EFFECT OF DEWORMING ON COGNITIVE PERFORMANCE OF RURAL PRIMARY SCHOOLCHILDREN IN BACHOK, KELANTAN

by

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Semua laporan kemajuan dan laporan akhir yang dikemukakan kepada Bahagian Penyelidikan dan Pembangunan perlu terlebih dahulu disampaikan untuk penelitian dan perakuan Jawatankuasa Penyelidikan di Pusat Pengajian.

USM R&D/JP-04

LAPORAN AKHIR PROJEK PENYELIDIKAN
R&D JANGKA PENDEK

A. MAKLUMAT AM

Tajuk Projek: Effect of deworming on cognitive performance of rural primary schoolchildren in Bachok, Kelantan.

Tajuk Program: Geran jangka pendek 304/ PPSP/ 6131214

Tarikh Mula: 1 April 2002

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Hasil projek ini didapati pelajar-pelajar sekolah rendah diluar bandar di Kelantan akan meningkat tahap kemajuan ujian kognitif selepas menerima satu dose ubat

ubat albendazole 400mg.

☐ **Rekaan atau perkembangan produk baru,**
(*Sila beri penjelasan/makluman agar mudah dikomputerkan*)

(1) ______ nil ______

______

(2) ______

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(3) ______

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(3) ______

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☐ **Memperbaiki/meningkatkan produk/proses/teknik yang <u>sedia ada</u>**
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(1) ______ nil ______

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(2) ______

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(3) ______

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(Nyatakan jenis klien yang mungkin berminat)

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(2) 8th National Conference on Medical Sciences

(3) Persidangan Kesihatan Negeri Kelantan Ketiga

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J. PELAJAR IJAZAH LANJUTAN

(*Nyatakan jumlah yang telah dilatih di dalam bidang berkaitan dan sama ada diperingkat sarjana atau Ph.D).*

Nama Pelajar

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30. 5. 04

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TANDATANGAN PENGERUSI JAWATANKUASA PENYELIDIKAN PUSAT PENGAJIAN

Fn. My doc geran j/pendek

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Dr Anees Abdul Hamid
PUM 0772

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LIST OF ABBREVIATIONS

ALO	-	*Ascaris lumbricoides*
CI	-	Confidence Interval
C	-	Control group
df	-	degree of freedom
EMM	-	Estimated Marginal Mean
epg	-	egg per gram
Gp.	-	Group of intervention
HW	-	hookworm
IQR	-	Interquartile Range
Med.	-	Median
OR	-	Odds ratio
Pre-I	-	Pre-intervention
Post-I	-	Post-intervention
RCPM	-	Raven's Colored Progressive Matrices
RM	-	Ringgit Malaysia
ROC	-	Receiver Operating Characteristic curve
SD	-	Standard Deviation
SE	-	Standard Error
T	-	Treatment group
TTO	-	*Trichuris trichiuria*
WART	-	Wide Range Achievement Test
WISC- III	-	Wechsler Intelligence Scale for Children – 3rd edition
WHO	-	World Health Organization

DEFINITION OF TERMS

Helminthiasis	- Helminth infections
Prevalence of helminthiasis	- the number of schoolchildren with positive ova was divided with the total number of children involved in the study
Rural schools	- schools with total number of children less than 500
Sanitary latrines	- include pump and flush latrines
Unsanitary latrines	- include pit latrine and river latrine

ABSTRAK

Kajian kesan anthelmintik ke atas fungsi kognitif kanak-kanak sekolah rendah luar bandar di Bachok, Kelantan

Pengenalan:

Kajian sebelum ini telah menunjukkan bahawa jangkitan cacing adalah merupakan masalah utama di kalangan pelajar-pelajar sekolah. Ini adalah disebabkan oleh kegiatan luaran, kebersihan diri yang tidak memuaskan dan kemiskinan. Jangkitan cacing juga didapati berkait rapat dengan pencapaian yang rendah dikalangan pelajar-pelajar tersebut. Kajian ini bertujuan untuk membolehkan kami untuk mengenalpasti kesan rawatan anthelmintik pada fungsi kognitif kanak-kanak sekolah luar bandar di Bachok, Kelantan.

