no other family members reported having diarrhoea or other gastroenteritis symptoms. These differences in the reporting of symptoms were significant (for *Giardia*, Fisher exact test, P=0.0008; for *Cryptosporidium*, Fisher exact test, P<0.0001).
None of the pet samples (one cat and three dog samples, all collected from positive households) returned a positive sample for either _Giardia_ or _Cryptosporidium_. The family with the cat, however, reported that it had been suffering from blood-stained diarrhoea and had been treated by a veterinarian, who was not able to isolate any specific agent. No faecal specimens from the cat were provided to this study. The dogs were all reported to be asymptomatic.

### 3.7 RISK FACTOR ANALYSIS

Based on information elicited from the questionnaire that was completed by parents of the children in the study (Appendix 8), a number of risk factors for parasite infection were tested. The association between these risk factors and infection with _Giardia_ and/or _Cryptosporidium_ are shown in Tables 3.4-3.7. Using univariate analysis, only one factor was significantly associated with infections of _Giardia_ (P<0.05), while seven factors were found to be significantly associated with _Cryptosporidium_ infections. No risk factors were shared between the two parasites.

For _Giardia_ infection, the only significant risk factor was the number of adults living in the household, with infection more likely to occur in children who had fewer adults living in the household (Table 3.4). Two other factors, although not statistically significant, showed strong trends for an association with _Giardia_ infection (0.05<P<0.10). These were whether the parent(s) had any previous knowledge of _Giardia_ and whether they were aware of the signs and symptoms of _Giardia_ infection.
(Table 3.5). For both of these, there was a greater chance of infection in the children of parents with this knowledge.

### Table 3.4  Continuous risk factors for *Giardia* infection (significant risk factors in bold type)

* Indicates significance at P<0.05, with the Bonferroni correction

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Mean in –ve cases (± SEM)</th>
<th>Mean in +ve cases (± SEM)</th>
<th>Probability (F=0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of child (months)</td>
<td>20.10 (±0.66)</td>
<td>20.05 (±2.07)</td>
<td>0.98</td>
</tr>
<tr>
<td>Length of time child had been enrolled at childcare centre (months)</td>
<td>10.59 (±0.53)</td>
<td>12.35 (±1.63)</td>
<td>0.31</td>
</tr>
<tr>
<td>Child’s age at enrolment at centre (months)</td>
<td>0.77 (±0.04)</td>
<td>0.64 (±0.12)</td>
<td>0.28</td>
</tr>
<tr>
<td><strong>Number of adults living in the household</strong></td>
<td><strong>1.96 (±0.02)</strong></td>
<td><strong>1.75 (±0.06)</strong></td>
<td><strong>0.001</strong></td>
</tr>
<tr>
<td>Number of children &lt;15 years living in the household</td>
<td>1.55 (±0.53)</td>
<td>1.45 (±0.16)</td>
<td>0.55</td>
</tr>
<tr>
<td>Number of hours/week spent by child in the centre</td>
<td>6.19 (±0.20)</td>
<td>7.20 (±0.64)</td>
<td>0.13</td>
</tr>
<tr>
<td>Risk Factor</td>
<td>Prevalence of <em>Giardia</em> infection (%)</td>
<td>Probability ($\chi^2 = 0$)</td>
<td></td>
</tr>
<tr>
<td>----------------------------------------------------------------------------</td>
<td>--------------------------------------</td>
<td>-----------------------------</td>
<td></td>
</tr>
<tr>
<td>Child was male</td>
<td>0.55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child was female</td>
<td>0.45</td>
<td>0.83</td>
<td></td>
</tr>
<tr>
<td>Child's place of birth was Australia</td>
<td>0.10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child's place of birth was other than Australia</td>
<td>0.00</td>
<td>0.15</td>
<td></td>
</tr>
<tr>
<td>Child attended other form of childcare than this centre</td>
<td>0.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child did not attend other form of childcare than this centre</td>
<td>0.11</td>
<td>0.18</td>
<td></td>
</tr>
<tr>
<td>Child had siblings also attending childcare</td>
<td>0.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child did not have siblings also attending childcare</td>
<td>0.08</td>
<td>0.58</td>
<td></td>
</tr>
<tr>
<td>Child wore a nappy 24 hours/day</td>
<td>0.10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child did not wear a nappy 24 hours/day</td>
<td>0.06</td>
<td>0.51</td>
<td></td>
</tr>
<tr>
<td>Child wore disposable nappies</td>
<td>0.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child wore cloth nappies</td>
<td>0.07</td>
<td>0.77</td>
<td></td>
</tr>
<tr>
<td>Child required assistance to use the toilet</td>
<td>0.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child did not require assistance to use the toilet</td>
<td>0.09</td>
<td>0.66</td>
<td></td>
</tr>
<tr>
<td>Child had diarrhoea or other gastroenteritis symptoms within the last four weeks</td>
<td>0.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child did not have diarrhoea or other gastroenteritis symptoms within the last four weeks</td>
<td>0.07</td>
<td>0.32</td>
<td></td>
</tr>
<tr>
<td>A family member had diarrhoea or other gastroenteritis symptoms within the last four weeks</td>
<td>0.08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No family member had diarrhoea or other gastroenteritis symptoms within the last four weeks</td>
<td>0.10</td>
<td>0.77</td>
<td></td>
</tr>
<tr>
<td>Child had visited a farm in the past four weeks</td>
<td>0.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child did not visit a farm in the past four weeks</td>
<td>0.11</td>
<td>0.49</td>
<td></td>
</tr>
<tr>
<td>Child had travelled overseas in the previous four weeks</td>
<td>0.14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child had not travelled overseas in the previous four weeks</td>
<td>0.09</td>
<td>0.64</td>
<td></td>
</tr>
<tr>
<td>Child/family owned pets</td>
<td>0.09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child/family did not own pets</td>
<td>0.09</td>
<td>0.93</td>
<td></td>
</tr>
<tr>
<td><strong>Parent had previous knowledge of <em>Giardia</em></strong></td>
<td><strong>0.12</strong></td>
<td><strong>0.05</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Parent had no previous knowledge of <em>Giardia</em></strong></td>
<td><strong>0.05</strong></td>
<td><strong>0.08</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Parent knew the signs and symptoms of giardiasis</strong></td>
<td><strong>0.12</strong></td>
<td><strong>0.04</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Parent did not know the signs and symptoms of giardiasis</strong></td>
<td><strong>0.04</strong></td>
<td><strong>0.08</strong></td>
<td></td>
</tr>
</tbody>
</table>
Seven risk factors were found to be significantly associated with *Cryptosporidium* infection, although only three of these were significant after applying a Bonferroni correction. The age of the child and the length of time the child had been enrolled at the centre were both positively associated with infection. The mean age of positive children (20.6 months) was higher than in the negative children (16.6 months). Children that were positive had attended childcare for a longer time than the negative children (11.2 and 7.8 months respectively) (Table 3.6). The prevalence of infection was also greater if the child had some other form of childcare, for example being cared for by another family member, if the child or a close family member had suffered from signs and symptoms of infectious diarrhoea in the previous four weeks, if the child had visited a farm in the previous four weeks and if the parents had some knowledge of the signs and symptoms of cryptosporidiosis (Table 3.7).

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Mean in −ve cases (± SEM)</th>
<th>Mean in +ve cases (± SEM)</th>
<th>Probability (F=0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (months) of infected child</td>
<td>16.59 (± 1.73)</td>
<td>20.61 (± 0.67)</td>
<td>0.03</td>
</tr>
<tr>
<td>Length of time (months) child has been enrolled</td>
<td>7.78 (± 1.40)</td>
<td>11.19 (± 0.53)</td>
<td>0.02</td>
</tr>
<tr>
<td>at this childcare centre</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child's age at enrolment at centre</td>
<td>0.75 (±0.04)</td>
<td>0.78 (±0.10)</td>
<td>0.80</td>
</tr>
<tr>
<td>Number of adults living in the household</td>
<td>1.94 (±0.02)</td>
<td>1.96 (±0.05)</td>
<td>0.69</td>
</tr>
<tr>
<td>Number of children &lt;15 years living in the</td>
<td>1.54 (±0.05)</td>
<td>1.57 (±0.14)</td>
<td>0.83</td>
</tr>
<tr>
<td>household</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of hours/week spent by child in the centre</td>
<td>6.32 (±0.21)</td>
<td>6.07 (±0.54)</td>
<td>0.68</td>
</tr>
</tbody>
</table>

56
Table 3.7  Categorical risk factors for *Cryptosporidium* infection (significant risk factors in bold type)

- Indicates significance at $P<0.05$, with the Bonferroni correction

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Prevalence of <em>Cryptosporidium</em> infection (%)</th>
<th>Probability ($\chi^2 = 0$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child was male</td>
<td>0.57</td>
<td></td>
</tr>
<tr>
<td>Child was female</td>
<td>0.43</td>
<td>0.62</td>
</tr>
<tr>
<td>Child’s place of birth was Australia</td>
<td>0.13</td>
<td></td>
</tr>
<tr>
<td>Child’s place of birth was other than Australia</td>
<td>0.11</td>
<td>0.81</td>
</tr>
<tr>
<td><strong>Child attends/has other form of childcare than this centre</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child does not attend/have other form of childcare than this centre</td>
<td>0.17</td>
<td>0.006*</td>
</tr>
<tr>
<td><strong>Child had siblings also attending childcare</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child did not have siblings also attending childcare</td>
<td>0.12</td>
<td>0.56</td>
</tr>
<tr>
<td><strong>Child wore a nappy 24 hours/day</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child did not wear a nappy 24 hours/day</td>
<td>0.14</td>
<td>0.21</td>
</tr>
<tr>
<td><strong>Child wore disposable nappies</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child wore cloth nappies</td>
<td>0.15</td>
<td>0.71</td>
</tr>
<tr>
<td><strong>Child required assistance to use the toilet</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child did not require assistance to use the toilet</td>
<td>0.11</td>
<td>0.71</td>
</tr>
<tr>
<td><strong>Child had diarrhoea or other gastroenteritis symptoms within the last four weeks</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child did not have diarrhoea or other gastroenteritis symptoms within the last four weeks</td>
<td>0.20</td>
<td>0.001*</td>
</tr>
<tr>
<td><strong>A family member had diarrhoea or other gastroenteritis symptoms within the last four weeks</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No family member had diarrhoea or other gastroenteritis symptoms within the last four weeks</td>
<td>0.26</td>
<td>&lt;0.0001*</td>
</tr>
<tr>
<td><strong>Child had visited a farm in the past four weeks</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child did not visit a farm in the past four weeks</td>
<td>0.30</td>
<td>0.02</td>
</tr>
<tr>
<td><strong>Child had travelled overseas in previous four weeks</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child had not travelled overseas in previous four weeks</td>
<td>0.11</td>
<td>0.30</td>
</tr>
<tr>
<td><strong>Child/family owned pets</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child/family did not own pets</td>
<td>0.14</td>
<td>0.61</td>
</tr>
<tr>
<td><strong>Parent had previous knowledge of <em>Cryptosporidium</em></strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parent had no previous knowledge of <em>Cryptosporidium</em></td>
<td>0.15</td>
<td>0.66</td>
</tr>
<tr>
<td><strong>Parent(s) know the symptoms of cryptosporidiosis</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parent(s) do not know the symptoms of cryptosporidiosis</td>
<td>0.24</td>
<td>0.05</td>
</tr>
</tbody>
</table>
Following univariate analysis, all variables significant at $P \leq 0.25$ (Tables 3.4-3.7) were offered to the multivariate logistic normal regression model. A stable multivariable model could not be generated for *Giardia*. For *Cryptosporidium*, however, having visited a farm in the past four weeks, having a family member with signs or symptoms of gastroenteritis in the past four weeks, the child having signs or symptoms of gastroenteritis in the past four weeks and the child receiving other forms of childcare beside the current childcare centre were significant in the final model (Table 3.8).

Children who had visited a farm were 9.7 times more likely to be positive for *Cryptosporidium*. Similarly, children belonging to a family with another family or household member with signs or symptoms of gastroenteritis were 8.6 times more likely to be positive for *Cryptosporidium*, as were children who had had signs or symptoms of gastroenteritis (2.6 times) and children that received other forms of childcare (5.7 times).

**Table 3.8** Characteristics associated with presence of *Cryptosporidium* in children attending childcare (n=306). Values obtained from multivariate logistic regression model

<table>
<thead>
<tr>
<th>Factor</th>
<th>$b$</th>
<th>SE $(b)$</th>
<th>Odds Ratio</th>
<th>95% CI of Odds Ratios</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-5.4</td>
<td>0.86</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Child had visited a farm in the past four weeks</td>
<td>2.3</td>
<td>0.73</td>
<td>9.7</td>
<td>2.3, 40.4</td>
<td>0.002</td>
</tr>
<tr>
<td>A family member had diarrhoea or other gastroenteritis symptoms in the past four weeks</td>
<td>2.2</td>
<td>0.6</td>
<td>8.6</td>
<td>2.7, 27.8</td>
<td>0.003</td>
</tr>
<tr>
<td>Child had diarrhoea or other gastroenteritis symptoms in the past four weeks</td>
<td>0.95</td>
<td>0.56</td>
<td>2.6</td>
<td>0.9, 7.8</td>
<td>0.093</td>
</tr>
<tr>
<td>Child attends other form of childcare than this centre</td>
<td>1.7</td>
<td>0.65</td>
<td>5.7</td>
<td>1.6, 20.3</td>
<td>0.008</td>
</tr>
</tbody>
</table>
CHAPTER FOUR

DISCUSSION

4.1 INTRODUCTION

It has been well established that the high number of young children grouped together in close contact in childcare centres facilitates the transmission of pathogens, including transmission to other children, adult care providers and parents (Pickering and Osterholm 1997; Barros 1999). The present study was designed to determine the occurrence of infections of *Giardia* and *Cryptosporidium* in children attending childcare centres in Western Australia, including seasonal trends, transmission beyond the childcare centre, the extent of asymptomatic illness and specific risk factors for infection.

Despite an extensive search of the literature, few similar Australian studies were found. One study specifically designed to determine differences in rates of *Giardia* infections in childcare centres between Aboriginal and non-Aboriginal children, (Grimmond *et al.* 1988) found an overall prevalence of 10.7%, with the highest prevalence in the Aboriginal children. Other studies were not specifically designed to determine the prevalence of *Giardia* or *Cryptosporidium*, but investigated outbreaks of diarrhoea in childcare centres to determine the pathogens responsible. Both *Giardia* and *Cryptosporidium* were implicated in some of these outbreaks. Ferson and Young (1992) investigated an outbreak of diarrhoea in a childcare centre in Sydney and
detected Cryptosporidium in 28% and Giardia in 14% of faecal samples collected from the children in the centre, while Ferguson et al. (1995), in a prospective study of diarrhoeal outbreaks in childcare centres in Sydney, found that 8% of these could be attributed to Giardia. Ferson et al. (1997) isolated Giardia from 6% of faecal samples during a study of rotavirus infections in Sydney childcare centres. In a survey of 92 childcare centres in Sydney to document the occurrence of communicable disease outbreaks, Jorm and Capon (1994) reported that diarrhoea was the most frequently reported sign, but they did not examine stools for pathogens.

Although many similar studies have been conducted overseas, this study appears to be the first study designed to look at the incidence and prevalence of Giardia and Cryptosporidium in apparently healthy children attending childcare centres in Australia.

4.2 SAMPLE COLLECTION

Twenty percent of the children in this study did not provide any faecal samples during the sampling period. It was difficult to regulate the collection of faecal samples for several reasons:

- Collection was carried out by childcare centre carers, and was therefore dependent on their willingness to carry out this task. The frequent employment of casual staff made this even more difficult, since these carers were often unaware of the study or of their role in it.

- Many of the children in the study attended childcare on a part-time basis.
• Not all children will defaecate while attending a centre (this is even more of a problem with those only attending part-time).

• Children may have been absent from the centre during the collection week due to illness, or being on holiday.

Fewer samples were collected during the summer holiday period of late December to early February (Fig 3.1). Similarly, Jorm and Capon (1994) found less reports of communicable disease in childcare centres in Sydney during December and January and suggested that the reason for this was that many childcare centres close during these periods. Although all of the centres in the present study remained open except for the Christmas/New Year period, it is reasonable to assume that many parents took leave from work during this time, and therefore did not put their child into care.

4.3 GIARDIA AND CRYPTOSPORIDIUM INFECTIONS IN CHILDCARE CENTRES IN PERTH, WESTERN AUSTRALIA

Despite the difficulties encountered, and the subsequent limitations of the faecal sample collection, 7.8% of the children sampled had at least one sample positive for *Giardia*, while 10.8% were positive for *Cryptosporidium*. These figures may well be an underestimate since only one faecal sample was collected per child per month. Intermittent shedding of both *Giardia* cysts (Boreham and Shepherd 1984; Wolfe 1990) and *Cryptosporidium* oocysts (Hoepelman 1996) have been reported.
It has traditionally been the practice to collect three faecal samples when \textit{Giardia} infection is suspected. Sealy and Schuman (1983), however, considered the collection of two stools to be sufficient on the basis of their own research, in which 82\% of all \textit{Giardia}-positive stools were found in the first stool sample and a further 18\% in a second sample. Black \textit{et al.} (1977) and Mason and Patterson (1987) were able to diagnose 86\% and 89\% of \textit{Giardia} infections respectively on a single stool sample. Novotny \textit{et al.} (1990) collected single stool samples to survey childcare children for \textit{Giardia} and \textit{Cryptosporidium} based on the results of Sealy and Schuman (1983), but felt that their results may have been under-reporting the prevalence of the parasites by up to 15\%.

In the present study it was not possible to collect more than one sample per child, because childcare employees carried out all stool sample collections. To estimate the true prevalence from this single sample it was assumed that 85.7\% of total infections (the mean from the studies of Black \textit{et al.} 1977, Sealy and Schuman 1983 and Mason and Patterson 1987) and would be identified in the first sample collected. Based on this assumption, the real prevalence for \textit{Giardia} and \textit{Cryptosporidium} in children in the present study was 8.9\% and 12.3\% respectively.

Direct comparison between the present study and other similar studies conducted overseas is problematic not just because of potential geographical, climatic and social differences, but because of differences in study design and objectives. In Table 1.1, the details of the most comparable studies in this area conducted over the past 30 years are
summarised. Investigations of outbreaks of infectious diarrhoea in childcare centres have found infection levels of *Giardia* from 3 to 38% in the USA and Canada, (Black *et al.* 1977; Keystone *et al.* 1978, Keystone *et al.* 1984; Cody *et al.* 1994), and from 21 to 73% for *Cryptosporidium* in South Africa and France (Walters *et al.* 1988; Bretagne *et al.* 1990).

In numerous studies in the USA, Canada, France, Israel, Spain, Portugal and Italy, where asymptomatic children were sampled either once, or repeatedly over a period of time, *Giardia* and *Cryptosporidium* were isolated from 6 to 47% and 0.8 to 35% of children respectively (Woo and Paterson 1986; Heijbel *et al.* 1987; Lacroix *et al.* 1987; Crawford *et al.* 1988; Ish-Horowticz *et al.* 1989; Steketee *et al.* 1989; Garcia-Rodriguez 1990; Novotny *et al.* 1990; Rauch *et al.* 1990; Varga and Delage 1990; Pettoello-Mantovani *et al.* 1995; Franco and Cordeiro 1996). The results from the present study for *Giardia* (7.8 to 8.9%) and *Cryptosporidium* (10.8 to 12.3%) are at the lower end of this range.

Similar studies in childcare centres in developing countries have indicated a consistently higher level of infection, with *Giardia* and *Cryptosporidium* being isolated from 3 to 63.3% and up to 89% respectively of faecal samples in Venezuela, Brazil, Mexico and Cuba (Nunez *et al.* 1999; Oberhelman *et al.* 2001; Cheng-Ng *et al.* 2002; Miller *et al.* 2003).
Thirty seven percent of children found to be positive for Giardia were positive more than once, with some returning positive samples over periods up to seven months, but not always consecutively. Only one child returned a negative faecal sample in between positive episodes (Table 3.3). Repeated or continuous infections with Giardia are not unusual. Pickering et al. (1984), in two separate surveys of children in several childcare centres, found that in the second survey, conducted five months after the first, 4% of the initially infected children were still infected. In a concurrent longitudinal survey conducted over 18 months, 15% of children were infected with Giardia over a period of 6.2 ± 1.2 months (range 2-14 months). Similarly, Rauch et al. (1990) found that 37% of children infected with Giardia had two or more episodes of infection, with a mean interval of 5.0 ± 2.2 months between episodes of infection. Others have reported that, while they found that many children who were Giardia-positive during the course of their studies appeared to be positive for prolonged periods of time, it was not possible to determine whether this was indicative of the persistent nature of Giardia infections in some children, or whether the children were being reinfected (Ish-Horowicz et al. 1989; Nunez et al. 1999).

4.4 SEASONAL DIFFERENCES IN INFECTION RATES OF GIARDIA AND CRYPTOSPORIDIUM

In this study, the prevalence of both Giardia and Cryptosporidium varied with season, with a marked peak of infections in the months of February, March and April of 1999. Despite this peak, however, the results of this study suggest a trend of endemic infection.
for *Giardia*, with infections occurring across the two years of sampling, while *Cryptosporidium* appeared to be more epidemic with infections tending to be concentrated over the late summer/autumn period of 1999.

The peak of *Cryptosporidium* infections, although not repeated in the following late summer/autumn period, is consistent with the findings of others who have reported illness due to *Cryptosporidium* in childcare centres occurring in late summer and early autumn in both the northern and southern hemispheres (Montessori *et al.* 1985; Miller and van der Ende 1986; Biggs *et al.* 1987; Cordell and Addiss 1994; Casemore *et al.* 1997; Guerrant 1997). Seasonal patterns of infections with *Cryptosporidium* in particular, vary geographically, however, and infection has been found to be more predominant in the summer or late summer in Australia and Canada, during the rainy season (warm and wet season) in Central America, South Africa, Guinea Bissau, Mexico and India, spring, late summer and autumn in North America, autumn-winter in Spain and in the late summer in Germany (Montessori and Bischoff 1985; Wolfson *et al.* 1985; Miller and van der Ende 1986; Clavel *et al.* 1996; Roderiguez-Hernandez 1996; Casemore *et al.* 1997; Enriquez *et al.* 1997; Bern *et al.* 2000; Mosier and Oberst 2000; Amin 2002). In some studies, however, no seasonal variations have been reported (Merino *et al.* 1989).