Kaedah:

Satu kajian percubaan komuniti telah dijalankan dengan melibatkan pelajar-pelajar yang berumur antara 9 hingga 11 tahun dari 6 buah sekolah rendah di Bachok. Sekolah telah di bahagikan kepada 2 kumpulan secara rawak. Satu kumpulan berada dalam kumpulan menerima rawatan dan satu kumpulan lagi dalam kumpulan kontrol. Setiap pelajar didalam kumpulan rawatan akan menerima 400 mg albendazole tanpa mengira status jangkitan cacing mereka. Manakala pelajar didalam kumpulan kontrol hanya akan menerima rawatan apabila kajian ini selesai. Sampel najis telah diambil sekali sahaja pada permulaan kajian dimana pengenalan kepada jenis-jenis cacing telah dibuat dan

tahap serius jangkitan cacing teah di buat berdasarkan kepada ujian 'Modified Stoll's Technique'. Ujian-ujian kognitif taleh dijalankan pada setiap pelajar. Ujian-ujian tersebut adalah ujian aritmetik, ujian koding, ujian digit span forward dan ujian digit span backward. Ujian-ujian ini telah diambil berdasarkan kepada Wechsler Intelligence Scale for Children. Manakala ujian yang kelima adalah ujian Raven's colored progressive matrices. Selepas 6 bulan, ujian-ujian kognitif yang sama telah di ulang pada kanak-kanak tersebut.

Keputusan:

Terdapat 728 pelajar dari 6 buah sekolah rendah yang terpilih, tetapi hanya 600 (82.4%) mengikut serta kajian ini. Selepas 6 bulan program intervensi, seramai 572 (95.3%) selesai menjalankan ujian kognitif ulangan. Terdapat seramai 331(55.2%) pelajar yang berumur 9 tahun dan 269 (44.8%) berumur 10 tahun. 290 (48.3%) adalah pelajar perempuan manakala 310 (51.7%) adalah lelaki. Prevalen jangkitan cacing pada keseluruhan adalah 74.2% (n=445). Prevalen bagi jangkitan *Trichuris trichiuria, Ascaris lumbricoides* and hookworms were 67.2% (95% CI: 63.4%, 70.9%), 49.7% (95%CI: 45.6%, 53.7%) dan 1.2% (95%CI: 0.3%, 2.0%). Pada pemeriksaan awal, didapati pelajar yang mendapat jangkitan cacing telah menunjukkan skor keputusan yang lebih rendah berbanding dengan pelajar yang tidak mandapat jangkitan cacing perbezaan yang siknifikan pada ujian arithmetik, koding dan Raven's Colored Progressive Matrices dan tidak pada ujian digit span forward and backward. Kajian menunjukkan pelajar lelaki mempunyai risiko 1.57 kali lebih dari pelajar perempuan dan pelajar yang mempunyai bilangan kanak-kanak 5 atau lebih didalam keluarga mempunyai risiko 2.54 kali lebih dari pelajar yang mempunyai bilangan kanak-kanak

kurang dari 5 di dalam keluarga untuk mendapat jangkitan cacing. Setelah intervensi dengan memberi ubat cacing, albendazole, didapati pelajar yang menerima ubat ini menunjukkan peningkatan yang siknifikan pada ujian koding ($F_{1,57} = 5.41$, p=0.02) dan ujian Raven's colored progressive matrices ($F_{1,57} = 9.39$, p=0.02). Tetapi tidak pada ujian arithmetic, ujian digit span forward dan ujian digit span backward. Selepas di kawal 'adjusted', keputusan ujian didapati sama dengan analisis sebelum ini, iaitu ujian koding ($F_{1,56} = 5.33$, p=0.02) dan ujian Raven's colored progressive matrices ($F_{1,56} = 10.10$, p=0.00).

Kesimpulan:

Kanak-kanak yang mendapat jangkitan cacing telah menunjukkan kelemahan pada ujian kognitif yang telah dijalankan. Pemberian satu dos ubat cacing secara berkumpulan (mass treatment) adalah perlu kerana ia telah menunjukkan peningkatan dalam sebahagian ujian kognitif yang dijalankan.

Kata kunci ***anthelmintik, ujian kognitif, luar bandar, kanak-kanak sekolah rendah, Bachok***

ABSTRACT

Effect of deworming on cognitive performance of rural primary schoolchildren in Bachok, Kelantan

Introduction:

Previous studies have found that helminthiasis to be very common among school-aged children. This may be due to their outdoor activities, poor personal hygiene and poverty. Helminthiasis is also related to poor school performance. In this study, we are going to determine the effect of deworming on cognitive performance of rural primary school children in Kelantan.