There does not appear to be any conclusive evidence to demonstrate a consistent seasonal trend in *Giardia* infections (Black *et al.* 1983; Islam 1990). Roderiguez-Hernandez (1996) found a significantly higher prevalence of *Giardia* infection in winter
in Spain, while in the USA, Overturf (1994) reported a recurrent peak of infection in late summer. The prevalence in Guatemala (Farthing et al. 1986) was higher in the cooler months when climatic conditions are known to favour cyst survival in these areas. While Giardia was most common in the months of the rainy season in Bangladesh in one study (Islam 1990), a previous longitudinal study by Black et al. (1983) had not demonstrated any seasonality of infections with Giardia in that country. Both Daly et al. (1988) and Addiss et al. (1992) noted consistent peaks in Giardia infection in the USA in the late summer/early autumn period, while Garcia-Rodriguez et al. (1990) found that infections in Spain peaked in winter.

Despite the peak of infections found in March/April 1999, the results of the present study do not provide any evidence for consistent seasonal trends in infection with Giardia or Cryptosporidium in childcare centres in Australia. It is possible that the increase in both Giardia and Cryptosporidium infections found in March and April of 1999, was due more to an unusually high occurrence of the parasites at this time rather than a generalised seasonal peak, since despite extending the period of sample collection to include the late summer/autumn period of 2000, the peak of infections was not repeated in the second year of sampling in this study. The weather data available for Perth during this period in both 1999 and 2000 do not vary remarkably (Figs 3.2-3.4). The mean maximum temperatures for March and April 1999 and 2000 were 27.8°C, 28.2°C and 28.8°C, 25.7°C respectively, while the mean humidity for both years was 63%, 59% and 57%, 62% and the mean rainfall, 26.8mm, 30.2mm and 22.2mm, 32.6mm. While these data may be consistent with oocyst survival, they do not
explain the difference in infection rates between the two years. Ferson et al. (1992) found an unexpected rise in the number of positive Cryptosporidium samples identified in laboratories in New South Wales in January 1991 compared with the previous year, and reported a similar increase at the Adelaide Children’s Hospital in the same period. Their explanation was that there may have been a widespread epidemic of cryptosporidiosis in that year, rather than a seasonal trend of infections.

Several reasons have been cited for seasonal variations in the incidence and/or prevalence of both Giardia and Cryptosporidium. These include increases in rainfall, facilitating the spread of contaminated surface water used for drinking, especially in tropical and developing areas of the world (Newman et al. 1994; Muhuri 1996; Enriquez et al. 1997; Conteas et al. 1998; Mosier and Oberst 2000; Amin 2002); farm activities, including calving and lambing, which may lead to greater pollution from farm waste entering water supplies (Mosier and Oberst 2000); and temperature and humidity changes favouring the survival of oocysts (Mata 1984; Amin 2002). It has also been suggested that summer peaks for Giardia (Daly et al. 1988) and Cryptosporidium (Conteas et al. 1998) are linked to an increase in outdoor pursuits, for example, recreational water use, including an increased use of public swimming pools (van Asperen et al. 1996; Conteas et al. 1998), and contamination of water supplies, with people drinking untreated water (Daly et al. 1988; Conteas et al. 1998).
4.5 RISK FACTORS FOR GIARDIA AND CRYPTOSPORIDIUM INFECTIONS

Risk factors for infectious diarrhoea in children may vary depending on the environment in which the child lives. Those children living in crowded, often unsanitary conditions in developing areas of the world may have a higher risk partly due to the lack of hygiene but also due to factors such as storage of cooked food in unrefrigerated conditions and contaminated drinking water supplies (Leach et al. 2000; Molbak 2000). Zoonotic transmission caused by close contact with animals such as pigs and dogs in the household, has also been suggested (Katsumata et al. 1998; Molbak 2000).

In more developed countries, such as Australia, the United Kingdom, the USA and European countries, a major risk factor for infectious diarrhoea is attendance at a childcare centre (Collet et al. 1991), but even within these centres, certain factors may predispose to infection. The age of the child is a major factor, both in undeveloped countries and childcare centres, with younger children, usually aged less than two years and not toilet-trained, much more at risk than older, toilet-trained children (Goodman et al. 1984; Biggs et al. 1987; Pickering and Engelkirk 1990; Hillis et al. 1992; Osterholm 1994; Ferson et al. 1997; Pickering and Osterholm 1997; Katsumata et al. 1998; Huskins 2000). In the present study only non-toilet-trained children, usually aged three years or under, provided faecal samples, and therefore it was not possible to make comparisons with older age groups. Within this more specific age group, however, it
was found that while infection with *Giardia* was not significantly associated with the age of the child, infection with *Cryptosporidium* was significantly age-associated, with children in the range of 19 to 24 months being more likely to be positive than older children.

An attempt was made early in the study to recruit a cohort of non-child-care-attending children from Community Child Health Clinics operated by the Department of Health, Government of Western Australia, but this was unsuccessful. It was not possible, therefore, to compare the rates of infection with *Giardia* and *Cryptosporidium* in children attending childcare centres and those who never attended childcare centres. Novotny *et al.* (1990), however, sampled children both in childcare centres and a cohort who never attended childcare (toddler age only), and found that 16% of childcare-attending children and 9% of non-childcare-attending children were infected with *Giardia*, although this difference was not statistically significant. Others have reported that the incidence of infectious diarrhoea among children attending childcare centres compared with those who never attend, may be as much as two to five times greater (Bartlett *et al.* 1985; Ojembarrena Martinez *et al.* 1986; Alexander *et al.* 1990; Reves and Pickering 1992; Collet *et al.* 1994; Pickering and Osterholm 1997).

Infection rates have been found to be higher in larger childcare centres than smaller ones (Bell *et al.* 1989; Collet *et al.* 1994; Mottonen and Uhari 1992; Osterholm 1994; Churchill and Pickering 1997; Huskins 2000). Although no evidence was found for this in the present study, the enrolment size range of the centres was small (45 to 125), and it
is possible that with a larger number of centres and range of enrolment sizes, a different result may have been found. The physical characteristics of the centres is also a factor, for example the distance between food preparation areas and toileting areas, and centres having dedicated nappy changing areas (Osterholm 1994; Churchill and Pickering 1997). In this study, all of the centres had separate areas for toileting and nappy changing, and for food preparation.

The risk of enteric infection is greater among children in their first year of attendance at a childcare centre, decreasing with duration of attendance (Huskins 2000). Newly enrolled children in their first few weeks of attendance appear to be most at risk (Staat et al. 1991; Huskins 2000; Robinson 2000), possibly because they acquire enteric pathogens from asymptomatic children, and subsequently gain immunity to those pathogens (Robinson 2000). Staat et al. (1991) conducted a study to determine whether the incidence of diarrhoea was greater among children in their first four to eight weeks of enrolment in a childcare centre, and observed a significantly higher incidence of diarrhoea (1.6-fold greater) among children in their first four weeks compared with later periods. Although rotavirus was identified in 18% of diarrhoea cases and Giardia in 6%, neither pathogen was significantly associated with recent enrolment. These studies, however, have considered the risk of infectious diarrhoea and not the presence of specific pathogens.

Conversely, both Pickering et al. (1984) and Addiss et al. (1991) found that children attending childcare centres for longer than three months were more likely to have
*Giardia*-positive stools than those who had attended for less than three months. The results of the present study are more consistent with this trend, since although there was no significant risk found for either parasite with recent enrolment at a childcare centre in this study, children who were infected with *Cryptosporidium* had attended childcare for a longer period (mean of 11.2 months) than those not infected (mean of 7.8 months). Period of attendance was not, however, associated at all with *Giardia* infection.

Studies for risk factors for infectious diarrhoea within childcare centres have found that centres where staff prepare and serve food as well as toilet children, tend to have higher diarrhoeal rates (Lemp et al. 1984; Pickering et al. 1984; Sullivan et al. 1984; Crawford and Vermund. 1987; Bell et al. 1989; Mottonen and Uhari 1992; Churchill and Pickering 1997; Ferson et al. 1997). In this study, 80% of the carers who completed the questionnaire discussed in Chapter 2.6 and Chapter 6, prepared and/or served food to children as well as toileting children on the same day, and this percentage did not differ significantly between childcare centres (Chapter 7).

Other risk factors within childcare centres include class size and staffing ratios (Ferson 1997; Huskins 2000). Childcare centres where children are not separated into different age groups tend to have higher rates of infectious diseases including diarrhoea (Pickering 1990; Osterholm 1994; Churchill and Pickering 1997; Ferson et al. 1997). Lemp et al. (1984) reported that the risk of diarrhoea in three year old children who stayed in the same room as under two year olds, was 4.3 (95% CI 2.1-9.0) times greater than the risk for those who were separated from the younger children. All childcare
centres licensed in Western Australia are required to adhere to the Western Australian Community Services Child Care Guidelines which clearly state the minimum staff to children ratios required for each age group. All the centres in this study separated the children into age groups roughly corresponding to infants, toddlers and preschoolers, with only minor variations in the specific ages of the children within these groups (Table 2.3).

4.6 SYMPTOMATIC AND ASYMPPTOMATIC INFECTIONS

It has previously been reported that *Giardia* infections in young children are often asymptomatic (Bartlett *et al* 1991; Thompson 1994a) and that these asymptomatic infections can persist for months (Robinson 2001). Hoque *et al.* (2001) suggested that up to 75% of *Giardia* cases remain asymptomatic, with these carriers providing an important source of infection. Reports of asymptomatic *Giardia* infection in childcare centres where there have been no recently reported outbreaks of diarrhoea, have ranged between 8% and 78% (Black *et al.* 1977; Sealy and Schuman 1983; Pickering *et al.* 1984; Bartlett *et al.* 1985; Woo and Paterson 1986; Rauch *et al.* 1990; Ortega and Adam 1997; Pickering and Osterholm 1997), while during investigations of diarrhoea outbreaks, rates of up to 42% have been reported (Keystone *et al.* 1984; Heijbal *et al.* 1987; Addiss *et al.* 1991). The rates in these studies may be an underestimate, since it is not always possible to collect accurate information about signs and symptoms of a disease from the parents or carers of a child. Addiss *et al.* (1991) stated that they were
only able to collect this information from about two thirds of the infected children in their study.

Information regarding the signs and symptoms of giardiasis was collected from the parents or carers of 76% of the *Giardia*-positive children in the present study and the results do not contradict the above reports. More than half of the children positive for *Giardia* in this study showed no signs or symptoms of disease at all. Some children even appeared to have had the infection for several months with no reported manifestations of disease.

Asymptomatic carriage of *Cryptosporidium* in childcare centres during outbreaks of diarrhoea of between 3.7 and 22.9% have been reported (Taylor *et al.* 1985; Alpert *et al.* 1986; Stehr-Green *et al.* 1987; Heijbel *et al.* 1987, Melo Cristino *et al.* 1988; Walters *et al.* 1988), but it is possible that because information on symptoms was collected retrospectively, many of these could have been resolving infections. Crawford *et al.* (1988) reported that 27% of children found to be positive for *Cryptosporidium* were asymptomatic, although the sample size in their study was very small (n=31). Some of the asymptomatic children in the study had had diarrhoea in the previous month, so could still have been shedding oocysts from a previous symptomatic infection. In prevalence studies where there had been no outbreak of diarrhoea, 55.6 to 75% of the children who were *Cryptosporidium*-positive were reported to be asymptomatic (Lacroix *et al.* 1987; Addiss *et al.* 1991), however in a study to determine the prevalence of *Giardia* and *Cryptosporidium* in children attending childcare centres in
Spain, Roderiguez-Hernandez et al. (1996) found that none of the 35% of children found to be positive for Cryptosporidium were asymptomatic.

The rate of true asymptomatic Cryptosporidium infection is therefore difficult to determine, at least in industrialised countries, and estimates may be inaccurate because of the prolonged period of oocyst shedding after diarrhoea has ceased (Stehr-Green et al. 1987; Vuorio et al. 1991; Tangermann et al. 1991), since some studies report only current and not recent symptoms (Vuorio et al. 1991). Also, although diarrhoea is usually the most common manifestation of cryptosporidiosis, other signs and symptoms which are mild or non-specific may not have been reported, or the children may have been too young to report them (Cordell and Addiss 1994).

In the present study only five out of 37 Cryptosporidium infections (13.5%) were found to be asymptomatic. None of these children had had any signs or symptoms of cryptosporidiosis in the four weeks prior to infection. Parents were questioned during telephone conversations and through the completion of a questionnaire (Chapter 2.4; 2.6) to ensure that comprehensive information regarding any possible signs or symptoms of infection during the previous four weeks was obtained.

In many developing countries, where Cryptosporidium infection is endemic, the percentage of asymptomatic infection has been found to be higher, for example in Peru (Checkley et al. 1997; Checkley et al. 1998.), Venezuela (Chacin-Bonilla 2000), Southern India (Mathan et al. 1985), Bolivia (Esteban et al. 1998) and Pakistan (Iqbal
2001). Asymptomatic rates as high as 63% have been found in some of these communities (Checkley et al. 1997). It is possible that repeated exposure to the parasite because of unsanitary and poor living conditions in these countries may provide immunity (Newman et al. 1994; Esteban et al. 1998; Chacin-Bonilla 2000) or that in some of these studies, children may have had recent but unreported diarrhoea and were still shedding oocysts (Esteban et al. 1998).

4.6.1 Asymptomatic infections and the value of exclusion policies

One of the most common practices in childcare centres is that of exclusion of children with diarrhoea. The American Academy of Pediatrics Committee on Infectious Diseases (1997) recommends that children with diarrhoea, other than that caused by *Shigella*, typhoid fever or *E. coli* 0157:H7, may attend childcare as long as the stool is contained within the child’s nappy. Most childcare centres, however, would find this difficult to police and would consider the risk of faecal contamination not justified, finding it easier to exclude the child completely. The Australian National Health and Medical Research Council recommends exclusion of children with diarrhoea until the diarrhoea has ceased (Roberts 1997). All the childcare centres in the present study exclude ill children, especially those with diarrhoea. This is a controversial practice, however, with some researchers in favour of exclusion on infection control grounds (Pickering 1986; Ferson 1994; Churchill and Pickering 1997), while others take the opposing view (Shapiro et al. 1986; Rauch et al 1990; Jarman and Kohlenberg 1991; Cody et al. 1994). Jarman and Kohlenberg (1991) argue that there is little scientific
evidence to support the practice of exclusion, since for most common infectious
diseases, children may remain contagious for several days after they have recovered.

*Cryptosporidium*, for example, has an extended period of shedding, often for some time
after the signs and symptoms of the disease have passed (Cordell and Addiss 1994).
This means that keeping the child home for a few days does not necessarily reduce the
risk to other children of acquiring disease, since children returning after the diarrhoea
has ceased may still be highly contagious, and may be transmitting the parasite to others
(Churchill and Pickering 1997)

Asymptomatic infections provide an additional problem with exclusion policies. This is
especially the case with *Giardia* infections, which are so often asymptomatic, as these
children will not be excluded and will remain in contact with other children within the
childcare centre, enabling them to transmit the infection to other children and carers. It
is possible in fact, that people with asymptomatic *Giardia* infection may be more
important in the spread of *Giardia* than those with diarrhoea, because infectious cysts
are more prevalent in formed and semi-formed stools than they are in watery stools
(Child day Care Infectious Disease Study Group 1984; Crawford and Vermund 1987;
Bartlett *et al.* 1991). This, combined with the high incidence of asymptomatic *Giardia*
infections, strengthens the argument for practices that interrupt the transmission of
organisms causing infectious diarrhoea, rather than relying on the practice of exclusion.
Many centres in this study complained that despite having very clear guidelines
regarding the exclusion of children with diarrhoea, there was often a low compliance
rate among parents, with parents either not advising the centre that the child had
diarrhoea, or stating that it was due to non-infectious causes, for example, diet, or the child teething.

4.6.2 Costs to parents of ill children

Children suffering from symptomatic infectious diarrhoea provide a problem for parents/carers in that they will usually be excluded from the childcare centre while they have diarrhoea and therefore parents must find alternative care arrangements, or be absent from work themselves to care for their child. Published reports have shown that the parents of children attending childcare centres lose 2 to 39 days of work per year caring for children who are unable to attend their usual childcare due to illness, and that more days are lost through illness of younger children than older ones (Dahl et al. 1991; Ponka et al. 1991; Mottonen and Uhari 1992; Davis et al. 1994; Ferson and Fisher 1994). Mottonen and Uhari (1992) reported that 40% of parental absenteeism from work is caused by children’s illness, and Davidson (1994) reported that some parents have even lost their jobs because of their children’s illness.

Costs related to loss of work and medical care due to infections of children attending childcare centres have been estimated at US$1.8 billion per year in the USA alone (Haskins 1989). The primary component of these costs are not medical, but in lost work days in having to care for ill children (Bell et al. 1989; Haskins 1989; Avendano et al. 1993; Hardy et al. 1994; Carabin et al. 1999). Although it has been shown that respiratory illness accounts for more lost days than infectious diarrhoea (Haskins 1989; Ferson and Fisher 1994), infectious diarrhoea still has a significant impact, with the
costs being greater for infants and toddlers (Hardy et al. 1994). Alternative day care for sick children is not readily available (Soto and Marin-Lira 1993). A major finding in a recent Australian study by Slack-Smith et al. (2000) was that parents with ill children lacked adequate options for alternative care for their children.

4.7 TRANSMISSION BEYOND THE CHILDCARE CENTRE

4.7.1 Transmission of infectious disease to childcare centre carers

Although faecal samples were not collected from carers in this study because the majority of carers refused to provide regular samples, published research has indicated that attack rates among childcare providers are similar to those among household contacts, with reports of transmission of *Giardia* to 7 to 38% of carers, and *Cryptosporidium* to 0 to 22% of carers (Keystone et al. 1978; Heijbel et al. 1987; Walters et al. 1988; Steketee et al. 1989). Others have reported up to 40% of carers developing diarrhoea during outbreaks in childcare centres (Pickering and Reves 1990; Reves and Pickering 1992). Formasini et al. (1994) found that childcare providers had a significantly greater risk of contracting infectious disease and that they lost more workdays due to infectious disease than did the general population. The risk of infection for infectious diarrhoea appears to be greatest in staff that care for children still in nappies (Combee et al. 1986; Walters et al. 1988; Tangermann et al. 1991). Anecdotal evidence from the present study indicated that carer absenteeism due to
illness was not an uncommon occurrence in the centres studied, and casual employees were frequently employed in most centres.

4.7.2 Transmission to family and household members

It has been shown that transmission of infectious diarrhoea from the childcare centre to family and household contacts presents a very real risk, with rates of transmission of between 10 and 71% being reported (Black et al. 1977; Combee et al. 1986; Biggs et al. 1987; Stehr-Green et al. 1987; Hannah and Riordon 1988; Tangermann et al. 1991; Reves and Bartlett 1992). Transmission of *Giardia* and *Cryptosporidium* from children attending childcare to household and close contacts have been estimated between 5 and 25% and 6 and 32% respectively (Black et al. 1977; Pickering et al. 1981; Alpert et al. 1986; Heijbel et al. 1987; Stehr-Green et al. 1987; Nwanyanwu et al. 1989; Tangermann et al. 1991).

Although not all of the close contacts of the infected children in this study would consent to providing their own faecal samples, in 25% of the families of children positive for *Giardia*, and 40% of those positive for *Cryptosporidium*, at least one family member was also found to be positive. Where samples were not provided, anecdotal evidence suggested that the parents were infected, with 12.5% of families of *Giardia*-positive children and 48% of families of *Cryptosporidium*-positive children, reporting signs and symptoms of the disease within the family. Families of infected children were significantly more likely to suffer signs and symptoms of disease than families of non-
infected children. Consequently, transmission of infectious disease from children to parents means that not only may parents have problems with loss of income or threatened employment through their children's illness, but they may also lose workdays through their own illness.

Transmission of Cryptosporidium into the community provides an additional threat in that while it is a self-limiting disease in the immunocompetent host, it can be very debilitating and even life threatening in the immunocompromised host. At least one parent in this study whose child was found to be positive for Cryptosporidium reported a family member on cancer therapy, not an uncommon occurrence in present society. Sreedharan et al. (1996) reported finding Cryptosporidium oocysts in the faeces of 1.8% of cancer patients who were receiving chemotherapy and who were suffering from diarrhoea. It is therefore essential that the transmission of these parasites is kept to a minimum.

4.8 CONCLUSIONS

The results of this study indicate that both Giardia and Cryptosporidium are present in childcare centres in Australia and are responsible for infectious enteric illness in a significant number of children. This creates problems for parents who not only have to deal with the distress of an ill child, but also with the difficulties of finding alternative care for the child due to the exclusion policies of most centres. The high percentage of asymptomatic infections of Giardia, in particular, found in this study, and the apparent
endemicity of *Giardia*, shows that even with exclusion policies, continued transmission of the parasite, both within and beyond the childcare centre, is likely.

The most effective way to control these parasites in childcare centres is to maintain or improve basic hygiene procedures, particularly handwashing. The exclusion of infected children may not be necessary, or may at least be kept to a minimum, if these practices are utilized by childcare centres (Jarman and Kohlenberg 1991; Robinson 2001). It is not only important for the carers to have an understanding of the importance of this procedure and to practice it effectively, but for the children to be taught the same practice.