Method:

This study was a community trial involving 600 schoolchildren in Bachok from 6 primary schools (aged between 9 and 11 years) was undertaken. The sampling frame involved all 17 rural primary schools in Bachok, Kelantan. Based on the sample size calculations, manpower and limitation of time, six schools were randomly selected with 728 schoolchildren. One-stage cluster sampling was used to choose the schools whereby all Standard 3 and Standard 4 children in the selected schools were recruited. At baseline, questionnaires on socioeconomic and health data related with helminthiasis were given, stool analysis and also cognitive performance tests was done. The cognitive tests administered to each child were the arithmetic test, coding test, digit span forward and backward tests. These three tests were taken from the Wechsler Intelligence Scale

for Children. The other test given was the Raven's colored progressive matrices test. The schools were then randomly assigned into treatment and control group. Each child in the treatment group received 400mg albendazole while children in the control group were not given anthelmintic until the end of the study. After 6 months all of the cognitive tests were repeated.

Results:

A total of 728 children from 6 schools were invited to join this study. However, 600 children (82.4%) were enrolled, and 572 children (95.3%) completed the study after 6 months. There were 331 (55.2%) children aged 9-10 years and 269 (44.8%) children aged 10-11 years. There were 290 (48.3%) girls and 310 (51.7%) boys. The overall prevalence of total helminthiasis was 74.2% (n=445). Prevalence of *Trichuris trichiuria, Ascaris lumbricoides* and hookworms were 67.2% (95% CI: 63.4%, 70.9%), 49.7% (95%CI: 45.6%, 53.7%) and 1.2% (95%CI: 0.3%, 2.0%) respectively. On baseline examination, children with helminthiasis scored significantly lower than those uninfected in arithmetic test, coding test and Raven's colored progressive matrices test. However, in the digit span forward test and digit span backward test, even though the scores were lower in the infected children compared to those not infected, the differences was not statistically significant. Male children are 1.57 times more associated with helminthiasis compared to female students and children who having number of children in the house 5 and more were 2.54 times more associated with helminthiasis compared to those having number of children less than 5. Following deworming with albendazole, at 6 months, multivariate analysis using repeated measures ANOVA showed significant difference in the coding test ($F_{1,57}$ = 5.41,

p=0.02) and the Raven's colored progressive matrices test ($F_{1,57}$ = 9.39, p=0.02) between the treated and control group. However, the digit span backward test, the arithmetic test and digit span forward test were not significantly different in the 2 groups. After adjusting for infection status and family income, almost similar result were noted whereby, children in the treatment group had significantly higher scores for the coding ($F_{1,56}$ = 5.33, p=0.02) and Raven's colored progressive matrices tests ($F_{1,56}$ = 10.10, p=0.00) compared to the control group. However, for 3 other tests, arithmetic, digit span forward and digit span backward there were no significant different.

Conclusion:

Children who have helminthiasis have generally poorer cognitive performance. Gender and number of children in the family were significantly associated with helminthiasis. There were improvements in certain cognitive tests 6 months after children were given anthelmintic. Mass deworming with single doses of oral albendazole should be given to rural schoolchildren as it may improve some aspects of their cognitive performance.

Key words ***deworming, cognitive performance, rural, primary school children, Bachok***

CHAPTER ONE

INTRODUCTION

Children are assets to a country's development. However, in order to become economically productive, the children need to be healthy and educated. In Malaysia, the government has implemented numerous health care activities through health clinics and school health units to ensure optimum health of the children. For education, the government has built schools, provide teachers, books and educational materials in order that these children are trained to meet the manpower needs for the country's development. The returns from these investments are compromised if these children are frequently absent from schools or are not able to maximise their learning capabilities because of poor health. Underachievement in schools or low scores in tests of cognitive ability had been shown to be related with short-term hunger, iron deficiency, iodine deficiency and helminthiasis (Grantham- Mc Gregor, 1990). Schoolchildren are particularly at risk from infections with parasitic worms. Epidemiological evidence worldwide show that school-aged children are not only more likely to be infected with helminths, they are also more likely to be more heavily infected than other age groups (Bundy *et al.*, 1988). Worldwide, these helminthiasis are roughly estimated to occur with the following frequency; Ascariasis 1,000 million; Trichuriasis 900 million; Hookworm infections (uncinariasis) 500 million; Enterobiasis 400 million; Strongyloidiasis 100 million; and Taeniasis 70 million. Helminthiasis are estimated to account for over 12 % of the total disease burden in girls aged five to fourteen years and over 11 % burden in boys, making it the largest contributor to the disease burden in this school age group. In Malaysia, the prevalence rate is between 30% and 80% in different population surveys (Lie *et al.*, 1971, Mahendra *et al.*, 1996 & Lee *et al.*, 1999). The disease is endemic in both tropical and temperate regions of the world where there is adequate moisture and low standards of hygiene and sanitation. Helminthiasis is associated with poverty and poor living conditions, inadequate sanitation and water supplies, soil quality and climate, poor personal and environmental hygiene and poor health awareness. The wide range of methods used in attempts to control helminthiasis includes chemotherapy, health education, environmental sanitation and hygiene. Helminthiasis has a harmful impact through blood loss, poor growth, malabsorption, diarrhea, impaired work capacity and poor cognitive function of infected children. Thus, this study was done to look at the effect of deworming on cognitive performance among primary school children living in rural areas in Bachok, Kelantan.

CHAPTER TWO

LITERATURE REVIEW

2.1 Helminthiasis

Helminthiasis or infection by gastrointestinal helminths is defined as the presence of species of parasitic worms living for an obligatory period in the human gut or its associated ducts or because they induced pathological changes in that site. Warren (1970) described helminths as insidiously infiltrating guerrillas, which damaged their hosts only when they reached large numbers. There are about 100 species of helminths reported to infect the human alimentary tract. However, the most common helminths are the nematodes. The nematode infections that are associated with clinical disease and are well documented are *Ascaris lumbricoides*, hookworm (*Ancylostoma duodenale and Necator americanus*) and *Trichuris trichiuria.* In this study, the author will focus on the three common helminths that are *Ascaris lumbricoides*, *Trichuris trichiuria* and hookworm.

2.1.1 Ascariasis

Ascariasis is caused by *Ascaris lumbricoides*, which is the largest nematode parasitism in the human intestine. *Ascaris lumbricoides* is highly specific for man and the infection does not produce a strong protective immunity. This worm is highly aggregation in the community which poor hygiene and sanitation particularly where people defecate indiscriminately around human settlements and where night soil is used as fertilizers in agriculture. These people also associated with poor economic status whereby when the presence of the adult worms in the small intestine it can lead to poor absorption of nutrient in children on a marginal poor diet with a heavy parasite load. *Ascaris lumbricoides* is highly aggregated among younger aged group and maximum worm burden occur at 5- 10 years of age.

There are few studies done regarding poor absorption of nutrient and ascariasis. Venkatachalam and Patwardhan (1953) have provided the best quantitative evidence of the degree of potential nutritional impairment that can occur in children as a result of ascariasis. They found that mild to moderate impairment of digestion or absorption of dietary protein (to the extent of 0.5g of nitrogen a day) in nine children infected with *Ascaris lumbricoides*. Therefore, they suggested that this impairment may be a significant factor in the development of hypoproteinosis in children whose diets are already inadequate in protein. According to Tripathy *et al.* (1971), ascariasis in children can lead to nutrient impairment when high parasite load is associated with low protein intake. They also found that malabsorption of fat in children harboring heavy infections. They conclude that a lesion, either functional or structural, in the intestinal mucosa can explain this absorption defect due to ascariasis.

Children affected with ascariasis may present with several complication. There are few medical and surgical complications due to adult worms such as intestinal obstruction and pneumonitis. However, chronic ascariasis is the common form of *Ascaris lumbricoides* infection especially among school-aged children. The children might present with growth retardation and poor in nutritional status, which also can lead to poor in school performance.

Some clinical studies shown that children infected with *Ascaris lumbricoides* have shown increased losses of nitrogen in feces, decreased absorption of fat and nitrogen, malabsorption and impaired absorption of vitamin A.

2.1.2 Hookworm infections

Hookworm infection is a major disease in many countries of the developing world and is an important cause of iron defiency anaemia in endemic areas (Schad and Warren, 1990). There are two main species, which infect humans, *Ancylostoma duodenale* and *Necator americanus*. Hookworm infection is common in the area where the sanitation is poor, indiscriminate defecation and the place where the practices of using the same place for defecation and going barefoot. Hookworm infection is common in older aged group comparing to school-aged children because of differences in level of exposures.