The second part of this study, therefore, involved the development, implementation and evaluation of a health intervention programme based on handwashing, which would not only be a cost-effective resource for the childcare centres to assist in reducing levels of *Giardia* and *Cryptosporidium* infection in the centres, but could be integrated into the normal childcare play routine, without the need for time-consuming in-service programmes.
PART TWO

DEVELOPMENT, IMPLEMENTATION AND EVALUATION OF A
HEALTH INTERVENTION PACKAGE
CHAPTER FIVE

INTRODUCTION

5.1 INTRODUCTION

The results of the present and published studies have shown that infectious diarrhoea caused by enteric pathogens including Giardia and Cryptosporidium, is a concern in childcare centres, both for the health of the children and the potential for transmission to the greater community. The most effective and cost-efficient way to prevent or control infectious diarrhoea in childcare centres is to improve hygiene standards by educating carers about infection control (Keystone et al. 1984; Garcia-Roderiguez 1990; Thompson et al. 1993; Thompson 1994b). Handwashing is considered to be the single-most important measure for preventing or reducing infection within the childcare centre (Pickering and Engelkirk 1990; Hanna and Brooks 1995; Juranek 1995; Cordell 2001), with several studies showing its efficacy in reducing the incidence of diarrhoea (Black et al. 1981; Bartlett et al. 1988; Steketee et al. 1989; Roberts et al. 2000a, 2000b).

The second part of this study involved the development, implementation and evaluation of a health intervention package aimed at increasing the awareness of, the importance of, and the compliance with, handwashing in childcare centres.
5.2 HAND HYGIENE

"The Prophet Mohammed ordered Muslims to wash their hands, especially in connection with using the toilet, before and after eating food, after touching the genital or anal area of oneself or others, after touching a dead body, or touching a dog" (Kamte 1999: p520).

Over the past century, hygiene improvements have played a major role in reducing morbidity and mortality from infections, especially those transmitted via the faecal-oral route and by direct contact (Steere and Mallison 1975; Aiello and Larson 2002). Handwashing in particular, remains the most important and low cost practice available for the prevention and control of infectious disease (Donowitz 1987; Larson 1988; Gaydos 2001; Guinan et al. 2002). The Centers for Disease Control and Prevention continue to recommend handwashing as the single most important procedure for preventing nosocomial infections (CDC 1985; Meengs et al. 1994), and the Global Water Supply and Sanitation Assessment Report provided by the World Health Organization in 2000 lists handwashing with plain soap as a key hygiene behaviour that is of greatest benefit to health (Aiello and Larson 2002).
5.3 PIONEERS IN INFECTION CONTROL

"If we are going to save the lives of all the women and children, what incentive will there be for a young man to go into medicine?" (O’Hern 1985:p27)

Infection control practices have an interesting but precarious history. The above quote was from a physician in New York in 1910, opposing a hygiene programme for mothers and children initiated by Dr Josephine Baker, a pioneer in establishing programmes in preventive medicine and public health. When Baker formed the Bureau of Child Hygiene to teach hygiene to childcare providers, a petition signed by more than 30 physicians was sent to the mayor of New York demanding that the Bureau should be abolished because: “it is ruining medical practice by its results in keeping babies well” (O’Hern 1985:p27). Ironically, Baker’s programmes were very successful in saving the lives and improving the health of many thousands of women and children (O’Hern 1985).

As early as the mid 18th century English obstetricians believed that infection was carried by midwives and physicians from one puerperal fever-infected woman to another (Greenhill 1966). Evidence to support the link between handwashing and contact transmission of infection was first established, however, by a Hungarian-born obstetrician, Ignaz Phillip Semmelweis in Europe (Daniels and Rees 1999).
In the late 1840’s in Vienna, Semmelweis observed a high mortality rate in the labour ward, especially when staffed by medical students who came straight from their anatomy lessons in the autopsy room. He postulated that the students were carrying infections on their hands from anatomy dissections of cadavers. This infection was then transmitted to the genital organs of the birthing mothers, and consequently into their blood. He ordered doctors and students to wash their hands with a chlorinating solution and clean their fingernails before they examined women in the labour ward. Although the mortality rate in his ward dropped to less than 1% (Greenhill 1966; Rotter 1998; Daniels and Rees 1999), his colleagues did not believe in his theories and reacted with hostility. When Semmelweis died in 1865, his beliefs were still largely ignored by clinicians (Lund et al. 1994). Semmelweis was, however, the first to demonstrate the importance of person-to-person transmission of infection and the role of handwashing as a barrier to this transmission. Handwashing is now widely acknowledged as the single-most important infection control measure (Rotter 1998).

Other pioneers in infection control include Oliver Wendall Holmes in the USA and French scientist, Louis Pasteur who contributed much to the germ theory of disease developed by Robert Koch, and was a staunch advocate of hygiene procedures. Pasteur stated at a seminar at the Academy of Medicine in France in 1879: “the thing that kills women with childbed fever is doctors that carry deadly microbes from sick women to healthy ones”, but his ideas were also received with much scepticism (Case 2002).
It should not, perhaps, be surprising that people in the 1800’s were reluctant to believe in these infection control theories. Not only were people unable to see microorganisms, but handwashing would have been a difficult procedure prior to the 20th century. There was no indoor plumbing so water was difficult to access, and to obtain warm or hot water it was necessary to heat it over a fire. As well, contact with water was usually associated with diseases such as malaria and typhoid (Case 2002).

5.4 NON-COMPLIANCE WITH HANDWASHING

Unfortunately, despite its simplicity, compliance with handwashing has continued to be poor since the days of Semmelweis (Albert and Condie 1981; Conly et al. 1989; Lund et al. 1994; Larson and Kretzer 1995; Tibballs 1996; O’Boyle et al. 2001; Pittet and Boyce 2001).

5.4.1 Non-compliance within the healthcare system

Although it is accepted that handwashing by both medical and nursing staff is the single-most important measure for preventing hospital-acquired infection (Steere and Mallison 1975; Albert and Condie 1981; Meengs et al. 1994; Prichard and Raper 1996; Tibballs 1996), and both the Centers for Disease Control and the American Hospital Association recommend handwashing after every patient contact (Conly et al. 1989), compliance with handwashing recommendations, especially by doctors, remains poor (Albert and Condie 1981; Larson and Killien 1982; Larson 1983; Quraishi et al. 1986;
Kaplan et al. 1986; Doebbeling et al. 1992; Kesavan et al. 1998). Reports in the early 1980’s showed that less than 50% of healthcare workers were washing their hands after patient contact (Albert and Condie 1981; Larson 1983), and more recent reports have indicated little improvement since then (Daniels and Rees 1999). Compliance rates as low as 10.6% in intensive care units, including paediatric units (Donowitz 1987; Tibballs 1996), 26% in surgical wards (Daniels and Rees 1999) and 33.3% in emergency departments (Meengs et al. 1994) have been reported.

5.4.2 Non-compliance within childcare centres

There have been many reports of poor handwashing and personal hygiene practices by carers within childcare centres (Black et al. 1981; Pickering et al. 1981; Lemp et al. 1984; Sullivan et al. 1984; Bartlett et al. 1985; Lopez et al. 1988; Robinson 2001). Poor compliance is evident with the children in these centres as well (Niffenegger 1997). In a study to determine pre-school children’s attitudes to various health behaviours, Jurs et al. (1990) found that the children in the study, who were aged three to five years, perceived handwashing to be of little importance to their health.

5.5 BARRIERS TO COMPLIANCE WITH HANDWASHING

Reasons given for non-compliance, both within the healthcare system and within childcare centres are similar. They include lack of education and/or knowledge, lack of time, concern about harm to skin, inadequate facilities, including inconvenient
placement of sinks and lack of hot running water, and perceived lack of importance (Larson and Killien 1982; Heenan 1992; Lund et al. 1994; Coignard et al. 1998; Kesavan et al. 1998; Rotter 1998; Hugonnet and Pittet 2000; O’Boyle et al. 2001). The use of disposable gloves may also be seen as reducing the need for handwashing (Ehrenkranz et al. 1992; Lund et al. 1994).

5.6 HANDWASHING TECHNIQUE

The Centers for Disease Control define handwashing as: “a vigorous, brief rubbing together of all surfaces of lathered hands, followed by rinsing under a stream of water” (Garner and Favero 1986, p233). Recommendations regarding the ideal duration of handwashing vary, but a minimum of ten seconds of vigorous washing with soap and water following by a similar rinse period is usually recommended for most normal, non-surgical, handwashes (Steere and Mallison 1975; Simmons et al. 1981; Meengs et al. 1994; Roberts 1997; O’Boyle et al. 2001).

5.6.1 Resident and transient flora

Microorganisms found within and upon the skin are classified as either resident or transient. Resident flora are microorganisms that survive and multiply on the skin and are commonly called commensals or normal flora, while transient flora do not normally live on the skin (Steere and Mallinson 1975). Resident flora are usually found in low numbers and rarely cause infections other than skin infections, except when introduced
into the body through invasive procedures such as surgery or into open wounds (Garner and Favero 1986). They are not easily removed by normal handwashing procedures and require chemical methods of removal such as the use of antiseptics and anti-microbial-containing products that kill or inhibit the growth of the microorganisms (Steere and Mallinson 1975; Garner and Favero 1986; Larson et al. 1989). This is only required when invasive or surgical procedures are undertaken.

Transient microorganisms are usually acquired from direct person-to-person contact, or during contact with contaminated objects or surfaces, and may consist of many different pathogenic organisms such as Streptococcus, E. coli, and Pseudomonas as well as Giardia and Cryptosporidium (Garner and Favero 1986). They usually survive less than 24 hours on the skin, are not firmly attached and are easily removed by the mechanical handwashing procedure previously described (Steere and Mallinson 1975; Garner and Favero 1986). Handwashing with plain soaps or detergents suspends the microorganisms and allows them to be rinsed off (Garner and Favero 1986; Larson et al. 1989). Since handwashing in the community is usually to remove transient contamination, for example, after defaecation, mechanical methods are considered sufficient for most situations including those that arise in childcare centres (Hoffman and Wilson 1994).
5.7 INTERVENTIONS TO INCREASE COMPLIANCE WITH HANDWASHING

Although educational interventions aimed at increasing medical and nursing staff awareness of the importance of handwashing and subsequent compliance with recommended regimes have frequently been implemented, few have been shown to have a long-term effect (Jarvis 1994; Lund et al. 1994; Tibballs 1996; O’Boyle et al. 2001). Conly et al. (1989) attempted to improve the handwashing practices of medical personnel with an educational programme, but found that although the intervention was successful in the short-term, the effect was not sustained in the long-term. They suggested that the reasons for this lack of long-term effect included a regular turnover of staff and the lack of ongoing education.

5.7.1 Interventions within childcare centres

The most common methods used to deal with infectious diarrhoea in childcare centres are the exclusion of sick children and improved hygiene, especially hand hygiene, which has been shown to reduce the risk of infection via the faecal-oral route (Black et al. 1981). Since enteric infections in childcare centres are most commonly spread by the hands of the children and employees (Black et al. 1981; Guinan 2002), good infection control practices in childcare centres rely not only on the carers’ knowledge of the importance of hygiene, but also of their awareness of how infection spreads, since this will reinforce their confidence in the efficacy of hygienic practices (Black et al.
Research in childcare, however, has found that not only do carers lack information about the transmission of infectious disease but that young children also lack knowledge and skills in handwashing (Lopez et al. 1988; Niffenegger 1997). It is therefore important that the children, as well as the carers, are targeted in any hygiene intervention programme (Guinan 2002).

Childcare facilities are an ideal target for health promotion activities, since they provide an environment where young children congregate, often for long periods during the day. Children can be taught basic hygiene through structured play and learning activities and childcare workers can teach both the children and their families about good hygiene practices (Berkelman and Thacker 1989).

All licensed childcare centres in Australia have access to the handbook, “Staying Healthy in Childcare” (Roberts 1997). Intervention programmes, however, are often considered by childcare employees to be time-consuming, and while the short-term effects may be significant, they often have limited long-term effects (Niffenegger 1997). This is perhaps due to a high staff turnover and limited time for directors to implement the programmes. Certainly anecdotal evidence from the present study would indicate that not only is the turnover of staff high and the employment of casual staff common, but it is not uncommon for the directors themselves to change employment frequently. Added to this, are the many demands on the time of directors in what appears to be becoming an increasingly stressful industry.
5.8 STUDY OBJECTIVES

Despite these constraints, all of the directors in this study showed a major interest in the control of infectious disease within their centres. This study did not, therefore, set out to replicate those infectious control programmes already available to the centres, but attempted to provide an alternative that would be acceptable to the childcare centres and the carers working in these centres.

The objectives for the second part of this study were:

1. To describe the characteristics of the childcare centres in this study in terms of the experience, education and training of the carers.

2. To examine whether carers’ characteristics influenced the risk of infection with *Giardia* and *Cryptosporidium* in childcare centres

3. To develop and implement a health intervention package aimed at reducing the risk of infectious diarrhoea in childcare centres, that would:
   
   • Have input from the childcare centre carers on the content of the intervention.
   
   • Be of minimal cost.
   
   • Be easy for the carers to use and understand.
   
   • Be instructive to both carers and children.
• Be able to be utilized as part of the normal play routine of the centre.

• Be fun to use for both carers and children.

• Contain elements that could be shared with the parents of the children.

4. To evaluate the health intervention package, firstly, to determine whether it would increase the knowledge of childcare centre carers about infectious diarrhoea, and secondly, to determine whether it would be accepted by carers as a useful resource for infection control within childcare centres.
CHAPTER SIX
MATERIALS AND METHODS

6.1 CHARACTERISTICS OF CARERS

All the carers who participated in the second part of this study completed two questionnaires (Appendices 6 and 7). Questionnaire development, including testing for reliability and validity has been discussed in Chapter Two.

This questionnaire was designed to have two distinct functions. Firstly, to provide data about the characteristics of the carers such as age, gender, qualifications, training and experience in childcare, number of hours worked per week and training received relating to infection control. Secondly, the questionnaire was designed to provide an evaluation of the health intervention package by including questions designed to test the knowledge and/or practices of carers who used the intervention compared to those in the control group who did not. This second function of the questionnaire is discussed in Section 6.6.

The complete questionnaire (Appendix 6) was given to all the carers in both test and control groups prior to the intervention, and the shortened version without the demographic questions (Appendix 7) was given to both groups after the intervention. It was not necessary to include the demographic questions for evaluation purposes, and a
shorter questionnaire will usually result in an increased response rate (Armstrong et al. 1994).

6.1.1 Carer qualifications

Carers were asked to list their qualifications related to childcare (if any). To facilitate data analysis, these have been categorised into five groups (Table 6.1).

Table 6.1 All qualifications listed by carers in this study, categorised into five major groupings

<table>
<thead>
<tr>
<th>Major qualifications groupings</th>
<th>Qualifications listed by carers</th>
</tr>
</thead>
</table>
| Degree/diploma in early childhood care or early childhood education | Degree in early childhood care or early childhood education  
Diploma in early childhood care or early childhood education  
Certificate in child care studies  
Associate diploma in child care |
| Nursing qualifications                                   | Registered mothercraft nurse  
Registered general nurse  
Enrolled nurse  
Registered nurse with postgraduate child health certificate  
Registered nurse with postgraduate paediatric nursing certificate |
| Teaching qualifications                                  | Graduate diploma of education                                                                 |
| Minor/introductory qualifications in childcare           | Certificate in child services: nanny  
Diploma in children’s services  
Introduction to childcare (TAFE*)  
Early childhood training certificate (ECU**)  
Certificate of community services (TAFE)  
Diploma: Western Australian Nanny Training College |
| No qualifications                                        | Untrained childcare assistant                                                                  |

* Technical and Further Education  
**Edith Cowan University
6.2 SURVEY OF CHILDCARE CENTRES TO DETERMINE INFECTION CONTROL EDUCATION NEEDS

It is important to involve the people for whom a health intervention is being designed in the development process, to ensure that they will use the resulting intervention (Wass 1994) and that differences in areas of concern and knowledge are taken into account (Kendall et al. 1986). To this end, Kendall et al. (1986) suggested that it is useful to solicit an expression of needs from carers in childcare centres at the beginning of a health education intervention to ensure that the intervention will be based on the stated needs of the carers. A survey was therefore developed (Appendix 13) and sent out to 100 randomly selected childcare centres throughout Western Australia. The 14 centres already in the study were also surveyed, both with the written surveys and through discussions with the directors of these centres. Therefore 114 centres in total were given the survey, which asked specific questions about which formats would be preferred in the education of both children and adults, regarding infection control in childcare centres. These surveys were distributed in a single mail-out, with no follow-up contact.

Of the 114 centres surveyed, 44 (39%) responded. From these replies, it was determined that not only were certain formats favoured but that the intervention should be directed at parents as well as carers and children. In Table 6.2 the percentage of childcare centres favouring various formats for both adults and children is indicated. Although video was a popular choice for both adult and child-centred interventions, this
proved to be too expensive and it was not possible to provide this option. The majority of the other formats however, were possible to use, and the health intervention package was developed using these preferences as a guide.

Table 6.2 The percentage of childcare centres (n=44) favouring various formats for a health intervention

<table>
<thead>
<tr>
<th>Format</th>
<th>% of respondents</th>
<th>Formats used in the health intervention package</th>
</tr>
</thead>
<tbody>
<tr>
<td>For adults</td>
<td></td>
<td></td>
</tr>
<tr>
<td>posters</td>
<td>95</td>
<td>yes</td>
</tr>
<tr>
<td>pamphlets</td>
<td>85</td>
<td>yes</td>
</tr>
<tr>
<td>list of available resources</td>
<td>75</td>
<td>yes</td>
</tr>
<tr>
<td>video</td>
<td>60</td>
<td>no</td>
</tr>
<tr>
<td>books</td>
<td>45</td>
<td>no</td>
</tr>
<tr>
<td>lectures</td>
<td>30</td>
<td>no</td>
</tr>
<tr>
<td>For children</td>
<td></td>
<td></td>
</tr>
<tr>
<td>songs</td>
<td>95</td>
<td>yes</td>
</tr>
<tr>
<td>video</td>
<td>90</td>
<td>no</td>
</tr>
<tr>
<td>posters</td>
<td>85</td>
<td>yes</td>
</tr>
<tr>
<td>games</td>
<td>75</td>
<td>no</td>
</tr>
<tr>
<td>colouring/activity books</td>
<td>70</td>
<td>yes</td>
</tr>
<tr>
<td>puppets</td>
<td>65</td>
<td>yes</td>
</tr>
</tbody>
</table>

6.3 HEALTH INTERVENTION

It was initially planned to have this package professionally produced by a media group at Murdoch University, but after having a proposal costed by this group, it was found to be beyond the budget of the project to do so. A similar plan was therefore used, but with less expensive development costs. The intervention was designed to be
inexpensive to produce: a prototype that, if successful, could easily be more professionally developed. The total cost of this package, including all materials and labour, was a little under $2,000, the majority of which ($1,200) was used for the development of the audio tapes. This provided for the development of 20 complete packages. It was also necessary that the package be an inexpensive addition to the health resources available to the childcare centres, since few childcare centres can afford the cost of continuous training for their staff and many depend on low-cost or free resources (Kendall et al. 1986), for example the Australian National Health and Medical Research Council (NHMRC) guidelines for preventing infectious diseases in childcare, “Staying Healthy in Child Care” (Roberts 1997). This resource is available free of charge to all childcare centres in Australia.

The intervention was centred around the theme of handwashing and was based on the recommended handwashing procedure outlined in the abovementioned NHMRC guidelines (Roberts 1997). This procedure, where wet hands are washed vigorously with liquid soap for ten seconds, and then rinsed under warm running water for a further ten seconds, is widely recommended as the single-most important procedure to prevent the transmission of infections in childcare centres (Donowitz 1996; American Academy of Pediatrics Committee on Infectious Diseases 1997; Carabin 1999).
6.4 COMPONENTS OF THE HEALTH INTERVENTION PACKAGE

6.4.1 Hand puppets

The use of puppets to teach children is effective because it not only stimulates their imagination, but also involves an interactive process where the puppets communicate with the children, and the children can play with the puppets to create their own stories and games (Mather 1984, 1988). In the present study, the puppets were based on the characters Supersoap and Gooey Germ, which were developed in collaboration with primary school children (aged five to twelve years). These children were asked to draw their idea of what the characters should look like, and hand puppets were then designed and hand-made based on the drawings of one five and one seven year old child using a concept of a “goodie”, Supersoap, who encouraged the children to wash their hands, and a “baddie”, Gooey Germ, who made them sick if he stayed on their hands (Appendix 14) (Figure 6.1). The puppets were also designed to be easily washable, since faecal contamination of the environment has been shown to be a significant factor in the transmission of infectious enteric disease in childcare centres (Laborde et al. 1993).
Figure 6.1 Photographs of the *Supersoap* and *Gooey Germ* puppets
6.4.2 Songs (on an audiotape)

Audiotapes can provide useful health education in a form that is often more interesting than written materials and accessible to those without literacy skills, for example, young children (Wass 1994). For this intervention, a musician/songwriter was given the concept of the package and was asked to write two songs about *Supersoap* and *Gooey Germ* that would be appropriate for preschool children (Appendix 15). Both the audiotape and the printed words to the songs were included in the package.

6.4.3 Story booklet

Based on the same characters and themes, a simple story about *Supersoap* and *Gooey Germ* was written and illustrated (Appendix 16). It was found that colour photocopying or printing was too expensive and not within the budget constraints of the project, and so coloured paper was used to highlight the drawings and make them more appealing to young children. While it was possible to use this option in the production of 20 packages, it was very time-consuming and would not be possible if the package were to be reproduced on a larger scale. In this case, colour printing would need to be considered.

6.4.4 Posters

A series of posters was designed so that they could be frequently changed to avoid over-familiarity with the messages contained on the posters (Appendix 17). Some were
directed more at the children, while others were directed at the adult carers and parents. It was anticipated that these posters would be placed strategically around the childcare centres, including the entrance to the centres, for full impact and not only above sinks and near toileting areas. This would ensure they would be seen by the parents of children as they delivered their children to the centre each day.

6.4.5 Colouring-in sheets

Some of the pictures from the storybook were photocopied and enlarged for the children to colour and take home. These pictures could easily be photocopied from the master copy on a regular basis by the childcare centre staff for use by the children.