Hookworm infection is usually associated blood loss, which can lead to iron deficiency anaemia. Blood loss occurs both from ingestion by the adult worm and through bleeding from the damaged mucosa as the adult hookworm live attached by their mouthparts or buccal capsules to the mucosa of the small intestine and results in bleeding into the gastrointestinal tract. Besides this, they facilitate the secretion of a proteolytic enzyme with anticoagulant activity, which lead to further loss of blood (Hotez & Cerami, 1983). Layrisse *et al.* (1976) reported that there was a wide estimate of fecal blood loss based on a variety of radio isotopic studies. They suggest that from 0.14 ml to 0.26 ml of blood is lost due to one *Ancylostoma duodenale* and 0.02 ml to 0.07 ml of blood due to one *Necator americanus*. The quantity of blood lost is directly related to the intensity and type of hookworm infection. Anaemia is an important public health issue since it is associated with a diminished capacity for sustained hard work and exercise. Studies from many countries show that the treatment for hookworm in particular may improve work productivity and physical fitness (Crompton & Stephenson, 1989, Stephenson *et al.*, 1990))

Besides causing iron deficiency anaemia, hookworm infections can also induce intestinal injury, which also can lead to alteration of the small bowel motility and intestinal protein loss resulting in hypoproteinaemia and hypoalbuminaemia (Banwell & Schad, 1978). Thus, hookworm infection can lead to protein energy malnutrition. There are also other complication of hookworm infection such as nitrogen imbalance and reduced appetite.

2.1.3 Trichuriasis

Trichuriasis is caused by *Trichuris trichiuria* and is the commonest infection of nematodes worldwide and Malaysia. The prevalence is varies in different parts of the world, being most common in the warm, humid, tropical and subtropical areas. In many of these latter areas poor sanitation, coupled with the use of night soil for fertilization of crops, predisposes to a high prevalence of this parasite. In Malaysia, the prevalence rate is between 30% and 80% in different population surveys (Lie *et al.*, 1971, Mahendra *et al.*, 1996 & Lee *et al.*, 1999). *Trichuris trichiura* infection is highly aggregated among younger aged group and maximum worm burden occur at 5- 10 years of age. Kamath (1973) did a study on Malaysian children and found that severe *Trichuris trichiura* infection in children produced chronic dysentery and together with malnutrition and multiple parasitic infection, contributed to severe anaemia and growth retardation. He found that chronic diarrhea and dysentery observed in *Trichuris trichiuria* infection could be related to the presence of large number of *Trichuris trichiuria* in the large bowel mucosa resulting in mucosal lesions. Straining at defecation often results in rectal prolapse. Fecal blood loss contributes to anaemia and hypoproteinemia. Congenital heart failure is a complication of anaemia and may aggravate edema in hypoproteinaemia patients. Severe trichuriasis has been associated with iron deficiency anaemia. One *Trichuris trichiuria* nematode consumes 0.005 ml of blood (Layrisse *et al.*, 1967). Iron deficiency anaemia in heavy *Trichuris trichiuria* infection is probably secondary to the chronic blood loss and the catabolic effects of secondary intestinal infection (Gilman *et al.*, 1976).

The morbidity associated with trichuriasis is due to worm unique mode of attachment to the wall of the large infection. Each worm is about 50 mm long and has a thin anterior part with which it burrows into the intestinal wall where it feeds on the intestinal tissues. The degree of morbidity is related to the intensity of infection.

2.2 Epidemiology of helminthiasis

2.2.1 Helminthiasis - Worldwide

Helminthiasis is still an important public health problem worldwide especially in developing countries. Helminths infect all population groups but the prevalence is highest among school-aged children (age 5-14 years). The prevalence of helminthiasis is higher among school age group (70%) compared to adults (49%) could reflect an age-dependent acquisition in insusceptibility but it also be explained by differences in behaviour that lead to lower degree of exposure to infection among adults (Hall *et al.*, 1992). Helminthiasis need to be control effectively as the school-aged group is a very important and crucial period in their growth and development.