6.4.6 Information sheets

Childcare centres often have a high turnover of staff members, sometimes up to 50% over a two-year period (Kendall et al. 1986). Because new personnel constantly require orientation and training, education for the staff of childcare centres should be continuous (Kendall et al. 1986). The information sheets in the health intervention in this study were designed to be simple and clear, easy to read and understand, while remaining informative and containing the minimum information required to inform the carers about controlling infectious gastroenteritis (Appendix 18). These could be photocopied by the centres and then given to all new employees, as well as those employed on a casual basis. The pre-/post-test questionnaires used to evaluate the
intervention were based on information given in these sheets, which was similar to the
information already available to carers in the “Staying Healthy in Childcare” handbook
(Roberts 1997).

6.4.7 Putting it all together

Instructions and suggestions for the use of the package and each of its components were
included (Appendix 19). All the components were put into a hand-made calico bag, The
Supersoap Bag, with handles so that the bag could be hung in a convenient position
within the centre for regular use (Figure 6.2).

Figure 6.2 Photograph of The Supersoap Bag
6.5 IMPLEMENTATION OF THE HEALTH INTERVENTION

Randomised control design is well established as a method for evaluating health interventions (Nutbeam et al. 1996). The basic elements of this design are the undertaking of pre-test studies to establish baseline measurements, the use of a representative sample of the population, random assignment of subjects to intervention and control groups, and the use of a clearly defined intervention and post-test studies to identify change from the baseline measurements (Nutbeam et al. 1996). The present study utilised this design.

Only 13 childcare centres were involved in testing the intervention, since the one rural centre in the study agreed to pilot the intervention prior to implementation, after deciding they did not wish to continue with the study due to accreditation commitments. These centres were divided randomly into two groups, test (n=7) and control (n=6). All carers in all centres were given a questionnaire to complete (Appendix 6) prior to implementation of the intervention. The test group were then give one month to implement the intervention and all carers in both groups were given the questionnaire again (Appendix 7), without the demographic questions relating to characteristics of the carers. This was designed to provide an evaluation of the knowledge gained by the carers through use of the intervention. Once all the questionnaires were received, the control centres were also given The Supersoap Bag. All the childcare centres in this study kept The Supersoap Bag at the end of their involvement in the study.
6.6 EVALUATION OF THE HEALTH INTERVENTION

Ideally, the intervention in this study should have been evaluated either by observation of carers compliance with handwashing before and after the intervention, and/or by measuring whether there was a reduced incidence of *Giardia* and *Cryptosporidium* within the childcare centres in the 12 months following the intervention to compare with the twelve months preceding. It was not, however, within the scope of this project to be able to evaluate the intervention using either of these methods, due partly to the time and resources required, but also because most of the childcare centres were unwilling to undertake another 12 months of faecal sampling. It is also possible that observation of handwashing before and after the intervention would still not have provided an accurate evaluation, since the carers may have been affected in their behaviours by being observed (the Hawthorne effect; Last 1988). The intervention was therefore evaluated through the use of a pre-/post-test questionnaire.

6.6.1 Objective evaluation using pre- and post-test questionnaires

The first section of the questionnaire completed by all the carers who took part in this study was comprised of questions designed to test the knowledge and practices of carers relating to infection control, particularly handwashing procedures (Appendix 6). The questionnaires were completed by both test and control groups, before and after implementation of the intervention in the test groups.
6.6.2 Subjective Evaluation

At the completion of this study, all the childcare centres were sent a survey (Appendix 21) designed to provide a subjective evaluation of the health intervention package. In the survey, carers were asked questions designed to evaluate the effectiveness of the intervention in answering the following questions posed by Hawe et al. (1990: p61)

- *Is the programme or activity reaching the people for whom it was designed?*
- *What do the participants think of the programme/activity?*
- *Is the programme/activity being implemented as planned?*
- *Are all aspects of the programme/activity of good quality?*

6.7 STATISTICAL ANALYSIS

All questionnaire data were entered into an excel spreadsheet. Data entries were verified against raw values (independently by at least two people) prior to any analyses.

Descriptive statistics for carer characteristics, activities, qualifications and training were calculated from questionnaire responses and are shown as means (with ranges) or as percentages. Differences in carer characteristics, activities, qualifications and training among childcare centres were tested by Chi-square test of independence or one-way analysis of variance. Associations between parasite infection rates and carer characteristics were tested by Pearson product moment correlation. Prior to analyses of variance or correlation analyses, variables were tested for normality and transformed, if
necessary. When multiple tests of the same hypothesis were performed, a Bonferroni correction was used to obtain an experiment-wide error rate of 0.05.

The efficacy of the health intervention package in changing carer knowledge and self-reported practices was evaluated using logistic regression models, with questionnaire (pre-test or post-test) and centre (test or control) as the factors. A significant interaction term, as tested by a likelihood-ratio Chi-square test (twice the difference of the log likelihoods between the full model and the model without the interaction term), indicated that the particular knowledge or self-reported practice was affected by the intervention.

All statistical comparisons were performed with JMP version 4 (SAS, Cary, North Carolina).
CHAPTER SEVEN

RESULTS

Of the 201 carers who had initially agreed to take part in this study, 146 (72%) completed the first questionnaire, and 158 (79%) completed the second. One hundred and forty four carers (72%) completed both questionnaires. Only questionnaires from carers who had completed both were included in the analyses. Those who did not complete one or both of the questionnaires (n=57) had been absent from the centre at the time due to annual leave or illness.

7.1 CHARACTERISTICS OF CHILDCARE CENTRE CARERS

Using the demographic data collected from the questionnaire, the characteristics, activities, qualifications and training of all the carers in each centre were tabulated (Tables 7.1 to 7.4). The mean age of all carers over all childcare centres was 30 years (range 16-60 years) and 17% of them had pre-school or school-aged children of their own (Table 7.2). The mean hours of employment were 34 hours per week, and they had been employed as childcare workers for an average of seven years, with an average of four years at their current place of employment (Table 7.1).

Over all childcare centres, 82% of all carers prepared and/or served food to children daily, while 65% toileted children and 72.9% changed nappies daily (Table 7.2). Eighty
percent of all carers both prepared and/or served food to children and/or toileted children or changed nappies on a daily basis (Table 7.2).

Of the 144 carers over all the childcare centres who completed both questionnaires, 53% had degrees and/or diplomas in early childhood care or education, while 38% were unqualified childcare assistants (Table 7.3). A further 7% also held either nursing or teaching qualifications and 8% held minor or introductory childcare qualifications (Table 7.3).

While all of the carers over all childcare centres received education about handwashing during their training course (where undertaken) 97% received information about food preparation and 86% about care of children with diarrhoea (Table 7.4). During employment at their current childcare centre, 96% of the carers had received education about handwashing while 88% had received education about food preparation and 83% about care of children with diarrhoea (Table 7.4).
Table 7.1 Characteristics of carers within each childcare centre

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<th>U14</th>
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<th>U16</th>
<th>U41</th>
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<td>19</td>
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<td>6</td>
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<td>Age (years)</td>
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<td>35</td>
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<td>Percentage of carers with own school or pre-school aged children</td>
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<td>7</td>
<td>22</td>
<td>8</td>
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<td>29</td>
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<tr>
<td>Length of time employed as childcare worker (years)</td>
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<td>6.9</td>
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<td>8.9</td>
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<td>3.4</td>
<td>2.5</td>
<td>8.5</td>
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<td>2.6-14</td>
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<td>0.8-8.7</td>
<td>0.5-6.5</td>
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Table 7.2  Percentage of carers in each childcare centre who performed food preparation and toileting activities

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<th>U13</th>
<th>U14</th>
<th>U15</th>
<th>U16</th>
<th>U41</th>
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<td>15</td>
<td>24</td>
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<td>Number of carers responding</td>
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<td>19</td>
<td>9</td>
<td>5</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Percentage of carers who prepared and/or served food on a daily basis</td>
<td>91</td>
<td>96</td>
<td>66</td>
<td>91</td>
<td>65</td>
<td>96</td>
<td>83</td>
<td>32</td>
<td>83</td>
<td>100</td>
<td>100</td>
<td>87</td>
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<tr>
<td>Percentage of carers who toileted children on a daily basis</td>
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<td>82</td>
<td>77</td>
<td>41</td>
<td>65</td>
<td>61</td>
<td>79</td>
<td>10</td>
<td>57</td>
<td>88</td>
<td>80</td>
<td>75</td>
<td>83</td>
</tr>
<tr>
<td>Percentage of carers who changed nappies on a daily basis</td>
<td>83</td>
<td>82</td>
<td>88</td>
<td>91</td>
<td>45</td>
<td>73</td>
<td>70</td>
<td>32</td>
<td>68</td>
<td>77</td>
<td>100</td>
<td>75</td>
<td>100</td>
</tr>
<tr>
<td>Percentage of carers who toileted children and/or changed nappies, and prepared and/or served food on a daily basis</td>
<td>91</td>
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<td>72</td>
<td>100</td>
<td>65</td>
<td>92</td>
<td>70</td>
<td>32</td>
<td>78</td>
<td>100</td>
<td>100</td>
<td>75</td>
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</table>
Table 7.3  Percentage of carers in each childcare centre with different qualifications  
(Note: some carers had more than one qualification)

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<tr>
<td>Number of carers employed in centre</td>
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<td>15</td>
<td>24</td>
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<td>Number of carers responding</td>
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<td>12</td>
<td>14</td>
<td>19</td>
<td>9</td>
<td>5</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Percentage of carers with degree/diploma in early childhood care</td>
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<td>47</td>
<td>44</td>
<td>42</td>
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<td>0</td>
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<td>0</td>
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</tr>
<tr>
<td>Percentage of carers with teaching qualifications</td>
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<td>0</td>
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<tr>
<td>Percentage of carers with minor/introductory qualifications in</td>
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<td>Percentage of carers with no qualifications</td>
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</table>
7.1.1 Differences between childcare centres

There were significant differences between childcare centres in the mean age of carers ($F_{12,129} = 9.73$, $P < 0.0001$), the length of time the carers had been employed as childcare workers ($F_{12,131} = 3.40$, $P < 0.001$), how long they had worked at their current centre ($F_{12,131} = 4.66$, $P < 0.0001$) and the mean number of hours per week worked by the carers ($F_{12,131} = 3.60$, $P < 0.0001$). Significant differences also were found between centres in the percentage of carers who toileted children ($\chi^2_{12} = 114.7$, $P < 0.0001$) on a daily basis, but not in the percentage who changed nappies ($\chi^2_{12} = 85.7$, $P = 0.13$), prepared and/or served food ($\chi^2_{12} = 76.6$, $P = 0.33$) or both toileted children and/or changed nappies and prepared and/or served food on the same day ($\chi^2_{12} = 85.7$, $P = 0.13$).

There were no significant differences among centres in the percentage of carers with degrees or diploma in childcare ($\chi^2_{12} = 8.89$, $P = 0.71$), minor or introductory qualifications in childcare ($\chi^2_{12} = 13.67$, $P = 0.32$), or no qualifications in childcare ($\chi^2_{12} = 18.17$, $P = 0.11$).

There were differences between centres in those who had received information while at their current childcare centres on handwashing ($\chi^2_{12} = 30.26$, $P = 0.0025$), food preparation ($\chi^2_{12} = 36.10$, $P = 0.0003$) and care of children with diarrhoea ($\chi^2_{12} = 21.38$, $P = 0.045$). There were no differences, however, between childcare centres in the percentage of carers who had received information about these factors during their
training course, (for handwashing $\chi^2_{12}=0$; for food preparation $\chi^2_{12}=13.70$, $P=0.32$; for care of children with diarrhoea ($\chi^2_{12}=16.14$, $P=0.18$).

7.1.2 Differences between test and control groups

Although childcare centres were randomly allocated to test and control groups for evaluation of the health intervention, significant differences were found between the two groups in the carers’ age ($F_{1,140}=24.39$, $P<0.0001$), the length of time the carers had been employed as childcare workers ($F_{1,142}=7.97$, $P=0.0002$), how long they had worked at their current centre ($F_{1,142}=12.95$, $P<0.0001$) and the mean number of hours per week worked by the carers ($F_{1,142}=7.61$, $P<0.0001$). There was a significant difference between test and control centres in those who changed nappies on a daily basis ($\chi^2_{1}=13.5$, $P=0.04$), and those who both prepared and/or served food and toileted children and/or changed nappies on the same day ($\chi^2_{1}=13.5$, $P=0.02$). No significant differences between the test and control groups were found for any of the other characteristics listed in Tables 7.1-7.4. The differences between test and control groups in many of the carers characteristics and practices, despite random allocation of centres to the two groups, highlights the necessity for a pre-test, post-test evaluation of the impact of any health intervention on carer knowledge and practices.
Table 7.4  Percentage of carers in each childcare centre who received training related to infection control during their training course (if applicable) or during employment at their current childcare centre

<table>
<thead>
<tr>
<th>Carer characteristics</th>
<th>U1</th>
<th>U6</th>
<th>U7</th>
<th>U8</th>
<th>U9</th>
<th>U10</th>
<th>U13</th>
<th>U14</th>
<th>U15</th>
<th>U16</th>
<th>U41</th>
<th>U42</th>
<th>U52</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of carers</td>
<td>12</td>
<td>15</td>
<td>9</td>
<td>12</td>
<td>10</td>
<td>13</td>
<td>12</td>
<td>14</td>
<td>19</td>
<td>9</td>
<td>5</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Percentage of carers who received information about handwashing during training course (if applicable)</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Percentage of carers who received information about handwashing during employment at this childcare centre</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>92</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>88</td>
<td>80</td>
<td>63</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Percentage of carers who received information about food preparation during training course (if applicable)</td>
<td>90</td>
<td>90</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>67</td>
<td>100</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of carers who received information about food preparation during employment at this childcare centre</td>
<td>82</td>
<td>93</td>
<td>100</td>
<td>100</td>
<td>89</td>
<td>100</td>
<td>100</td>
<td>85</td>
<td>88</td>
<td>100</td>
<td>60</td>
<td>28</td>
<td>83</td>
</tr>
<tr>
<td>Percentage of carers who received information about care of children with diarrhoea during training course (if applicable)</td>
<td>57</td>
<td>88</td>
<td>60</td>
<td>100</td>
<td>100</td>
<td>83</td>
<td>100</td>
<td>89</td>
<td>70</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Percentage of carers who received information about care of children with diarrhoea during employment at this childcare centre</td>
<td>70</td>
<td>67</td>
<td>67</td>
<td>100</td>
<td>76</td>
<td>100</td>
<td>90</td>
<td>100</td>
<td>84</td>
<td>88</td>
<td>100</td>
<td>63</td>
<td>50</td>
</tr>
</tbody>
</table>
7.1.3 Relationship between carer characteristics and

*Giardia/Cryptosporidium* infections in childcare centres

In Tables 7.5 and 7.6 the associations between infection rates of *Giardia* and *Cryptosporidium* in the childcare centres and the characteristics of carers in the centres are summarised. There was no significant relationship between *Giardia* infections in any of the childcare centres and the data collected in the questionnaires. There was, however, a significant positive correlation between *Cryptosporidium* infections and whether carers had received any information about handwashing while at their current childcare centre, although significance was not retained when the Bonferroni correction was applied.
<table>
<thead>
<tr>
<th>Characteristic of carer</th>
<th>Relationship with infection rates of Giardia</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>r^2</td>
</tr>
<tr>
<td>Mean age (years) of carers</td>
<td>0.02</td>
</tr>
<tr>
<td>Percentage of carers with own school or pre-school aged children</td>
<td>0.12</td>
</tr>
<tr>
<td>Mean hours of employment (per week)</td>
<td>0.06</td>
</tr>
<tr>
<td>Mean length of time employed as childcare worker (years)</td>
<td>0.02</td>
</tr>
<tr>
<td>Mean length of time employed at this childcare centre (years)</td>
<td>0.06</td>
</tr>
<tr>
<td>Percentage of carers with degree/diploma in early childhood care or early childhood education</td>
<td>0.19</td>
</tr>
<tr>
<td>Percentage of carers with minor/introductory qualifications in childcare</td>
<td>0.01</td>
</tr>
<tr>
<td>Percentage of carers with no qualifications</td>
<td>0.02</td>
</tr>
<tr>
<td>Percentage of carers who received information about handwashing during training course (if applicable)</td>
<td>No variation</td>
</tr>
<tr>
<td>Percentage of carers who received information about handwashing during employment at this childcare centre</td>
<td>0.06</td>
</tr>
<tr>
<td>Percentage of carers who received information about food preparation during training course (if applicable)</td>
<td>0.13</td>
</tr>
<tr>
<td>Percentage of carers who received information about food preparation during employment at this childcare centre</td>
<td>0.01</td>
</tr>
<tr>
<td>Percentage of carers who received information about care of children with diarrhoea during training course (if applicable)</td>
<td>0.21</td>
</tr>
<tr>
<td>Percentage of carers who received information about care of children with diarrhoea during employment at this childcare centre</td>
<td>0.01</td>
</tr>
</tbody>
</table>

1 All carers in all childcare centres received information about handwashing during their training course
Table 7.6  The relationship between characteristics of childcare centre carers and infection rates for Cryptosporidium in each childcare centre: significant relationships shown in bold type

<table>
<thead>
<tr>
<th>Characteristic of carer</th>
<th>Relationship with infection rates of Cryptosporidium</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$r^2$</td>
</tr>
<tr>
<td>Mean age (years) of carers</td>
<td>0.05</td>
</tr>
<tr>
<td>Percentage of carers with own school or pre-school aged children</td>
<td>0.19</td>
</tr>
<tr>
<td>Mean hours of employment (per week)</td>
<td>0.04</td>
</tr>
<tr>
<td>Mean length of time employed as childcare worker (years)</td>
<td>0.08</td>
</tr>
<tr>
<td>Mean length of time employed at this childcare centre (years)</td>
<td>0.05</td>
</tr>
<tr>
<td>Percentage of carers with degree/diploma in early childhood care or early childhood education</td>
<td>0.003</td>
</tr>
<tr>
<td>Percentage of carers with minor/introductory qualifications in childcare</td>
<td>0.05</td>
</tr>
<tr>
<td>Percentage of carers with no qualifications</td>
<td>0.003</td>
</tr>
<tr>
<td>Percentage of carers who received information about handwashing during training course (if applicable)</td>
<td>No variation¹</td>
</tr>
<tr>
<td>Percentage of carers who received information about handwashing during employment at this childcare centre</td>
<td>0.40</td>
</tr>
<tr>
<td>Percentage of carers who received information about food preparation during training course (if applicable)</td>
<td>0.003</td>
</tr>
<tr>
<td>Percentage of carers who received information about food preparation during employment at this childcare centre</td>
<td>0.28</td>
</tr>
<tr>
<td>Percentage of carers who received information about care of children with diarrhoea during training course (if applicable)</td>
<td>0.04</td>
</tr>
<tr>
<td>Percentage of carers who received information about care of children with diarrhoea during employment at this childcare centre</td>
<td>0.003</td>
</tr>
</tbody>
</table>

¹ All carers in all childcare centres received information about handwashing during their training course
7.2 EVALUATION OF HEALTH INTERVENTION

7.2.1 Differences between the responses of test and control groups before and after the intervention.

The percentage of carers in both the test and control groups correctly responding to questions relating to their knowledge and practices in pre- and post-test questionnaires is listed in Table 7.7. As only the test group received the health intervention between the pre- and post-test questionnaires, a significant interaction term indicates that the intervention successfully changed the knowledge and/or behaviour of the carers.

Significant differences in pre- and post-test responses were found between the test and control groups for knowledge of the important organisms causing infectious diarrhoea in children in childcare centres, knowing that it is best to use warm, running water to wash hands, and knowing the minimum time to wash hands in childcare centres (Table 7.7). There were also significant differences in pre- and post-test responses between test and control groups for knowledge of whether the organisms causing infectious diarrhoea can be transmitted by asymptomatic individuals, and in the time taken by respondents to wash their hands at the childcare centre, although these significant differences were not retained after the Bonferroni correction (Table 7.7).

There were no significant differences in pre- and post-test responses between the test and control groups in their knowledge of the factors important in the spread of infectious diarrhoea in childcare centres, the transmission of diarrhoea-causing
organisms, the best soap to use in childcare centres and the most important times for both carers and children to wash their hands while at the centres (Table 7.7).
Table 7.7  Percentage of carers with correct responses to questions testing knowledge and practices related to infection control in the test and control groups, before and after implementation of the health intervention. Significant differences in correct responses between test and control groups shown in bold type. *Indicates significant at P<0.05 with the Bonferroni correction.

<table>
<thead>
<tr>
<th>Question</th>
<th>Control group</th>
<th>Intervention Group</th>
<th>Interaction $\chi^2$</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correctly listing important organisms causing infectious diarrhoea in childcare centres</td>
<td>42.8</td>
<td>41.3</td>
<td>58.0</td>
<td>87.6</td>
</tr>
<tr>
<td>Correctly stating whether most of these organisms can be transmitted by an asymptomatic individual</td>
<td>88.9</td>
<td>87.3</td>
<td>82.7</td>
<td>96.3</td>
</tr>
<tr>
<td>Correctly stating that warm, running water is best for washing and rinsing hands</td>
<td>71.4</td>
<td>58.7</td>
<td>72.8</td>
<td>95.1</td>
</tr>
<tr>
<td>Correctly stating the minimum time necessary for handwashing within childcare centres</td>
<td>14.3</td>
<td>12.7</td>
<td>35.8</td>
<td>86.4</td>
</tr>
<tr>
<td>Stating that the minimum time actually taken by the carer to wash their hands while at the childcare centre was not less than 20 seconds</td>
<td>16.1</td>
<td>11.1</td>
<td>19.8</td>
<td>48.1</td>
</tr>
<tr>
<td>Correctly stating the factors important in the spread of infectious diarrhoea in childcare centres</td>
<td>6.3</td>
<td>7.9</td>
<td>14.8</td>
<td>24.7</td>
</tr>
<tr>
<td>Correctly stating how the organisms causing infectious diarrhoea are transmitted within childcare centres</td>
<td>85.2</td>
<td>87.1</td>
<td>98.8</td>
<td>86.4</td>
</tr>
<tr>
<td>Correctly stating the best soap to use for handwashing within childcare centres</td>
<td>15.9</td>
<td>15.9</td>
<td>67.9</td>
<td>69.1</td>
</tr>
<tr>
<td>Correctly stating the most important times for carers to wash their hands while at a childcare centre</td>
<td>92.1</td>
<td>92.1</td>
<td>95.1</td>
<td>96.3</td>
</tr>
<tr>
<td>Correctly stating the most important times for children to wash their hands while at a childcare centre</td>
<td>81.0</td>
<td>85.7</td>
<td>90.9</td>
<td>97.4</td>
</tr>
</tbody>
</table>
7.2.2 Subjective evaluation

Twenty-five evaluation sheets (Appendix 20) were returned from the 14 participating childcare centres. The majority of centres appeared to find the intervention package easy and interesting to use and enjoyed using it. They also found that it was an appropriate vehicle for delivering the handwashing message to children (Table 7.8).