Worldwide, these helminthiasis are roughly estimated to occur with the following frequency; Ascariasis 1,000 million; Trichuriasis 900 million; Hookworm infections (uncinariasis) 500 million; Enterobiasis 400 million; Strongyloidiasis 100 million; and Teniasis 70 million. According to Bundy *et al.* (1997), the global prevalence of infection with the number of cases in school aged children are estimated as roundworm - 35 % (320 million), whipworm - 25 % (233 million) and hookworm infections - 26 % (239 million).

Ascariasis, trichuriasis, and hookworm infections have been reported in 150 of 208 countries worldwide. In Latin America, helminthiasis affects 20% - 30% of the general population, but with prevalence as high as 60 - 80% in highly endemic areas. In Jamaica, Hutchinson *et al.* (1997) did a cross-sectional study on the prevalence of helminthiasis among eight hundred primary school children aged 9-13 years and found that the prevalence of *Trichuris trichiuria* infection was 38.3%, 33.9% for light infection and 4.4% for moderate infection while for *Ascaris lumbricoides* the prevalence was 19.4%, 9.6% for light infection and 9.8% for medium infection. No heavy infection was found. Nokes *et al.* (1991) found that overall prevalence of helminthiasis infections was 71.3%. The prevalence of *Trichuris trichiuria, Ascaris lumbricoides* and *Necator americanus* infections were 67.4%, 30.5% and 6.2% respectively.

2.2.2 Helminthiasis in Malaysia

In Malaysia helminthiasis are common especially in the rural population. A number of studies on helminthiasis have been done previously. The prevalence varies from study to study and from place to place. The prevalence and intensity of infection is concentrated among children aged 4 – 15 years of age and were found to be higher in boys (Kan and Poon, 1987, Bundy *et al.*, 1988).

Lie *et al.* (1971) found that in Ampang area, prevalence of *Trichuris trichiuria*, *Ascaris lumbricoides* and *Necator americanus* infetions were 84%, 82% and 33% respectively and in Berenang area the prevalence were 31%, 33% and 24% respectively. Lo *et al.* (1979) did a survey in 3 rural kampungs in Teluk Datuk, Kuala Lumpur involving 834 school children aged 6 to 12 years. They found that the overall prevalence was 95%. The prevalence rate for *Trichuris trichiuria* was between 79% - 88%, for *Ascaris lumbricoides* was between 84% - 89% and hookworm between 31%-51%. Double infection was the commonest occurrence (45.1%), followed by triple infection 37.2% and single infection 12.7%. The average worms load for hookworm was 1, 964, for *Ascaris lumbricoides* was 59, 700 and for *Trichuris trichiuria* was 6, 233 eggs per gram.

Lee *et al.* (1999) did a study among school children in Sarawak and found that, the prevalence of *Ascaris lumbricoides* in primary school children was 14.5%, *Trichuris trichiuria* was 27.5% and hookworm infection was 7.6%. For secondary school students, the prevalence was 9.0% for *Ascaris lumbricoides*, 23.3% for *Trichuris trichiuria* and 6.8%

for hookworm infection. Children from rural schools had higher prevalence (43.7%) compared to those from urban schools (15%).

In 1984, Kan published a survey among 1,157 Indian primary schoolchildren from 8 schools from urban and rural areas in and around Kuala Lumpur. She found the helminthiasis was prevalent among both urban and rural school children, ranging from 69.8% to 100% and overall prevalence of helminthiasis was 89.02%. *Trichuris trichiuria* was the predominant helminth where 85.2% to 100% of all infected children had the parasite. Urban schoolchildren tend to be more heavily infected than rural children. *Ascaris lumbricoides* was found to be more common among urban schoolchildren, 64.5% to 85.7% compared to rural children, 16.3% to 46.3%. Hookworm infection was more prevalent among rural schoolchildren, 37.2% to 46.3% and among urban schools, the prevalence ranged from 0.7% to 7.2%. For urban school children, double infections with *Ascaris lumbricoides* mixed with *Trichuris trichiuria* ranged from 96.7% - 100 % while infection with *Ascaris lumbricoides* and hookworm and *Trichuris trichiuria* and hookworm were negligible. For rural schoolchildren, infections with *Ascaris lumbricoides* mixed with *Trichuris trichiuria* ranged from 15.4% - 56.1%, for *Trichuris trichiuria* and hookworm were ranged from 39.4% to 84.6% and for *Ascaris lumbricoides* and hookworm were negligible. Triple infections with all three types of helminthes were more common among rural school children (11.6% to 21.4%) than those from urban schools (1.6% to 4.6%).

In Kelantan, Mahendra *et al.* (1996) found that the prevalence of *Ascaris lumbricoides* was 16%, *Trichuris trichiuria* was 33% and hookworm was 0.6% among urban primary school children. For rural primary school children, the prevalence for *Ascaris lumbricoides* was

47.6%, for *Trichuris trichiuria* was 52.4% and for hookworm was 16.2%. Zulkifli *et al.* (1999) did a study among preschool children aged 1 to 7 years from Kuala Betis, Gua Musang, Kelantan and they found that the overall prevalence of helminthiasis was 56.0%. The prevalence of *Trichuris trichiuria* was 33.9%, *Ascaris lumbricoides* was 47.5% and hookworm was 6.2%.

2.3 Factors affecting helminthiasis

Many factors are known to influence the prevalence of helminthiasis. Geographical and climatic factors are very important, because of the nature of their mode of transmission. Age is another factor that has been clearly shown to be related to the prevalence of helminthiasis, either because of immunological factors or age related behavioral patterns. Behavioral patterns are different from people in the group with the other group and are affected by the socioeconomic status, education, traditional health-related practices, as well as the availability and use of health care facilities. The prevalence of soil-transmitted helminth infections is also known to be much higher in the lower socio-economic classes (Chan, 1985, Crompton, 1986, Cooper, 1991, Hagel *et al.*, 1993 & Crompton and Savioli, 1993). The prevalence of geohelminth infections among preschool children living in an urban slum area in Sri Lanka was significantly related to the educational level of the mother and not to the father may reflect the greater role that the mother plays in the care of the preschool child in the community (de Silva *et al.*, 1996).

In Macao, Chan (1992) found that the prevalence of helminthiasis was significantly higher among 12-18 year old children, children born in China and those with large family size or sibling size. He also found that the prevalence was not related to sex, education of parents, occupation of father, family income, employment status of mother and residence. Ali *et al.* (1999) reported that among 1322 students in Ethopia, there was a significant association between poor personal hygiene and rate of infection. However, no statistically significant associations were observed between family size and infection, latrine usage and infection, source of drinking water and infection and habit of drinking water and infection. Henry (1981) in rural St Lucia, West Indies found that the other environmental factors such as cleanliness of living areas, location of toilets and non usage of toilets, type of drinking water, socioeconomic factors such as overcrowding and household income were all related to helminthiasis infection.

In Malaysia, Norhayati *et al.* (1998) conducted a community- based study in an area highly endemic for helminthiasis to elucidate the demographic, behavioural and environmental factors that predispose children to this infection. They found that low level of mother's education was a risk factor for moderate and severe infection of *Ascaris lumbricoides* and usage of well water and age $\leq$ 6 years old for the moderate and severe infection with *Trichuris trichiuria.* Another study by Zulkifli *et al.* (1999) in Kuala Betis, Gua Musang among 397 pre-school children, found that factors associated with helminthiasis among the children were older age group, poor water supply and households with more than 5 members. However, father's occupation either working as rubber tapers, government servant or doing small business was not a risk factor towards helminthiasis.

2.4 Effect of helminthiasis

Due to the insidious onset of helminthiasis, a long life span, lack of protection from infection, inavailability of vaccination, ease of infection and reinfection and manifestation of auto infection, a large population of helminths can built up within a host, who will then harbor a large worm burden. These helminths stay, grow and bred in their bodies but also consume the food and nutrient inside them, which can lead to several effects. The effect of helmnthiasis can be insidious, chronic and accumulative. Most of the time the onset of helminthiasis are insidious. A child and his parent may not be aware of the infection and this is the usual case among children in endemic areas. Nutritional impairment is often related with chronic helminthiasis and usually leads to protein-energy malnutrition, iron-deficiency anaemia and vitamin A deficiency. Although malnutrition is caused by many causes, it is closely related with socioeconomic factors and many studies found that helminthiasis is related with malnutrition in developing countries.

The effects of helminthiasis infections can be divided into direct effect and indirect effects. For direct effects, it can be iron deficiency anaemia, malnutrition, poor growth, reduced work and productivity, intestinal obstruction and biliary ascariasis. Indirect causes can effect on the cognitive function, socioemotional, psychological and behavioural development of the affected child.