Space was left for general comments at the end of the survey. Thirty two percent of carers responded very positively and stated that they not only found it a useful addition to the infection control resources available at their childcare centre, but that the children had also responded positively to the intervention and after using the intervention, were actively reminding the carers to wash hands.

Negative comments were made by 12% of carers who stated that they would not consider using it at all. Other comments included 12% of carers who considered that the germ puppet was too scary for younger children, 8% who considered the intervention might encourage the children to become obsessed with handwashing and 8% who felt that twenty seconds was too long to spend on a single handwash for children. These comments were made by carers in two of the childcare centres.
Table 7.8  Percentage of carers who responded positively and negatively to a subjective evaluation of different aspects of the health intervention package

<table>
<thead>
<tr>
<th></th>
<th>% Response (Yes)</th>
<th>% Response (No)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy to use</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Instructions appropriate and easy to use</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Interesting for carers to use</td>
<td>88</td>
<td>12</td>
</tr>
<tr>
<td>Interesting for children to use</td>
<td>92</td>
<td>8</td>
</tr>
<tr>
<td>Well liked by the children</td>
<td>92</td>
<td>8</td>
</tr>
<tr>
<td>Carer enjoyed using it</td>
<td>88</td>
<td>12</td>
</tr>
<tr>
<td>Carer would use it regularly</td>
<td>88</td>
<td>12</td>
</tr>
<tr>
<td>The intervention taught handwashing</td>
<td>88</td>
<td>12</td>
</tr>
<tr>
<td>procedures appropriately for childcare</td>
<td></td>
<td></td>
</tr>
<tr>
<td>centres</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
CHAPTER EIGHT
DISCUSSION

8.1 INTRODUCTION

The majority of research on infectious disease in childcare centres emanates from North America, Europe and Scandinavia (Jarman and Kohlenberg 1991; Ferson 1997), and the present study is only the second of its type to be conducted in childcare centres in Australia. Many previous studies have been conducted in high quality, often university-based centres (Jarman and Kohlenberg 1991), where the families are from higher socio-economic backgrounds, such as in the only other similar Australian study conducted by Roberts (1998). The conclusions from these studies may not, therefore, always be able to be extrapolated to other childcare settings. The centres in the present study, however, were randomly chosen, covering a wide area of Perth, with a variety of postcodes inclusive of a range of socio-economic areas (ABS 1996b).

8.2 RISK FACTORS FOR INFECTIOUS DIARRHOEA IN CHILDCARE CENTRES

In Chapters 3 and 4 of this study, the risk factors for children attending childcare centres that might predispose to infectious diarrhoea were discussed. As well as factors related to the centre and the children within the centre, certain risk factors related to the carers within childcare centres have also been identified. These include poor hygiene and
child-handling practices, and carers who both toilet children and/or change nappies, and prepare and/or serve food on the same day (Ekanem et al. 1983; Child Day Care Infectious Diseases Group 1984; Lemp et al. 1984; Bartlett et al. 1985; Petersen and Bressler 1986; Crawford and Vermund 1987; American Academy of Pediatrics Committee on Infectious Diseases 1997). Although hygiene practices were not directly observed in this study, 80% of carers stated that they prepared and/or served food to children and/or toileted children or changed nappies on a daily basis. This is despite the fact that this characteristic has been frequently cited as being strongly associated with a high incidence of infectious diarrhoea in childcare centres and the literature regarding infection control in childcare centres is unanimous in recommending that separate staff perform these duties (Ekanem et al. 1983; Lemp et al. 1984; Sullivan et al. 1984; Aronsen and Osterholm 1986; Crawford and Vermund 1987; Carson 1987; Cordell and Addiss 1994; Thompson 1994b; Churchill and Pickering 1997; Uhari and Mottonen 1999).

Although no relationship was found in this study, between the percentage of carers performing both these practices and infection rates with Giardia and Cryptosporidium in the childcare centres, this may have been because this characteristic was so common, and the percentage of carers performing it did not differ significantly between centres. Significant differences were found between centres in a number of other carer characteristics and practices, such as mean age, length of time employed as a childcare worker, hours worked per week and daily toileting of children, but in no case were these
characteristics or practices significantly related to infection rates with *Giardia* or *Cryptosporidium*.

**8.3 THE IMPORTANCE OF HANDWASHING AS A PRIMARY MEANS OF INFECTION CONTROL IN CHILDCRE CENTRES**

There is a large body of evidence available from studies in a variety of settings to indicate that there is a causal link between effective and appropriate handwashing and a reduced risk of the transmission of infections, including infectious diarrhoea (Black *et al.* 1981; Bartlett *et al.* 1988; Larson 1988; Kotch *et al.* 1994; Krilov *et al.* 1996; Stoller *et al.* 1991; Carabin *et al.* 1999; Uhari and Mottonen 1999). Faecal contamination of hands has been cited as the primary mode of transmission of infectious diarrhoea within childcare centres (Petersen and Bressler 1986; Pickering 1986; Laborde *et al.* 1993; Carabin *et al.* 1999). The effectiveness of handwashing in childcare centres was first illustrated by Black *et al.* (1981) and has since been accepted as the single-most important means of reducing the transmission of infections in the centres (Cordell and Addiss 1994; Churchill and Pickering 1997; American Academy of Pediatrics Committee on Infectious Diseases 1997).

While some studies, including that of Black *et al.* (1981), have looked at the efficacy of specific interventions in controlling the spread of infections in childcare (Van *et al.* 1991, Holaday *et al.* 1994, Holaday *et al.* 1995), others have used multidimensional intervention programmes, including a variety of specific procedures and training
courses (Bartlett et al. 1988; Butz et al. 1990; Kotch et al. 1994; Krilov et al. 1996; Carabin et al. 1997; Roberts 1998; Uhari and Mottonen 1999). No study since that of Black et al. (1981) has tested the efficacy of handwashing as a single infection control intervention in childcare centres (Huskins 2000). The intervention developed in the present study used handwashing of both carers and children as the primary method of interrupting the transmission of enteric parasites within and beyond childcare centres.

8.3.1 Previous infection control education of childcare centre staff

Robinson (2001) suggests that childcare centre staff have usually received minimal education about the importance of handwashing after nappy changes or prior to food preparation. In the present study, however, 96% of carers had received some information about handwashing during employment at their current childcare centre, and all of those who had completed some sort of training course in childcare had received information about handwashing during their course. A smaller but still appreciable percentage had received information about food preparation (88% during employment at their current childcare centre and 97% during their training course), and care of children with diarrhoea (83% during employment at their current childcare centre and 86% during their training course). This compares favourably with the findings of Lopez et al. (1988) that 48% of staff had had no in-service training and 70% had no formal pre-employment training in infection control. There was some indication that the provision of information about handwashing during employment at the childcare centre was related to infection rates with Cryptosporidium, although this
relationship was in the opposite direction to that expected and may have been an
artefact.

8.4 HEALTH INTERVENTION PACKAGE

8.4.1 Qualifications of childcare centre staff

Given the documented lack of compliance of medical and nursing personnel with both
hygiene practices and interventions to improve these (Albert and Condie 1981; Larson
and Killien 1982; Donowitz 1987; Meengs et al. 1994; Tibballs 1996; Kesavan et al.
1998), it should not be surprising that the education of staff in childcare centres in
prevention measures may result in less than optimal success. Following the
implementation of an intensive infection control programme, Uhari and Mottonen
(1999) found there was little improvement in the knowledge base of staff regarding the
cause and mode of infection spread, despite the fact that rates of respiratory infections
and diarrhoea were reduced in the centres.

Health care workers usually have the advantage of tertiary education, and a greater
knowledge of infection control principles, yet compliance with infection control
procedures, and sustained improvement in these after the implementation of
interventions designed to improve compliance levels, are consistently documented as
being poor (Conly et al. 1989; Dubbert et al. 1990; Larson and Kretzer 1995; Larson et
al. 1997). No single intervention has been shown to have a sustained improvement in
handwashing compliance behaviours in healthcare workers (Larson and Kretzer 1995; Larson et al. 1997; Kretzer and Larson 1998). Greater knowledge and education, therefore, does not necessarily translate into greater compliance with infection control procedures, even a procedure as simple and cost-effective as handwashing (Larson and Kretzer 1995).

Not all childcare workers on the other hand, have post-secondary school qualifications. In the present study, more than one third of the carers were unqualified childcare assistants with no post-secondary school training, and only 53% held degrees or diplomas relating to early childhood care, nursing or education. There were no differences between childcare centres in the percentage of carers with different educational qualifications. Similarly, in an investigation of the health and safety practices in childcare centres in New South Wales, Harris et al. (1994) found that 33% of carers were either unqualified or did not state their qualifications, while 67% had qualifications in childcare studies, teaching or nursing.

It is important, therefore, when designing health interventions for childcare centre staff, that the educational levels of staff are taken into account to ensure that the content of the intervention is fully understood by the carers, and that they understand why such measures are required (Pickering 1986). The information in this study was deliberately kept simple and clear so that it would be easy to read and understand, while retaining the most important information required to inform the carers about controlling infectious diarrhoea within childcare centres. Most of the information was similar to
that found in the “Staying Healthy in Childcare” handbook previously mentioned in Chapter 6, which would already be very familiar to the staff within the centres, and focused on interrupting the transmission of infectious enteric pathogens through effective handwashing.

Backett-Milburn and MacKie (1999) suggest that health education programmes do not always consider the perceived needs of the target population in the design and implementation of interventions. In this study, the carers had a large amount of input into deciding the formats which should be used, and who should be targeted, that is, children and parents as well as carers (Chapter 6). The intervention was therefore not designed as a formal, structured programme such as that of Roberts (1998). Although it has been shown that there is a need for formal in-service education relating to infection control within childcare centres (Ferson 1997; Roberts 1998), many centres are constrained both financially, and by the amount of time they can spare for their carers to take from normal work duties to attend in-service programmes.

The varied components of the intervention in this study were designed to facilitate a “hands-on” approach, with an emphasis on informal, rather than formal teaching. It was also designed to be quick and easy to access and use at any time during the usual childcare centre routine. In this way, it was hoped that carers would use the intervention more frequently, reinforcing the messages of the intervention regularly for themselves, since it has been suggested that staff may have a poor memory for what they are taught (Bartlett et al. 1988). In their study, Bartlett et al. (1988) found that
although 93% of staff who attended a training session passed a test immediately afterwards, none passed the same test eight months later.

8.4.2 Health education of pre-school children in childcare

Hughes et al. (1996) suggested that there had been little evaluation to assess whether it was effective or appropriate to target children for health education. Other studies have indicated, however, that education of this age group about matters affecting their health may be both beneficial and effective (Krenzelok et al. 1981; Jurs et al. 1990; Taras et al. 1994), since the preschool years have been shown to be a period of rapid development and acquisition of skills (Canadian Institute of Child Health 1989).

Several components of the health intervention package in this study, such as the puppets, songs, story booklet and colouring-in pictures, were directed at the children within childcare centres. It was recognised that this type of education would be most effective in the two to three year plus age group, since from this age, children usually begin to become independent with toileting and handwashing (Roberts 1998).

Anecdotal feedback and feedback from the carers in this study suggested that the package worked best with these children, rather than the younger, toddler-aged children.

Preschool children in childcare centres have previously been targeted for health education. Krenzelok et al. (1981) developed a program to teach poison prevention to children aged 30 to 60 months in childcare centres that resulted in an improved
understanding of poison prevention in the children of nearly 100%. A handwashing programme using a stuffed bear called “Scrubby Bear” was used to teach disabled children aged four to six years attending a paediatric hospital when and how to wash their hands (Day et al. 1993), however, the researchers found that an increase in the knowledge of the children about the importance of handwashing was not enough to sustain an improvement in handwashing behaviours. Similarly, Niffenegger (1997) developed a programme designed to teach both the carers and children aged three to five years in childcare centres about germs and handwashing using a variety of activities, including puppets called “Soapy” and “Sudy”. In contrast, to the findings of Day et al. (1993), Niffenegger reported that the children using these activities responded positively and appeared to remember many of the important concepts involved as well as putting them into practice. Subjective evaluation from and anecdotal evidence regarding the health intervention package in the present study suggested that the children responded very positively to the puppets, songs, storybooks and colouring-in pictures.

A handwashing campaign for children in hospitals in the USA using a bear called “T. Bear”, was highly successful in encouraging young children to wash their hands at appropriate times, but unfortunately “T. Bear” himself was found to be a significant source of contamination with pathogenic bacteria (Hughes et al. 1986; Uhari and Mottonen 1999). Contamination of the environment within childcare centres has been well documented (Petersen and Bressler 1986; Carabin et al. 1999), with most recommended policies for infection control including protocols for regular cleaning of
toys and environmental surfaces (Carson 1987; Giebink 1990; Harris et al. 1994). The puppets in this package were therefore designed to be machine-washable to reduce the risk of contamination.

8.4.3 Health education of families of pre-school children in childcare

Health education of young children has been shown to be most effective when the family is involved, since a child's perception that their family approves of health messages learnt at childcare acts to reinforce these messages (Taras et al. 1994). A common complaint verbalised by the directors of the childcare centres in this study was that parents often either did not advise the centre if their child had had diarrhoea prior to being left at the centre, or were tardy about collecting their child when contacted by the centre if the child was ill (see Chapter 4.6.1). The majority of the centres therefore wanted to have some education about infectious illness in childcare directed at the parents, with two major objectives. Firstly, to increase the parents' awareness of the importance of notifying the childcare centre if their child had diarrhoea, and keeping them away from the centre until the diarrhoea had ceased, in keeping with the exclusion policies of most centres. Secondly, to increase the parents' awareness of the need to maintain their own levels of hygiene, especially appropriate handwashing after toileting or changing nappies of their children.

The colouring pictures in this study were designed to be taken home by the children, because activities that young children bring home can be useful in involving family
members (Taras et al. 1994). It was also expected that the children would then talk to their parents about the puppets and songs that the carers in the childcare centres had been using to teach them about the importance of handwashing. In this way it was anticipated that the parents were receiving indirect and non-accusatory education about hygiene and infection control, by being invited to participate with their children at a preventive level. This was not, however, evaluated in this study.

8.5 EVALUATION OF HEALTH INTERVENTION

The aim of evaluation is not necessarily only to determine whether the intervention has worked, but also to understand why it worked so that it can be repeated and/or refined (Nutbeam et al. 1996). Therefore, a range of evaluation methods may need to be employed. The evaluation methods used in many studies of infectious disease control in childcare centres may be quite subjective. Many have relied on retrospective accounts of illness which are subject to both recall and informant bias, since they often rely on carer and/or parental recognition of illness (Jarman and Kohlenberg 1991). This may be flawed, since parents with children in childcare may either ignore minor illness or may seek medical help more readily to avoid work loss through their child’s absence from childcare (Jarman and Kohlenberg 1991). The majority of hygiene intervention studies designed to control infectious diarrhoea conducted over the past 20 years have used diarrhoea or gastrointestinal illness as at least one of the major outcomes (Aiello and Larson 2002). Definitions of illness, such as diarrhoea, however, can be quite
variable, since what is normal for one child may not be for another, and staff and/or parents may therefore apply these definitions differently.

In this study, two methods of evaluation were employed, one an objective pre-/post-test of knowledge about infection control practices, and the second, a more subjective evaluation of how useful the carers found the intervention.

8.5.1 Objective evaluation of The Supersoap Bag

The post-test responses of the group of centres who used the intervention in this study were significantly better than those of the control group who did not use the intervention in several important areas, including knowledge about specific causative organisms, transmission of these by asymptomatic individuals, and increased knowledge about effective handwashing technique. It has been shown, however, that increased knowledge about handwashing is not always enough to sustain improvements in handwashing behaviours and that continuous reinforcement of infection control principles is necessary to achieve a sustained effect (Conly et al. 1989; Niffenegger 1997).

In a review of infection control studies conducted over the past 20 years, Aiello and Larson (2002) found that although there was a strong trend towards immediate reductions in the levels of infections following the implementation of interventions related to improving levels of hygiene, particularly handwashing, there was little
evidence for a sustained long-term effect of the interventions. They concluded that it could well be that over a period of time, the positive effect of these interventions diminished. It was unfortunately not possible to test the long-term effect of this intervention by re-testing the centres at intervals over the following months, ideally at three to six month intervals for 12 months or longer, since all of the centres had been involved in the study for more than 18 months already, and two for 30 months, and consequently were all reluctant to continue this involvement for an extended period. It was hoped, however, that if the centres continued to use The Supersoap Bag on a regular basis, the concepts of infection control would remain uppermost in the consciousness of the carers in the centres, ensuring also that the children were being taught the same principles. Anecdotal evidence received via telephone contact made with the directors of all the centres at two consecutive six monthly intervals after the study’s completion suggested that after 12 months, in 57% of the centres the package was being used at least once per month, while 29% used it less than once per month but still used it occasionally, and 14% never used it again.

Full compliance with a handwashing programme by childcare centre staff is difficult to achieve (Black et al. 1981), and in childcare centres it is extremely difficult to maintain and monitor compliance with hygiene interventions (Larson 1988). Even in hospitals where the risk of cross-infection is generally recognised, compliance levels are consistently reported as being low and few interventions to influence handwashing have had a measurable, long-term effect (Larson et al. 1997; Rotter 1998).
8.5.2 Subjective evaluation of *The Supersoap Bag*

The objective evaluation of *The Supersoap Bag* found that the intervention significantly improved the knowledge of carers in some important areas of hygiene within childcare centres. The data from the pre-/post-test questionnaire did not, however, fully capture the carers’ perceptions of the usefulness and applicability of the intervention. For example, a hygiene intervention was developed by Roberts (1998) and subsequently distributed to childcare centres throughout Australia. Although this intervention had been shown to be effective in reducing infection rates of respiratory disease and diarrhoea within childcare centres (Roberts *et al.* 2000a, 2000b), the directors of four centres in the present study stated that they did not find Roberts’ intervention useful, that there were areas of the intervention they did not like, and that they would therefore not use it. If an intervention is not being used by a childcare centre, it cannot have the intended effect.

As discussed previously, long-term sustainability of the effect of hygienic interventions has generally been poor. It may be important, therefore, to design an intervention that not only can be shown to have an effect in improving the knowledge and practices of childcare centre carers, and subsequently reducing the rates of infection within centres, but that is also perceived by the carers themselves to be useful and so ensure the intervention will be used regularly (Kendall *et al.* 1986). Therefore, an initial subjective survey of carers needs was made prior to designing the intervention, and a subjective evaluation of their perceptions of the final product was performed after implementation.
of the intervention. It was hoped that this would provide information on how prepared the carers in each centre would be to actually use the intervention on a regular basis.

Figure 8.1 Photograph of children using components of *The Supersoap Bag* with their carer

Overall, the response of the carers within most of the centres in this study to *The Supersoap Bag* was positive. Between 88 and 100% of the carers who responded to the evaluation survey stated that they not only found the package easy to use and understand, but that it was also interesting and they enjoyed using it (Figure 8.1). They also stated that the children enjoyed using the package and the carers felt it taught handwashing appropriately within childcare centres. More than 80% of the carers were very positive in their added comments about the package, stating that they would not
only be happy to use it on a regular basis, but that they thought it was an effective method of teaching handwashing within childcare centres. The director of one centre commented that the children had started reminding the carers about handwashing, and that they were singing the songs from the audiotape, even when the tapes were not in use. These comments suggest that continued use of *The Supersoap Bag* was likely in the majority of centres in this study. At the completion of the study, the directors of two centres requested an extra *Supersoap Bag* for their centre. This was because they had found that *The Supersoap Bag* was being used so frequently by the carers that they wanted to have a bag in each of the older age-group rooms (toddler and preschool). This request was complied with.

In two centres, the carers gave very negative comments, mostly regarding the fact that they found the germ puppet to be too scary for younger children, and that 20 seconds was much too long a time to have to spend washing a child's hands. They also commented that this type of programme might make children become obsessive about handwashing. These comments are unfortunate in that they indicate a lack of understanding of the most basic principle of infection control within childcare centres, that of effective and appropriate handwashing. The literature in this area states that handwashing is the most important factor in infection control and that 20 seconds is the minimum time necessary for it to be effective (Boot and Caimcross 1993; Harris *et al.* 1994; Roberts 1997)
8.6 CONCLUSIONS

The second part of this study showed that, despite wide differences in carer characteristics, practices, qualifications and training between childcare centres, a simple health intervention can be effective in improving the infection control knowledge and practices of carers in childcare centres. It is also important to ensure that the carers will use any intervention that has been designed to improve hygiene practices. In this study, not only were the carers consulted beforehand and enabled to provide input into the design and development of the intervention package, they were also surveyed at the completion of the study to assess how well the intervention had been accepted by the carers. The results of this study indicated that in the majority of childcare centres, the intervention package was well liked by the carers and that they found it a useful addition to their resources with regard to infection control.
CHAPTER NINE

CONCLUSIONS

What's it all about...?

What is the purpose in undertaking and completing a PhD project and thesis? No doubt this is a question that many a post-graduate student has asked themselves in the wee small hours of the morning. There could, however, be said to be two main aims in such an undertaking. The first is to undertake a “novel” piece of research, something that will contribute new findings to the body of knowledge already existent on the subject, and the second, is as a learning experience for the student.

There is nothing new under the sun

So is any piece of research new? Perhaps it looks at a different aspect of a problem, or in a different place or from a different perspective to those who have come before, or puts a new interpretation on the results.

Although other studies, both in Australia and overseas, have investigated infectious diarrhoea in childcare centres, and have evaluated interventions to prevent the transmission of infectious diarrhoea, my study was the first to concentrate on infection
with *Giardia* and *Cryptosporidium* in apparently healthy children attending childcare centres in Australia. Given the faecal-oral mode of transmission of these parasites, investigating the presence of these parasites is relevant in childcare centres because many other common causative organisms of infectious diarrhoea in childcare centres are transmitted similarly, such as rotavirus. The methods used for interrupting their transmission, for example handwashing, will therefore be the same. My study also has some new aspects to the intervention, in that it involved the end-users, the carers in the childcare centres, in the development of the intervention package. It also involved children in developing those parts of the intervention directed at the children, since young children designed the puppets used in *The Supersoap Bag*. The evaluation methods used were new for this type of study, since they focused on not only testing whether the intervention was effective in terms of improving the knowledge and practices of carers about infection control, but also attempted to determine the carers attitudes to the intervention itself, since no intervention, no matter how effective, can work unless it is being used. The overall response of the carers to the intervention was positive, and most of the carers indicated that they would continue to use the package. This is important since much of the literature stresses the lack of long-term effectiveness of health interventions and the need for constant reinforcement of the health messages involved.

In the first part of this study, I identified *Giardia* and *Cryptosporidium* infections in 14 childcare centres across a range of socio-economic areas in Perth, Western Australia. The seasonal peak found in the first year, which, although not repeated in the second
year may suggest a target time for infection control programmes. Of special interest was the high asymptomatic rate of infection for *Giardia*, which is consistent with the findings of other studies. Since asymptomatic children will not be excluded from the childcare centre, but are still able to transmit infection, this stresses the importance of maintaining and/or improving hygiene practices, especially handwashing.

Any piece of research is fraught with difficulties. No doubt laboratory studies have their pitfalls, and certainly research involving people does, since it is very dependent on the co-operation of those involved in the study. Who could imagine that adults could be so possessive of their excretory products? Because of this simple fact, the rate of transmission from children to carers and families could not be properly determined. It was possible to say, however, that transmission of both *Giardia* and *Cryptosporidium* did occur between the children in the childcare centres and their families. This has the potential to cause problems for the parents of the children, not only due to the illness of the child and the resultant difficulties of finding alternate care or being absent from work, but also in the potential for absences from work caused through their own illness. It is therefore vital that transmission of infectious diarrhoea between children in childcare centres, the carers, families and the community beyond the childcare centre, is kept to a minimum. The easiest and cheapest way to achieve this for all concerned, is appropriate and effective handwashing.

The second part of this study dealt with the development, implementation and evaluation of a health education package aimed at interrupting the transmission of
enteropathogens in childcare centres. The rates of infection with *Giardia* and *Cryptosporidium* found in the first part of this study, and the high asymptomatic rate of infection with *Giardia*, indicate a continued need for the implementation of interventions to maintain and/or improve levels of hygiene within childcare centres. Unfortunately there is much published literature to attest to the fact that rates of non-compliance with a procedure as simple and cost-effective as handwashing are high, both with health care workers and within childcare centres.

The results of the evaluation methods used in this study showed that, firstly the knowledge of carers with regard to infection control, particularly handwashing, was improved by the use of the health intervention package, and secondly, that most of carers were prepared to use the package regularly. It has been shown that increasing a person’s knowledge about hygiene is not enough to produce a sustained improvement in hygiene practices, so this latter information is very important. Regular reinforcement of health education is necessary and the majority of even intensive education programmes have been shown to have little long-term effect. The health intervention package in this study could be refined and produced more professionally, since as a prototype it appears to have been successful in achieving its objectives of improving the knowledge of carers, and being used by the carers. Again, the long-term success of this intervention has yet to be measured. Although this would require a substantial funding commitment to support an observational survey, it would significantly strengthen the tentative conclusions reached here.
I stated at the beginning of this chapter that one of the main purposes in undertaking a PhD was as a learning experience for the student. There is absolutely no doubt in my mind, at least, that this whole experience, from the very first discussions on what the project might be, to trying to get the formatting just right for final submission, that this has been one very big learning curve for this particular student. So at the end of the day, what would I change?

I would very much like to have been able to have compared the infection rates of the parasites involved, with those of children not ever attending childcare. An attempt was made to recruit a cohort of children in this category, but this was unsuccessful. There is definitely something about collecting faecal samples that seems to concern people. Collecting samples from children across all age groups within the childcare centres would have enabled a better analysis of those age groups most at risk, while collecting samples from carers and parents on a regular basis would have given more information about the transmission dynamics of the parasites. Once again, no-one wanted to share their excretory products with me, and the carers in the centres had too many concerns about the psychological effects of collecting samples from toilet-trained children.

In Part Two of the study, it would have been ideal to collect faecal samples from all the centres for a further 12 months after the intervention, however, that would have been pushing beyond the limits of co-operation within the majority of the centres. I would
also have liked to observe the hygiene behaviours, particularly handwashing, of carers and children in the 12 months prior and following the intervention to detect any changes in behaviour. This was not possible, partly because of the intrusion for the childcare centres, but mainly because I did not have the resources to do so. As discussed previously, this method of evaluation does have its problems in that being observed can in itself, change the behaviours of the participants.

In conclusion, as previously stated, some valuable results have arisen from this study that have added to the existent body of knowledge on the subject. I would like to see either the intervention refined and professionally developed or at the least, a similar product produced for childcare centres, since it did fill a gap in the infection control resources of the childcare centres. Since obviously neither childcare centres themselves, nor infectious diarrhoea within these centres are going to go away, there will always be a need for health interventions that help to reduce the transmission of causative organisms such as *Giardia* and *Cryptosporidium* in childcare centres.
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Appendix 1  First contact letter to childcare centre directors, requesting their participation in the study

The Director
Childcare Centre

Dear Madam

My name is Jennifer Walters and I am a Registered General Nurse, currently undertaking a PhD at Murdoch University. I am studying the prevalence of some gastrointestinal parasites in children in childcare centres in Western Australia. This study has the approval of a paediatric gastroenterologist at Princess Margaret Hospital. The primary aim of the study is to develop a health education programme for use within childcare centres that would reduce the transmission of these parasites, and therefore gastroenteritis, in children.

The parasites I am studying cause infectious diarrhoeal diseases, which are extremely common in infants and young children, especially those who are non-toilet-trained. They are very easily spread from person to person. Some children infected with these parasites have no symptoms at all, but are carriers for the diseases and can pass them on to other people. Studies from the eastern states of Australia, and several overseas countries, have shown that outbreaks of these infections in childcare centres are increasing.

There are two main objectives to my study:

1. To determine how common these parasites are in young children attending childcare centres in Western Australia, since no surveys of Western Australian childcare centres have yet been carried out. To achieve this objective, I would like to collect stool (faecal) samples at monthly intervals from the children (from nappies or potties) in your centre. Childcare centre directors and parents will be notified immediately in the event of a positive sample.

2. My second objective is to develop a health education programme for staff in childcare centres. The programme is intended to supplement the resources that are already available to childcare centres and reinforce present staff knowledge about how to avoid transmission of the parasites from one child to another.

At the completion of the study, the health education package will be given to each childcare centre participating in the study to keep for ongoing use. A summary of study findings will be sent to all the childcare centres involved in the study.
All data will remain confidential and will only be used for statistical purposes. No centres or individuals will be named in any report or be identifiable from reported information. Should you consent to the survey, you are free at any time to withdraw consent to further participation at any stage of the survey without prejudice in any way.

I feel sure that with the minimum interruption to the routine of your centre and the routine of the children attending, you would find participation in this study to be very beneficial to the wellbeing of your centre and children. I will telephone you in one week to discuss the study, and ask if you would be prepared to participate.

Thank you for your interest and your cooperation.
Yours sincerely

Jennifer Walters.
Consent form: childcare centre

I have read the information provided to me about the study and understand the procedures proposed. Any questions I may have had have been fully answered to my satisfaction.

I agree to the children (or parents/legal guardians) and staff at my childcare centre being asked if they will agree to participate in the study. Provided written permission is obtained from these people, I agree to my childcare centre being used in this study. I am aware that I may withdraw at any stage without prejudice.

I agree that research data gathered for the study may be published providing the names of the centre, staff, children and relatives, or other identifying information are not used.

NAME OF DIRECTOR AND CHILD CARE CENTRE (PLEASE PRINT)

-------------------------------------------
signature of participant

date -------------------

Jennifer Walters ph 08 97263043

-------------------------------------------
name and contact number of investigator
Appendix 2  Consent form for childcare centres to participate in the study

I have read the information provided to me about the study and understand the procedure proposed. Any questions I may have had have been fully answered to my satisfaction.

I agree to the children (or parents/legal guardians) and staff at my childcare centre being asked if they will agree to participate in the study. Provided written permission is obtained from these people, I agree to my childcare centre being used in this study. I am aware that I may withdraw at any stage without prejudice.

I agree that research data gathered for the study may be published providing the names of the centre, staff, children and relatives, or other identifying information are not used.

NAME OF DIRECTOR AND CHILDCARE CENTRE (PLEASE PRINT)

--------------------------------------------------------------------------------

signature of participant

--------------------------------------------------------------------------------

date ---------------------

Jennifer Walters ph 08 97263043

--------------------------------------------------------------------------------

name and contact number of investigator
Appendix 3  Letter of explanation and consent form for parents

Dear Parent/s

My name is Jennifer Walters and I am a Registered General Nurse, presently working at Murdoch University. I am studying the causes of diarrhoeal infection in children in childcare centres in Western Australia. The aims of the study are to find out how common these infections are in young children attending Western Australian childcare centres and to develop a programme to reduce the spread of diarrhoea in these children.

To achieve this, we would like to collect stool (faecal) samples from the children at your childcare centre. We will supply the centre with special jars, which will enable a small sample of faeces to be collected from a child’s nappy or potty when they use their bowels. This collection will be on a monthly basis for twelve months, and other than collecting the jars from the centre, we will have no contact with your child.

In the event of an outbreak of diarrhoea during the study, we would also like to collect samples from all those concerned so that we can test for and identify the cause of the diarrhoea. This testing would be provided as a free service to the parents and the centre.

We would also like to ask you to fill out a short questionnaire that will provide us with some basic information about your child. This information will be non-intrusive, and will relate to subjects such as your child’s age, history of diarrhoea in the past few weeks, whether they wear nappies etc. The questionnaire should only take about 10 minutes to complete and the information will be kept completely confidential at all times.

During the study we will develop a health education package for childcare centres to use which will teach staff about the causes of infectious diarrhoea in childcare centres and how to avoid the spread of infection from one child to another. At the completion of the study, the education package will be given to each childcare centre participating in the study to keep for ongoing use, and a summary of study findings will be sent to the centres involved in the study.

All data will remain confidential at all times and will only be used for statistical purposes. No centre or individuals will be named in any report or be identifiable from reported information. Faecal samples will be sent to the laboratory with an identification number only. The children’s names will be kept with these identification numbers in a locked file, for the sole purpose of being able to trace any positive sample. In this event, the parents of the child will be contacted immediately, advised of the test results and provided with advice on how to act. Once the sampling has ceased, all names will be completely destroyed.
If you are happy for your child to take part in this important study, please read and sign the consent form attached. This consent gives permission for us to collect faecal samples, but you are completely free to withdraw from the study at any time.

If you have any questions at all, please feel free to contact me on ph 08 97263043, or alternatively contact my advisor in this study, Associate Professor Ian Robertson at Murdoch University on 93602459.

Thank you for your interest and your cooperation.

Yours sincerely

Jennifer Walters.
Consent form for parents/guardians of children in the study

Consent form: PLEASE RETURN THIS TO YOR CHILDCARE CENTRE

*Please note that this is not a legally binding document and that you may withdraw from the study at any stage without pressure*

I, the parent/guardian of --------------------------- have read the information provided to me about the above study and understand the procedures proposed. Any questions I may have had have been fully answered to my satisfaction.

I am aware that I may withdraw my child from the study at any stage without prejudice. I agree that research data gathered for the study may be published providing my name, my child’s name or other identifying information is not used.

_________________________________________________________________________
NAME OF PARENT/GUARDIAN (PLEASE PRINT)
_________________________________________________________________________
signature of participant/parent/legal guardian

date:----------

Jennifer Walters ph 08 97263043
(name and contact number of investigator)
Appendix 4  Letter of explanation and consent form for childcare centre employees

Dear childcare employee,

My name is Jennifer Walters and I am a Registered General Nurse, with current registration with the Nurses’ Board of Western Australia. I am undertaking a PhD at Murdoch University, studying the causes of infectious diarrhoeal disease in children in childcare centres in Western Australia. The primary aim of the study is to develop a health education programme for use within childcare centres that would reduce the transmission of infections in children attending childcare centres.

I feel sure that with the minimum interruption to the routine of your work at the childcare centre and to the routine of the children attending, you would find participation in this study to be very beneficial to your work in childcare, as well as to the wellbeing of the centre and children attending.

There are two main objectives to my study:

1. The first is to find out how common diarrhoeal infections are in young children attending childcare centres in Western Australia. To achieve this, I would like to collect stool (faecal) samples at monthly intervals from the children at your childcare centre. We will supply the centre with special collection jars, which will enable a small sample of faeces to be easily collected from a child’s nappy or potty when they use their bowels. Disposable gloves, plastic bags and paper bags will also be supplied to ensure that the faeces can be collected quickly and easily. This collection would be on a monthly basis for twelve months, and other than collecting the jars from the centre, we will have no contact with the children.

We would also anticipate that in the event of an outbreak of diarrhoea during the study period, we would collect samples from all those concerned so that we can test for and identify the cause of the diarrhoea. This testing would be provided as a service to the centre and the parents of the children attending.

Finally, we would also like to ask you to fill out a short questionnaire that will provide us some basic information. This information will be non-intrusive, and will relate to subjects such as your qualifications and experience in childcare, knowledge of infectious diarrhoea, practices within the childcare centre etc. The questionnaire should only take about 10 minutes to complete and the information will be kept completely confidential at all times.

2. The second major aim of this study is to develop a health education package for childcare centres to use which will teach staff about the causes of infectious diarrhoea in childcare
centres and how to avoid the spread of infection from one child to another. This would have the effect of reducing gastrointestinal disease in children attending childcare centres.

At the completion of the study, the education package will be given to each childcare centre participating in the study to keep for ongoing use, and a summary of study findings will be sent to all the centres involved in the study.

All data will remain confidential at all times and will only be used for statistical purposes. No childcare centres or individuals will be named in any report or be identifiable from reported information. Faecal samples will be sent to the laboratory with an identification number only. Names will be kept with these identification numbers in a locked file, for the sole purpose of being able to trace any positive sample. In this event, the person or parent if it is a child’s sample, will be contacted immediately, advised of the test results and provided with advice on how to act. Once the sampling has ceased, all names will be completely destroyed.

If you are happy to take part in this important study, please read and sign the consent form attached. This consent gives permission for us to collect faecal samples from you as already discussed, but is not binding, so that at any time you are completely free to withdraw permission. No pressure will be brought to bear on you at any time to continue participation in the study.

If you have any questions at all, please feel free to contact me on ph 08 97263043 or alternatively contact my advisor in this study, Associate Professor Ian Robertson at Murdoch University on 93602459.

Thank you for your interest and your cooperation.

Yours sincerely

Jennifer Walters.
Consent form: childcare employees

I have read the information provided to me about the study and understand the procedures proposed. Any questions I may have had have been fully answered to my satisfaction.

I am aware that I may withdraw from the study at any stage without prejudice.

I agree that research data gathered for the study may be published providing the names of the centre, staff, childcare attendees or relatives, or other identifying information are not used.

----------------------------------------
NAME OF PARTICIPANT (PLEASE PRINT)

----------------------------------------
signature of participant

date --------------

Jennifer Walters ph 08 97263043
----------------------------------------
name and contact number of investigator
Appendix 5  Western Australian Community Services (Child Care) Regulations 1988: Regulation No. 30: Minimum staff requirements

Subject to regulations 28, 31, 32 and 34, the minimum number of staff members required to be present on childcare premises, other than premises specified in a licence or permit for family daycare and the minimum qualifications of those staff members, are as set out in the following table:

<table>
<thead>
<tr>
<th>Age of Children</th>
<th>Ratio Staff/Children</th>
<th>Child Numbers</th>
<th>Staff Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-2 years</td>
<td>1: 4</td>
<td>1- 4</td>
<td>A*/B*/C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5- 8</td>
<td>A*/B*/C +2D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9-12</td>
<td>A*/B*/C =2D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>A*/B*/C +2D</td>
</tr>
<tr>
<td>2-3 years</td>
<td>1: 5</td>
<td>1- 5</td>
<td>1D or 1 A/B/C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6-10</td>
<td>1D + 1 A/B/C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11-15</td>
<td>2D + 1 A/B/C</td>
</tr>
<tr>
<td>3-6 years</td>
<td>1:10</td>
<td>1-10</td>
<td>1D or 1 A/B/C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11-20</td>
<td>1D + 1 A/B/C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>21-30</td>
<td>2D + 1 A/B/C</td>
</tr>
</tbody>
</table>

A refers to the holder of a degree or diploma in early childhood care or early childhood education from a recognized Australian University or College of Advanced Education or overseas equivalent as determined by the Child Care Services Board;

A* refers to a holder of a qualification referred to in item A which includes a specialist course on the principles and practices of the care and education of children from birth to two years of age, in addition to a practicum of 100 hours (minimum) with this age group or overseas equivalent as determined by the Child Care Services Board;

B refers to a holder of a two year certificate in child care studies or associate diploma in child care or overseas equivalent as determined by the Child Care Services Board;

B* refers to the holder of a qualification referred to in item B which includes a specialist course on the principles and practices of the care and education of children from birth to two years of age in addition to a practicum of 100 hours (minimum) with this age group or overseas equivalent as determined by the Child Care Services Board;
C refers to a registered Mothercraft Nurse or holder of a mothercraft nursing qualification, or overseas equivalent as determined by the Child Care Services Board;

D refers to a worker without any of the above qualifications
Appendix 6  Pre-test questionnaire for childcare centre employees

SURVEY TO HELP PREVENT INFECTIONS IN CHILDREN WHO ATTEND CHILDCARE CENTRES

Thank you very much for taking the time to answer the questions in this questionnaire. It should only take around 10 minutes of your time to complete. All your answers will be completely confidential, seen only by myself.

You may erase your name written in pencil at the top of this page but please leave the code number intact as this is the only way I have to match up the answers from both of the questionnaires that you will complete.

Please answer **ALL** the questions to the best of your ability and do not compare answers with any other staff member, since this would provide me with false results.

When you have completed the questionnaire, please place it in the envelope provided, seal it and hand it to your director for me to collect.

Your assistance in answering this questionnaire will assist in the development of a health education programme for childcare centres, aimed at reducing the spread of common infections in young children. Once again, thank you very much for your cooperation.

Jennifer Walters  (ph 08 97263043)
Q1. There are many bugs/germs that cause infectious diarrhoea in children in childcare centres. Please list the ones that you know of.

_________________________________________________

_________________________________________________

_________________________________________________

_________________________________________________

Q2. How do you think these bugs/germs are usually caught or passed on to others?

_________________________________________________

_________________________________________________

_________________________________________________

_________________________________________________

Q3. A person who has one of these bugs is only infectious (can only pass on the infection) while they actually have diarrhoea:

*(please tick ONLY ONE box)*

☐ yes
☐ no
☐ not sure
Q4. Which of the following do you believe to be THE MOST IMPORTANT FACTORS that aid in the spread of bugs/germs causing diarrhoea in children?

(you may tick more than one box)

- contaminated food
- contaminated water
- young children sharing toys
- coughing and sneezing near people
- not washing hands thoroughly with soap after toileting and before meals
- the presence of young children (0-6yrs)
- non-toilet-trained children
- non-immunised children
- owning pets
- playing with pets
- unwormed pets
- other (please specify) ____________________________
- not sure

Q5. When washing your hands at your childcare centre, what type of soap is it best to use to remove most of the germs?

(please tick ONLY ONE box)

- disinfectant-type soap: solid bar
- disinfectant-type soap: liquid
- normal household solid bar soap
- normal household liquid soap
- other (please specify)
- not sure
Q6. **What kind of soap is available to wash your hands at this childcare centre?**

*(please tick all the appropriate boxes)*

- disinfectant-type soap—solid bar
- disinfectant-type soap—liquid
- normal household soap—solid bar soap
- normal household soap—liquid soap
- other (please specify)
- not sure

Q6. **When washing hands in the childcare centre, which of the following is it best to use?**

*(please tick ONLY ONE box)*

- cold running water
- a bowl of fresh warm water
- warm running water
- any of these
- other (please specify)
- not sure

Q7. **What is the minimum time needed to wash your hands to remove most of the bugs/germs? (This time includes washing and rinsing)**

*(please tick ONLY ONE box)*

- Less than 10 seconds
- 10-19 seconds
- 20 seconds
- 21-30 seconds
- 31-40 seconds
- 41-50 seconds
- 51-60 seconds
- More than 60 seconds
- not sure
Q8. How long do you usually take to wash your hands while working at this childcare centre?

(try counting the seconds next time you wash your hands and please be honest)

☐ Less than 10 seconds
☐ 10-19 seconds
☐ 20 seconds
☐ 21-30 seconds
☐ 31-40 seconds
☐ 41-50 seconds
☐ 51-60 seconds
☐ More than 60 seconds
☐ not sure

Q9. Please list the times when you feel it is important to wash your hands while working at this childcare centre:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Q10. Please list the times when you feel it is important to wash the hands of children while at this childcare centre:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
Q11. How often do you prepare food and/or feed children in this childcare centre?

(please tick ONLY ONE box)

- every day
- 4 days per week
- 3 days per week
- 2 days per week
- once per week
- never
- Other (please specify)

Q12. How often do you toilet children in this childcare centre (ie: take children to the toilet and assist them or place children on a potty)?

(please tick ONLY ONE box)

- every day
- 4 days per week
- 3 days per week
- 2 days per week
- once per week
- never
- Other (please specify)

Q13. How often do you change nappies on infants in this childcare centre?

(please tick ONLY ONE box)

- every day
- 4 days per week
- 3 days per week
- 2 days per week
- once per week
- never
- Other (please specify)
Q14. While at work at this childcare centre, how often do you feed children/prepare food AND change nappies/toilet children ON THE SAME DAY?

(please tick ONLY ONE box)

☐ every day
☐ 4 days per week
☐ 3 days per week
☐ 2 days per week
☐ once per week
☐ never
☐ Other (please specify) ____________________________
Q15. **During your childcare training course** (if you attended one) did you receive any information about the following?

If you answer yes to any of these, please tick the appropriate box to indicate in which format the information was presented *(you may tick more than one format)*

**FOR EXAMPLE:**

<table>
<thead>
<tr>
<th>a) handwashing</th>
<th>type of format</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes</td>
<td>verbal</td>
</tr>
<tr>
<td>no</td>
<td>written (pamphlets/handouts)</td>
</tr>
<tr>
<td>don’t remember</td>
<td>written (booklets/handbooks)</td>
</tr>
<tr>
<td></td>
<td>video</td>
</tr>
<tr>
<td></td>
<td>demonstration by staff</td>
</tr>
<tr>
<td></td>
<td>other (please specify)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>a) handwashing</th>
<th>type of format</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes</td>
<td>verbal</td>
</tr>
<tr>
<td>no</td>
<td>written (pamphlets/handouts)</td>
</tr>
<tr>
<td>don’t remember</td>
<td>written (booklets/handbooks)</td>
</tr>
<tr>
<td></td>
<td>video</td>
</tr>
<tr>
<td></td>
<td>demonstration by staff</td>
</tr>
<tr>
<td></td>
<td>other (please specify)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>b) preparing food</th>
<th>type of format</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes</td>
<td>verbal</td>
</tr>
<tr>
<td>no</td>
<td>written (pamphlets/handouts)</td>
</tr>
<tr>
<td>don’t remember</td>
<td>written (booklets/handbooks)</td>
</tr>
<tr>
<td></td>
<td>video</td>
</tr>
<tr>
<td></td>
<td>demonstration by staff</td>
</tr>
<tr>
<td></td>
<td>other (please specify)</td>
</tr>
</tbody>
</table>

187
c) what to do for a child with diarrhoea

<table>
<thead>
<tr>
<th>Yes</th>
<th>verbal</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>written (pamphlets/handouts)</td>
</tr>
<tr>
<td>Don’t remember</td>
<td>written (booklets/handbooks)</td>
</tr>
<tr>
<td></td>
<td>video</td>
</tr>
<tr>
<td></td>
<td>demonstration by staff</td>
</tr>
<tr>
<td></td>
<td>other (please specify)</td>
</tr>
</tbody>
</table>

Q16. **During your employment at this childcare centre**, have you received any information about the following?

If you answer yes to any of these, please tick the appropriate box to indicate in which format the information was presented *(you may tick more than one format)*

<table>
<thead>
<tr>
<th>a) handwashing</th>
<th>type of format</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>verbal</td>
</tr>
<tr>
<td>No</td>
<td>written (pamphlets/handouts)</td>
</tr>
<tr>
<td>Don’t remember</td>
<td>written (booklets/handbooks)</td>
</tr>
<tr>
<td></td>
<td>video</td>
</tr>
<tr>
<td></td>
<td>demonstration by staff</td>
</tr>
<tr>
<td></td>
<td>other (please specify)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>b) preparing food</th>
<th>type of format</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>verbal</td>
</tr>
<tr>
<td>No</td>
<td>written (pamphlets/handouts)</td>
</tr>
<tr>
<td>Don’t remember</td>
<td>written (booklets/handbooks)</td>
</tr>
<tr>
<td></td>
<td>video</td>
</tr>
<tr>
<td></td>
<td>demonstration by staff</td>
</tr>
<tr>
<td></td>
<td>other (please specify)</td>
</tr>
</tbody>
</table>
c) what to do
for a child with
diarrhoea

☐ yes  ☐ verbal
☐ no   ☐ written (pamphlets/handouts)
☐ don’t remember  ☐ written (booklets/handbooks)
                      ☐ video
                      ☐ demonstration by staff
                      ☐ other (please specify)____________________

For the following questions, where boxes are provided, please tick or put the appropriate number in the box. Unless otherwise requested, please tick or number ONLY ONE BOX.

Q17. What age are you?

☐ ☐ years

Q18. Are you male or female
(Please tick the relevant box)

☐ M
☐ F

Q19. How long have you been working as a childcare worker

☐ ☐ years  ☐ ☐ months
Q20. Please indicate which qualifications you have (you may tick more than one box):

- [ ] degree in early childhood care or early childhood education
- [ ] diploma in early childhood care or early childhood education
- [ ] certificate in child care studies
- [ ] associate diploma in child care
- [ ] registered Mothercraft Nurse
- [ ] registered General Nurse
- [ ] Enrolled Nurse
- [ ] other nursing qualifications (please specify) ____________________________
- [ ] other teaching qualifications (please specify) ____________________________
- [ ] none of the above
- [ ] other (please specify) ________________________________________________

Q21. How long have you been employed at your current childcare centre?

[ ] [ ]

years months

Q22. How many hours per week do you usually work at your current childcare centre?

[ ]

hours per week

Q23. Do you have children of your own? (please tick the appropriate boxes)

- [ ] pre-school
- [ ] school-aged
- [ ] post-school-aged

This is the end of the questionnaire. Thank you very much for taking the time to answer all the questions. Your responses will be very helpful in developing measures to prevent the spread of some diseases to children both within and outside of childcare centres.
Appendix 7  Post-test questionnaire for childcare centre employees

SURVEY TO HELP PREVENT INFECTIONS IN CHILDREN WHO ATTEND CHILDCARE CENTRES

Thank you very much for taking the time to answer the questions in this questionnaire. This second questionnaire is shorter than the first one and should only take about 5-10 minutes of your time to complete.

Please answer **ALL** the questions to the best of your ability. All your answers will be completely confidential, seen only by myself.

You may erase your name written in pencil at the top of this page but please leave the code number intact as this is the only way I have to match up the answers from both of the questionnaires that you will complete.

Please complete the questionnaire by yourself and do not compare answers with any other staff member, since this would provide me with false results.

There is an attachment at the end for you to make comments on the health education package “The Supersoap Bag” which you have used over the last two weeks. I would be very grateful if you could complete this section, since it will provide me with valuable feedback on how well this package really works, and where it needs improvement.

When you have completed the questionnaire, please place it in the envelope provided, seal it and hand it to your director for me to collect.

Once again, thank you very much for your cooperation.

Jennifer Walters  (ph 08 97263043)
Q1. There are many bugs/germs that cause infectious diarrhoea in children in childcare centres. Please list the ones that you know of.

____________________________________________________
____________________________________________________
____________________________________________________
____________________________________________________
____________________________________________________

Q2. How do you think these bugs/germs are usually caught or passed on to others?

____________________________________________________
____________________________________________________
____________________________________________________
____________________________________________________
____________________________________________________

Q3. A person who has one of these bugs is only infectious (can only pass on the infection) while they actually have diarrhoea:

(please tick ONLY ONE box)

☐ yes
☐ no
☐ not sure
Q4. Which of the following do you believe to be THE MOST IMPORTANT FACTORS that aid in the spread of bugs/germs causing diarrhoea in children?

(you may tick more than one box)

- contaminated food
- contaminated water
- young children sharing toys
- coughing and sneezing near people
- not washing hands thoroughly with soap after toileting and before meals
- the presence of young children (0-6yrs)
- non-toilet-trained children
- non-immunised children
- owning pets
- playing with pets
- unwormed pets
- other (please specify) ________________________________
- not sure

Q5. When washing your hands at your childcare centre, what type of soap is it best to use to remove most of the germs?

(please tick ONLY ONE box)

- disinfectant-type soap:solid bar
- disinfectant-type soap:liquid
- normal household solid bar soap
- normal household liquid soap
- other (please specify)
- not sure
Q6. What kind of soap is available to wash your hands at this childcare centre?

*(please tick all the appropriate boxes)*

- disinfectant-type soap: solid bar
- disinfectant-type soap: liquid
- normal household solid bar soap
- normal household liquid soap
- other (please specify)
- not sure

Q7. When washing hands in the childcare centre, which of the following is it best to use?

*(please tick ONLY ONE box)*

- cold running water
- a bowl of fresh warm water
- warm running water
- any of these
- other (please specify)
- not sure

Q8. What is the minimum time needed to wash your hands to remove most of the bugs/germs? (This time includes washing and rinsing)

*(please tick ONLY ONE box)*

- Less than 10 seconds
- 10-19 seconds
- 20 seconds
- 21-30 seconds
- 31-40 seconds
- 41-50 seconds
- 51-60 seconds
- More than 60 seconds
- not sure
Q9. How long do you usually take to wash your hands while working at this childcare centre?

(try counting the seconds next time you wash your hands and please be honest)

- Less than 10 seconds
- 10-19 seconds
- 20 seconds
- 21-30 seconds
- 31-40 seconds
- 41-50 seconds
- 51-60 seconds
- More than 60 seconds
- not sure

Q10. Please list the times when you feel it is important to wash your hands while working at this childcare centre:

_________________________________________________________________
_________________________________________________________________
_________________________________________________________________

Q11. Please list the times when you feel it is important to wash the hands of children while at this childcare centre:

_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
Q12. How often do you prepare food and/or feed children in this childcare centre?

(please tick ONLY ONE box)

☐ every day
☐ 4 days per week
☐ 3 days per week
☐ 2 days per week
☐ once per week
☐ never
☐ Other (please specify)

Q13. How often do you toilet children in this childcare centre (ie: take children to the toilet and assist them or place children on a potty)?

(please tick ONLY ONE box)

☐ every day
☐ 4 days per week
☐ 3 days per week
☐ 2 days per week
☐ once per week
☐ never
☐ Other (please specify)

Q14. How often do you change nappies on infants in this childcare centre?

(please tick ONLY ONE box)

☐ every day
☐ 4 days per week
☐ 3 days per week
☐ 2 days per week
☐ once per week
☐ never
☐ Other (please specify)
Q15. While at work at this childcare centre, how often do you feed children/prepare food AND change nappies/toilet children ON THE SAME DAY?

*(please tick ONLY ONE box)*

- every day
- 4 days per week
- 3 days per week
- 2 days per week
- once per week
- never
- Other (please specify)

This is the end of the questionnaire. Thank you very much for taking the time to answer all the questions. Your responses will be very helpful in developing measures to prevent the spread of some diseases to children both within and outside of, childcare centres.
Appendix 8  Questionnaire completed by parents of all children in the study

SURVEY TO HELP PREVENT INFECTIONS IN CHILDREN WHO ATTEND CHILDCARE CENTRES

<table>
<thead>
<tr>
<th>ID</th>
</tr>
</thead>
</table>

Please write today’s date:  
What is the first name of your child(ren) attending this childcare centre  
What is your relationship to the child(ren)

Thank you very much for giving up your time and allowing me to ask you some questions about your child(ren).
Your answers to this questionnaire will assist in the development of a health education programme for childcare centres aimed at reducing the spread of infections in young children attending these centres.

You will find some questions relating to travel, farm visits and pet ownership. The questions have been included because all of these have been implicated in the spread of some infections in humans.

This questionnaire should only take approximately 10-15 minutes to complete. If you have any difficulties with any of the questions, please do not hesitate to call one of the numbers below.

Thank you once again for your help.

Jennifer Walters (ph 08 97263043)

OR: Associate Professor Ian Robertson (08 93602459)
at Murdoch University
Q1. Please complete the following table for all children you have attending this childcare centre

<table>
<thead>
<tr>
<th></th>
<th>child 1</th>
<th>child 2</th>
<th>child 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>First name of child</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (years/months) of child</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex (M/F) of child</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How long has he/she attended this centre</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At what age did he/she first attend daycare</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Q2. Was your child(ren) born in Western Australia? (Please tick the appropriate boxes)

<table>
<thead>
<tr>
<th></th>
<th>child 1</th>
<th>child 2</th>
<th>child 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>no</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Q3. If not, please write in which state or country he/she was born

<table>
<thead>
<tr>
<th>state or country of birth</th>
<th>child 1</th>
<th>child 2</th>
<th>child 3</th>
</tr>
</thead>
</table>

Q4. Does your child(ren) have any other form of childcare other than this childcare centre?

- [ ] yes (please go to Q5)
- [ ] no (please go to Q6)
Q5. Please indicate what other form of childcare your child(ren) has other than this childcare centre
(please tick which boxes apply)

<table>
<thead>
<tr>
<th></th>
<th>child 1</th>
<th>child 2</th>
<th>child 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>another childcare centre</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>private babysitter/nanny in my home</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>private babysitter in babysitter’s/nanny’s home</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>grandparent</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>other relative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>other (please specify)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Q6. How many persons currently live in your household?
(please write the number of adults and children in the appropriate box)

adults
children (under 15 years of age)

Q7. What is the occupation of the major income-earner in your household?

Q8. Does your child have any brothers or sisters who are not at this centre?

yes (please go to Q9)
no (please go to Q10)
Q9. Please complete the following table:

<table>
<thead>
<tr>
<th>Age of brother or sister (yrs/mths)</th>
<th>brother/sister 1</th>
<th>brother/sister 2</th>
<th>brother/sister 3</th>
<th>brother/sister 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex of brother or sister (M/F)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Q10. Please complete below, the days and times your child(ren) usually attends this childcare centre.

(Place a tick in the box beside each day your child attends and write the hours for each day on the line beside each day)

For example:

<table>
<thead>
<tr>
<th>Hours each day (eg 8am-5pm)</th>
<th>child 1</th>
<th>child 2</th>
<th>child 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>8am-12pm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tuesday</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wednesday</td>
<td>8am-12pm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thursday</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Friday</td>
<td>8am-2pm</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hours each day (eg 8am-5pm)

<table>
<thead>
<tr>
<th>child 1</th>
<th>child 2</th>
<th>child 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tuesday</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wednesday</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thursday</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Friday</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Q11. Why did you choose this childcare centre for your child(ren)?

(You may choose more than one answer; if so, please rank them in order of importance for you: ie 1 for the most important reason, 2 for the next most important etc)

- close to home
- close to where mother works
- close to where father works
- close to where partner works
- it appeared to have the best facilities
- it was the most affordable centre I/we could find
- I/we liked the philosophy of the centre
- it has longer and more flexible opening times
- recommended to me/us by another person
- other (please specify)

Q12. Please complete the following table regarding toileting of any children you have attending this childcare centre (please place a tick in the relevant boxes)

<table>
<thead>
<tr>
<th></th>
<th>child 1</th>
<th>child 2</th>
<th>child 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>wears a nappy 24hrs per day</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>wears a nappy only at night &amp; for day naps</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>uses a potty sometimes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>uses a toilet with assistance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>uses a toilet without assistance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>other (please specify)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Q13. If your child(ren) still wears nappies, what kind of nappies do they wear?
(Please tick only one box)

- [ ] only disposable
- [ ] disposable sometimes, cloth sometimes
- [ ] only cloth
- [ ] other (please specify) ________________________________

Q14. Has your child(ren) suffered from any of the following in the past month?
(please tick the appropriate boxes)

<table>
<thead>
<tr>
<th></th>
<th>child 1</th>
<th>child 2</th>
<th>child 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diarrhoea</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abdominal pains or cramps</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any change in stool colour or odour</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any change in stool frequency</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Q15. Have you or any of your family suffered from any of the following in the past month?
(please state which family member, eg mother, brother etc)

<table>
<thead>
<tr>
<th></th>
<th>family member</th>
<th>family member</th>
<th>family member</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diarrhoea</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abdominal pains or cramps</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any change in stool colour or odour</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any change in stool frequency</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Q16. Has your child taken any medication other than paracetamol or asthma inhalers in the past month?

☐ yes (please go to Q17)
☐ no (please go to Q18)
☐ can’t remember (please go to Q18)

Q17. Please state which medication and why it was taken

________________________________________________________________________

Q18. If your child is ill and unable to attend childcare, what other arrangements are you able to make?
(please tick the relevant boxes)

☐ mother stays home to care for the child
☐ father stays home to care for the child
☐ partner stays home to care for the child
☐ other family member cares for the child (please specify) _______________________
☐ other arrangements (please specify) ____________________________

Q19. Has your child(ren) visited a farm in the past month?
(Please tick only one box)

☐ yes (please go to Q20)
☐ no (please go to Q21)
☐ can’t remember (please go to Q21)

Q20. Please state the type of farm and when visited (eg 2 days ago; 2 weeks ago):

<table>
<thead>
<tr>
<th>type of farm</th>
<th>When visited</th>
</tr>
</thead>
<tbody>
<tr>
<td>dairy farm</td>
<td></td>
</tr>
<tr>
<td>beef cattle</td>
<td></td>
</tr>
<tr>
<td>sheep farm</td>
<td></td>
</tr>
<tr>
<td>wheat/grain farm</td>
<td></td>
</tr>
<tr>
<td>mixed farm (please specify)</td>
<td></td>
</tr>
<tr>
<td>other (please specify)</td>
<td></td>
</tr>
</tbody>
</table>
Q21. Has your child(ren) travelled overseas in the last month?

☐ yes
☐ no

If yes, please state where to, and when the travel occurred

____________________________________________________________________________________

Q22. Has anyone in your household travelled overseas in the last month?

☐ yes
☐ no

If yes, please state who travelled (eg mother, grandfather, brother), where to, and when the travel occurred

<table>
<thead>
<tr>
<th>person who travelled</th>
<th>where they travelled to</th>
<th>when they travelled</th>
</tr>
</thead>
</table>

Q23. Do you have any pets or other domestic animals (such as chickens) at home?

☐ yes (please go to Q24)
☐ no (please go to Q34)
Q24. Please indicate in the table below the number of pets and animals you have. Please indicate the type of contact your child(ren) (those attending the childcare centre) has with any of the pets by writing yes or no in the appropriate boxes.

For example:

<table>
<thead>
<tr>
<th></th>
<th>dog</th>
<th>cat</th>
<th>budgie/cage bird</th>
<th>rabbit</th>
<th>guinea pig</th>
<th>other - please specify</th>
<th>other - please specify</th>
</tr>
</thead>
<tbody>
<tr>
<td>number of each pet</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>pet allowed inside house (for at least part of each day)</td>
<td>no</td>
<td>yes</td>
<td>yes - in cage</td>
<td>no</td>
<td>no</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>child has physical contact with pet (eg cuddling or patting)</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>child assists with cleaning pets bedding area</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>child assists with cleaning pets toileting area</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please complete this table

<table>
<thead>
<tr>
<th></th>
<th>dog</th>
<th>cat</th>
<th>budgie/cage bird</th>
<th>rabbit</th>
<th>guinea pig</th>
<th>other</th>
<th>other</th>
</tr>
</thead>
<tbody>
<tr>
<td>number of each pet</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pet allowed inside house (for at least part of each day)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>child has physical contact with pet (eg cuddling or patting)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>child assists with cleaning pets bedding area</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>child assists with cleaning pets toileting area</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
If you own a dog, please answer the following questions. If not, please go to Q28

Q25. Please complete the following table to provide information about your dog(s) and circle either yes, no or don’t know where appropriate:

For example

<table>
<thead>
<tr>
<th></th>
<th>dog 1</th>
<th>dog 2</th>
<th>dog 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>sex of dog</td>
<td>M</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>age of dog</td>
<td>6 years</td>
<td>2 years</td>
<td></td>
</tr>
<tr>
<td>has your dog had diarrhoea in the past 2 weeks</td>
<td>yes</td>
<td>no</td>
<td>don’t know</td>
</tr>
<tr>
<td>has your dog shown any other signs of illness in the past 2 weeks (please specify)</td>
<td>yes</td>
<td>no</td>
<td>don’t know</td>
</tr>
<tr>
<td></td>
<td></td>
<td>loss of appetite</td>
<td></td>
</tr>
</tbody>
</table>

Please complete this table:

<table>
<thead>
<tr>
<th></th>
<th>dog 1</th>
<th>dog 2</th>
<th>dog 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>sex of dog</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>age of dog</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>has your dog had diarrhoea in the past 2 weeks</td>
<td>yes</td>
<td>no</td>
<td>don’t know</td>
</tr>
<tr>
<td>has your dog shown any other signs of illness in the past 2 weeks (please specify)</td>
<td>yes</td>
<td>no</td>
<td>don’t know</td>
</tr>
</tbody>
</table>

Q26. When at home, where does your dog usually defecate?
(You may tick more than one box)

- [ ] grass/lawn
- [ ] garden bed
- [ ] indoor litter tray
- [ ] not sure
- [ ] other (please specify)______________________________________

Q27. How often do you remove and dispose of the faeces?
(Please tick only one box)

- [ ] daily
- [ ] 4 days per week

207
If you own a cat, please answer the following questions. If not, please go to Q31

Q28. Please complete the following table to provide information about your cat(s) and circle either yes, no or don’t know where appropriate:

<table>
<thead>
<tr>
<th>sex of cat</th>
<th>cat 1</th>
<th>cat 2</th>
<th>cat 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>age of cat</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>has your cat had diarrhoea in the past 2 weeks</th>
<th>yes</th>
<th>no</th>
<th>don’t know</th>
<th>yes</th>
<th>no</th>
<th>don’t know</th>
<th>yes</th>
<th>no</th>
<th>don’t know</th>
</tr>
</thead>
<tbody>
<tr>
<td>has your cat shown any other signs of illness in the past 2 weeks (please specify)</td>
<td>yes</td>
<td>no</td>
<td>don’t know</td>
<td>yes</td>
<td>no</td>
<td>don’t know</td>
<td>yes</td>
<td>no</td>
<td>don’t know</td>
</tr>
</tbody>
</table>

Q29. When at home, where does your cat usually defecate? (You may tick more than one box)

- [ ] grass/lawn
- [ ] garden bed
- [ ] indoor litter tray
- [ ] not sure
- [ ] other (please specify) ________________________________________________________________
Q30. How often do you remove and dispose of the faeces?  
(Please tick only one box)

- daily
- 4 days per week
- 3 days per week
- twice per week
- once per week
- once per fortnight
- never
- can’t remember
- not necessary- cat buries it
- other (please specify)

---

If you own any other pets, please answer the following questions. If not, please go to Q34

Q31. Please complete the following table to provide information about your pet(s) other than dogs or cats and circle either yes, no or don't know where appropriate:

<table>
<thead>
<tr>
<th></th>
<th>pet 1</th>
<th>pet 2</th>
<th>pet 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>sex of pet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>age of pet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>has your pet had diarrhoea in the past 2 weeks</td>
<td>yes</td>
<td>no</td>
<td>don't know</td>
</tr>
<tr>
<td></td>
<td>yes</td>
<td>no</td>
<td>don't know</td>
</tr>
<tr>
<td>has your pet shown any other signs of illness in the past 2 weeks (please specify)</td>
<td>yes</td>
<td>no</td>
<td>don't know</td>
</tr>
<tr>
<td></td>
<td>yes</td>
<td>no</td>
<td>don't know</td>
</tr>
</tbody>
</table>

Q32. When at home, where does your pet usually defecate?  
(You may tick more than one box)

- grass/lawn
- garden bed
- indoor litter tray
- not sure
- other (please specify)
Q33. How often do you remove and dispose of the faeces?
(Please tick only one box)

☐ daily
☐ 4 days per week
☐ 3 days per week
☐ twice per week
☐ once per week
☐ once per fortnight
☐ never
☐ can’t remember
☐ other (please specify) __________________________________________

For Q34-38, please tick the box which BEST answers each question for you.

Q34. Have you heard of *Giardia*? (before this study)
(Please tick only one box)

☐ yes
☐ no
☐ not sure

Q35. Have you heard of *Cryptosporidium*? (before this study)
(Please tick only one box)

☐ yes
☐ no
☐ not sure
Q36. Do you know what these parasites cause in humans? (Please tick only one box for each question)

Giardia  
☐ yes  ☐ no  ☐ not sure

Cryptosporidium  
☐ yes  ☐ no  ☐ not sure

Q37. If yes, what do you think they cause? (Please write in your own words on the lines provided)

Giardia  
________________________________________________________

Cryptosporidium  
________________________________________________________

Q38. Do you know how they are spread? (Please tick only one box for each question)

Giardia  
☐ yes  ☐ no  ☐ not sure

Cryptosporidium  
☐ yes  ☐ no  ☐ not sure

Q39. If yes, please state how you think they are spread (Please write in your own words on the lines provided)

Giardia  
________________________________________________________

Cryptosporidium  
________________________________________________________
Q40. If you answered yes to any of the above questions about *Giardia* and *Cryptosporidium*, please state where you received your information:

- at primary school
- at secondary school
- from a tertiary institution (eg TAFE, university)
- from television
- from radio
- from newspapers or magazines
- from books
- other (please specify)
- leaflets or brochures (please state where from eg from G.P.; Community Health Nurse etc)

This is the end of the questionnaire. Thank you very much for taking the time to answer all the questions. Your responses will be very helpful in developing measures to prevent the spread of some diseases to children both within and outside of childcare centres.
Appendix 9  Short version of questionnaire completed by parents of all children in the study

<table>
<thead>
<tr>
<th>ID</th>
</tr>
</thead>
</table>

SURVEY TO HELP PREVENT INFECTIONS IN CHILDREN WHO ATTEND CHILDCARE CENTRES

<table>
<thead>
<tr>
<th>Please write today’s date:</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is the first name of your child(ren) attending this childcare centre</td>
</tr>
<tr>
<td>What is your relationship to the child(ren)</td>
</tr>
</tbody>
</table>

This short version of the earlier questionnaire is to keep us up to date with any potential contact your child may have had with infection in the past month. By completing this, you may be able to assist us in tracing the source any infections that occur.

Please return this to your childcare centre as soon as you have completed it.

Thank you once again for your help.

Jennifer Walters (ph 08 97263043)

OR: Associate Professor Ian Robertson (08 93602459) at Murdoch University
Q1. Please complete the following table for all children you have attending this childcare centre

<table>
<thead>
<tr>
<th></th>
<th>child 1</th>
<th>child 2</th>
<th>child 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>First name of child</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Q2. How many persons currently live in your household? (please write the number of adults and children in the appropriate box)

- adults
- children (under 15 years of age)

Q3. Please complete the following table regarding toileting of any children you have attending this childcare centre (please place a tick in the relevant boxes)

<table>
<thead>
<tr>
<th></th>
<th>child 1</th>
<th>child 2</th>
<th>child 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>wears a nappy 24hrs per day</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>wears a nappy only at night &amp; for day naps</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>uses a potty sometimes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>uses a toilet with assistance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>uses a toilet without assistance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>other (please specify)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Q4. Has your child taken any medication other than paracetamol or asthma inhalers in the past month?

- yes (please go to Q17)
- no (please go to Q18)
- can’t remember (please go to Q18)
Q5. Please state which medication and why it was taken

Q6. Has your child(ren) suffered from any of the following in the past month?
(please tick the appropriate boxes)

<table>
<thead>
<tr>
<th></th>
<th>child 1</th>
<th>child 2</th>
<th>child 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diarrhoea</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abdominal pains or cramps</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any change in stool colour or odour</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any change in stool frequency</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Q7. Have you or any of your family suffered from any of the following in the past month?
(please state which family member, eg mother, brother etc)

<table>
<thead>
<tr>
<th></th>
<th>family member</th>
<th>family member</th>
<th>family member</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diarrhoea</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abdominal pains or cramps</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any change in stool colour or odour</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any change in stool frequency</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Q19. Has your child(ren) visited a farm in the past month?
(Please tick only one box)

☐ yes (please go to Q9)
☐ no (please go to Q10)
☐ can’t remember (please go to Q10)
Q9. Please state the type of farm and when visited (eg 2 days ago; 2 weeks ago):

<table>
<thead>
<tr>
<th>type of farm</th>
<th>When visited</th>
</tr>
</thead>
<tbody>
<tr>
<td>dairy farm</td>
<td></td>
</tr>
<tr>
<td>beef cattle</td>
<td></td>
</tr>
<tr>
<td>sheep farm</td>
<td></td>
</tr>
<tr>
<td>wheat/grain farm</td>
<td></td>
</tr>
<tr>
<td>mixed farm (please specify)</td>
<td></td>
</tr>
<tr>
<td>other (please specify)</td>
<td></td>
</tr>
</tbody>
</table>

Q10. Has your child(ren) travelled overseas in the last month?

☐ yes
☐ no

If yes, please state where to, and when the travel occurred

Q11. Has anyone in your household travelled overseas in the last month?

☐ yes
☐ no

If yes, please state who travelled (eg mother, grandfather, brother), where to, and when the travel occurred

<table>
<thead>
<tr>
<th>person who travelled</th>
<th>where they travelled to</th>
<th>when they travelled</th>
</tr>
</thead>
</table>

This is the end of the questionnaire. Thank you very much for taking the time to answer all the questions. Your responses will be very helpful in developing measures to prevent the spread of some diseases to children both within and outside of, childcare centres.
Appendix 10  Procedure for the microscopic examination of *Giardia* using the Zinc Flotation Method

1. Place faeces into a 10ml centrifuge tube using an applicator stick, up to the 1.5-2ml mark

2. Fill centrifuge tube up to the 10ml mark with distilled water.

3. Emulsify faeces with an applicator stick and centrifuge at 2000rpm for five minutes.

4. Pour off supernatant (infectious material supernatant must be poured into a waste container in a fume hood and not down the sink)

5. Refill the tube to the 10ml mark with zinc sulphate (ZnSO4) and remix. Centrifuge at 2000rpm for five minutes.

6. Heat wire loop and allow to cool. Transfer 2-3 loops from the surface of the centrifuge tube to a slide and add a cover slip. Reheat wire loop to sterilise.

7. Scan slide at 100x, and scan a small area at 400x.
Appendix 11  Procedure for the Malachite Green Stain for the detection of Cryptosporidium

1. Place faeces into a 10ml centrifuge tube up to the 1.5-2ml mark using an applicator stick.
2. Fill centrifuge tube up to the 10ml mark with distilled water.
3. Mix faeces using an applicator stick, and centrifuge at 2000rpm for five minutes.
4. Pour off supernatant
5. Using an applicator stick place a small drop of 5% malachite green stain onto a slide (2-5μL)
6. Using a plastic disposable pipette, take a small sample from the faecal plug (15-20μL) add it to the malachite green and mix together with the end of the pipette.
7. Cover with a 22x40 coverslip and scan at 400x.

Note: Malachite Green Stain= 5% weight volume Malachite Green in distilled water unfiltered.
Appendix 12  Letter to health professional re validity testing of questionnaires

Dear

Thank you very much for agreeing to look at these questionnaires for me. There are two questionnaires:

1. This is for the childcare employees and is the most important in terms of evaluating the education intervention. I have had difficulty in getting a balance between a questionnaire that is not too long and involved, but still asks questions that will sufficiently evaluate the intervention. I would appreciate any suggestions to improve this questionnaire. The health education programme will focus on using hygiene measures to prevent transmission of the parasites, primarily handwashing and care with both toileting and food preparation. It will include some basic information on the parasites and their transmission.

2. The next one is for parents of children who will be taking part in continuous surveillance. The families and pets of these children may also be sampled. The information required here is demographic data, any history which might have led to exposure to the parasites and some idea of the parent’s awareness of the parasites and their transmission.

Please consider the following while you are reading these questionnaires:

- are any questions unsuitable or worded badly
- should the overall format could be changed or improved
- are there any problems with clarity, for example, are the questions open to interpretation, and is the terminology appropriate
- are there other questions that should have been included
- will these questionnaires provide the information required

If there is anything else you need to know, please don’t hesitate to contact me either by email (jenalan@bigpond.com) or by phone at home: 08 97263043 or at Murdoch University: 08 97806291.

Thank you again.

Yours truly

Jennifer Walters
Appendix 13  Survey to determine perceived needs of childcare centres with regard to infection control

To the Director

My name is Jennifer Walters and I am currently undertaking a PhD at Murdoch University. As part of my project I am developing a health education package for childcare centres, aimed at reducing the transmission of infectious diarrhoea in children.

I would like to try to ensure that this package will be of genuine value to childcare centres and will both contain relevant information, and be delivered in a format that is “useable”. I am hoping to include material aimed at adult carers, but also material which can be used with children, so that the health message can be delivered to both the children and their carers.

With this in mind, I am writing to a number of centres in Western Australia to ask directors and staff working in these centres for their input and advice on what should and should not be included. The information I am seeking, is:

- What is already available to childcare centres in Western Australia?
- What information would you like to see included?
- What kind of format would you find most user-friendly (ie what would you be most likely to use)?
- What kind of format is most appropriate for use with children?

I realise that you are very busy, but I would really appreciate any advice you and your staff can provide, since I feel that a health education package that is developed in collaboration with those who may actually be using it, is much preferable to one that is developed with no input at all from those who may use it.

I have enclosed a brief survey form and would be very grateful if you could find the time to complete this for me and return it in the stamped-addressed envelope provided. I would appreciate return of the form, whether or not you have time to complete it.
Thank you very much for your time and cooperation.

Yours sincerely
Jennifer Walters
Survey to Determine the Health Education Needs of Childcare Centres in Western Australia with Regard to Preventing the Transmission of Diarrhoea and Gastroenteritis in Children

1. In a health education package aimed at preventing the transmission of gastroenteritis in children attending childcare centres, what information do you feel should definitely be included?

   a) For adults:

   ______________________________________________________
   ______________________________________________________
   ______________________________________________________
   ______________________________________________________
   ______________________________________________________

   b) For children:

   ______________________________________________________
   ______________________________________________________
   ______________________________________________________
   ______________________________________________________
   ______________________________________________________

2. What information do you feel might be useful but which you feel is not essential?

   a) For adults:

   ______________________________________________________
   ______________________________________________________
   ______________________________________________________

   b) For children:

   ______________________________________________________
   ______________________________________________________
3. Which of the following formats do you feel would be appropriate? (please tick as many as you wish)

a) For adults:

☐ video  
☐ pamphlets  
☐ posters  
☐ books  
☐ list of available resources  
☐ lectures  
☐ other-please state what other format you feel would be appropriate for adults:

☐ ☐ ☐ ☐ ☐ ☐ ☐

b) For children:

☐ video  
☐ posters  
☐ games  
☐ colouring/activity books  
☐ songs  
☐ puppets  
☐ other-please state what other format you feel would be appropriate for children:

☐ ☐ ☐ ☐ ☐ ☐ ☐

4. What resources do you currently use in your childcare centre, for education about preventing the transmission of diarrhoea:

a) Education of adult carers:

☐ ☐ ☐ ☐ ☐ ☐ ☐

☐ ☐ ☐ ☐ ☐ ☐ ☐

☐ ☐ ☐ ☐ ☐ ☐ ☐

☐ ☐ ☐ ☐ ☐ ☐ ☐

☐ ☐ ☐ ☐ ☐ ☐ ☐

☐ ☐ ☐ ☐ ☐ ☐ ☐
b) Education of children:


c) Education of parents:


Thank you very much for your time in answering this survey. Your responses will help to ensure that the final education package is of real use to childcare centres.
Appendix 14  Photographs of the original drawings of the Supersoap and Gooey Germ puppets
Appendix 14  Photographs of the original drawings of the Supersoup and Gooey Germ puppets
Appendix 15  Words to songs on audiotape

Yukky, pooey, gooey germs are hiding on your hands
They can make you very sick, they really, really can
So... wash your hands with Supersoap, counting up to ten
And don’t forget to rinse them off, counting once again.

1, 2, 3, 4, 5

6, 7, 8, 9, 10

1, 2, 3, 4

1, 2, 3, 4, 5, 6, 7, 8, 9, 10

(repeat)
Yukky old germs have got no hope

When you wash with Supersoap

Cause Supersoap is so big and strong

He'll keep those germs right out of this song

So wash your hands as you count to ten

And rinse them off again

1, 2, 3, 4, 5, 6, 7, 8, 9 and 10

1, 2, 3, 4, 5, 6, 7, 8, 9 and 10

(repeat)
**WHAT IS DIARRHOEA**

An increase in the frequency, runniness and/or volume of faeces. Diarrhoea may be non-infectious, such as when caused by food allergies, or result from taking medications such as antibiotics. It may also be infectious.

**WHAT BUGS CAUSE INFECTIOUS DIARRHOEA?**

Diarrhoea can be caused by a variety of bugs/germs, including bacteria, viruses and parasites.

**Bacteria:** include campylobacter, salmonella and shigella

**Viruses:** most commonly, rotavirus

**Parasites:** Giardia and cryptosporidium

(See "Staying Healthy in Child Care" for details of specific organisms)

**HOW ARE THEY SPREAD?**

Bugs that cause infectious diarrhoea are usually spread from hand to mouth. This means that when surfaces or fingers and hands become contaminated with bugs from infected faeces, children can easily take them into their mouths. Very young children are especially vulnerable.

**IT IS VERY IMPORTANT TO KNOW THAT PEOPLE CAN CARRY AND THEREFORE PASS ON, SOME OF THESE GERMS AND YET SHOW NO SIGNS OR SYMPTOMS OF DIARRHOEA OR GASTROENTERITIS.**
This is why good hygiene is so important, whether or not the children in your centre appear unwell.

**How do we prevent diarrhoeal diseases from spreading in childcare centres**

Good handwashing practices, for both carers and children are essential. Carers in childcare centres can act as role models to the children in their care by practicing and teaching appropriate hygiene behaviour.

Exclude from the centre any child or adult with diarrhoea until faeces have returned to normal. This may help prevent some infections being passed on to other children.

However, because children may carry and pass on infections but show no outwards signs themselves, good hygiene practices will always be the most important factor in keeping the infection rate down in your centre.
**WHY BOTHER?**

Handwashing is *the most important practice* that stops the spread of infections in childcare centres

**WHO NEEDS IT?**

*All* carers and children in childcare centres should wash their hands

**WHEN?**

**Carers:** When you arrive at the centre (to prevent the introduction of germs)

*ALWAYS* before handling any food, feeding or giving bottles to children

*ALWAYS* before eating your own food

*ALWAYS* after changing nappies

*ALWAYS* after toileting children

*ALWAYS* after using the toilet yourself
After cleaning up any secretions (e.g., vomit, faeces)

After wiping children’s (or your own) noses

Before going home (to avoid taking germs with you)

**Children:** when they arrive at the centre (this stops them introducing infection from outside the centre)

**ALWAYS** before eating

**ALWAYS** after nappy changes (babies’ hands can pick up germs from the change mat)

**ALWAYS** after using the toilet

After playing outside

After touching nose secretions

Before going home (this stops them taking any germs home with them)

**HOW IS IT DONE?**

The "**TEN PLUS TEN SECOND HANDWASH**"
HOW TO WASH YOUR HANDS

The Ten plus Ten Second Handwash

Use LIQUID SOAP

Use WARM RUNNING WATER

Rub hands well under water

Wash hands ALL OVER, counting to TEN

Wash: backs of hands, wrists, between fingers, under fingernails

Rinse hands, counting to TEN

Turn off tap with paper towel

Dry hands with paper towels
Appendix 19    Instructions and suggestions for use of *The Supersoap Bag*

*This Infection Control Health Education Package contains several different sections:*

1. **Handouts for childcare workers.**

   These can be given to current staff, new or casual relief staff, trainee staff and work-experience students. We suggest that you photocopy these as necessary. The information in these handouts has been kept to a minimum so that it can be read and understood quickly and easily. More detailed information is already available to childcare centres (see "Other Resources" below).

2. **Posters.**

   There are 10 posters included. Most relate to the need for handwashing, and are directed at carers and children. It is suggested that you rotate the use of these posters to avoid staff and parents becoming bored with or immune to the message of one poster used continuously.

3. **Puppets.**

   Two hand puppets are included. These are based on the characters "Supersoap" (the "goodie") and "Gooey Germ" (the "baddie"). These characters were designed by primary school children, and are repeated as a theme throughout the package. We suggest that you use them together with the songs on the tape and/or the story enclosed, or use them to create your own stories with the children.

4. **Songs**

   A cassette tape with two songs about the need to wash your hands is included. These songs were written by a local Western Australian singer-songwriter, and recorded with the assistance of young children. The songs were intended to be short and catchy, and easy and fun for children to learn. The words for the songs are also included, and we suggest you use this tape along with the puppets, and as part of your normal handwashing routine.

   (The two songs are repeated on side 2 of the tape).
5. **Story**

This is a short illustrated story about the antics of “Supersoap” and “Gooey Germ”. Some of the illustrations have been repeated in the colouring-in pictures. This story can be read to the children when using the puppets and/or songs. We also suggest that the carers also make up their own stories, and encourage the children to make up stories using these characters too.

6. **Colouring-in Pictures**

There are a series of pictures for children to colour in and take home. The pictures incorporate the characters, “Supersoap” and “Gooey Germ” as well as images of when and where it is important to wash your hands. We suggest that each centre photocopies these for the children to use. They can then be sent home with the children, reinforcing the handwashing message in the home as well as in the centre.

**Other Resources**

“Staying Healthy in Child Care” 2nd ed. (1997)
Commonwealth of Australia, Canberra

Health Department of Western Australia
Appendix 20  Questionnaire for subjective evaluation of The Supersoap Bag

“THE SUPEROAP BAG” EVALUATION SHEET

Dear childcare centre carer,

I have asked several questions below related to “The Supersoap Bag”. I would really appreciate it if you could find the time to complete this sheet, so that I can see what you feel are the strengths and weaknesses of the package.

Please circle yes or no as you feel is appropriate and be as honest as you can, because this is the best way for me to improve the package where necessary. It is you, the actual users of the bag, who can best evaluate it.

I have left space at the end of the questions for you to add any comments you would like to make.

Thank you all very much for all your cooperation over the past two years, it has been very much appreciated.

Best wishes

Jennifer Walters
Please circle yes OR no for each question. N/A means that this question is not applicable and does not need to be answered.

<table>
<thead>
<tr>
<th></th>
<th>Supersoap Bag (complete)</th>
<th>Handouts</th>
<th>Posters</th>
<th>Puppets</th>
<th>Songs</th>
<th>Story</th>
<th>Colouring-in pictures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy to use</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Instructions appropriate and easy to follow</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Interesting for carers to use</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Interesting for children to use</td>
<td>Yes</td>
<td>No</td>
<td>N/A</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Worked best with: 0-1yr olds</td>
<td>Yes</td>
<td>No</td>
<td>N/A</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>1-2yr olds</td>
<td>Yes</td>
<td>No</td>
<td>N/A</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>2-3yr olds</td>
<td>Yes</td>
<td>No</td>
<td>N/A</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>3-4yr olds</td>
<td>Yes</td>
<td>No</td>
<td>N/A</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>4yrs and older</td>
<td>Yes</td>
<td>No</td>
<td>N/A</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Was well liked by the children</td>
<td>Yes</td>
<td>No</td>
<td>N/A</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>I enjoyed using it</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>I would be happy to continue using it on a regular basis</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>I found it boring to use</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>The children were bored quickly when it was used with them</td>
<td>Yes</td>
<td>No</td>
<td>N/A</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>It presented the handwashing message in an appropriate way for</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>childcare centre use</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>
If you have any comments or suggestions to make, please add them here. Thank you.