2.3.1 Helminthiasis and nutrition

Children have smaller appetites but need relatively large amount of nutrients and energy for their rapid growth. If the children are infected with helminths, they need to share their intake with these parasites, which can lead to their poor growth and development if food intake is inadequate. There are a number of ways helminthiasis can affect nutritional intake of the host. Adult worms in the intestine of growing children will directly remove the food and nutrients so that the child will not get the nutrients required for their growth. Helminthiasis can also indirectly reduce food intake, food absorption and food utilization by the infected child. This can be due to the loss of appetite (anorexia) due to nausea, vomiting, abdominal upset or pain and diarrhea caused by helminthiasis. Furthermore, helminthiasis can cause abnormality of the intestinal wall, which is the site for the digestion and absorption of food, leading to some form of intestinal malfunction. Intestinal surface can be mechanically blocked by the presence of large number of worms such as *Ascaris lumbricoides* and it can affect the digestion and absorption of food. Hookworm can ulcerate the wall of small intestines and threadworms can cause edema, thickening and ulceration of small intestines. This pathology in the wall of intestine can lead to malabsorption and intestinal malfunction.

A number of studies have been done regarding helminthiasis and malnutrition. Most of the researchers assessed nutritional status of the subject by measuring z- score for height- for-age, weight- for- age and weight- for- height (Zulkifli *et al.*, 1999, Mahendra *et al.* 1997, Stephenson *et al.*, 1989 & WHO, 1986). There were also some researchers (Ng, 1984, Jelliffe, 1969) who used mid- upper arm circumference (MUAC) to assess malnutrition among the children. However, the z-score for height- for- age, weight- for- age and weight-for- height is the most commonly used index as it can measure nutritional status and growth at the same time.

Zulkifli *et al.* (1999) found that among Orang Asli pre-school children in Kelantan, the children who were infected were more stunted and underweight compared to those non infected. Mahendra *et al.* (1997) found that among school children in rural area in North-eastern Malaysia, those who were infected with heavy *Ascaris lumbricoides* infection had a significantly lower height- for- age score than *Ascaris lumbricoides* negative children. However, height- for- age and weight-for-age for heavy *Trichuris trichiuria* infected children were not significantly different from that of *Trichuris trichiuria* negative children. Weight-for-height score among heavily *Ascaris lumbricoides* and *Trichuris trichiuria* infected children were not significantly higher than that of uninfected children.

2.3.2 Helminthiasis and child growth

Child growth is influenced by several factors such as genetic, food intake, adequate nutrients, education and knowledge of parents in food preparation and food hygiene, socioeconomic situation of the family, cultural practices related with eating, food preparation and proper weaning practice. Helminthiasis affect the growth of children by depriving them of some of the nutrients needed for them to grow at the normal rate. The decelaration of growth of both height and weight is an indication of undernutrition.

Undernutrition may be characterized by stunting or nutritional dwarfism where the child is short for his age. Stunting in children is usually due to history of chronic undernourishment or malnutrition and also can be because of chronic persistent helminthiasis. Another common manifestation of malnutrition is wasting where a child's weight is low for his height. Often, children with helminthiasis infections show a combination of both stunting and wasting. Studies on helminthiasis and growth and helminthiasis and malnutrition were usually being conducted together.

2.3.3 Helminthiasis and cognitive performance

There are two possible mechanisms in the relationship between helminthiasis and cognitive performance. The first is direct whereby helminthiasis itself has a psychological effect by influencing either perceptual, central or effectors processes. In an extreme form this may result from damage to the central nervous system caused by eggs and worms. A less extreme form may be a systemic effect on neural processes which can affect basic cognitive processes and results in a reduction in functional efficiency. The second mechanism may be via malnutrition that is known to have consequences on cognitive function.

One cognitive domain that has been investigated in several studies with differing results is that of working memory. Working memory refers to the brain system that provides temporary storage and manipulation of the information necessary for more complex cognitive tasks such as language comprehension, learning and reasoning. The working memory model is composed of three main parts: an attentional controller/ central executive supplemented by two subsidiary systems called the phonological loop and the visual-spatial sketchpad. The phonological loop is assumed to be responsible for maintaining speech-based information. The visual-spatial sketchpad is assumed to perform a similar function in setting up and manipulating visuospatial imaginary. The central executive is a type of attentional controller. Within the central executive there is also a supervisory attentional system for maintaining goals and resisting distraction by stimuli that might otherwise trigger some other behaviour that is conflicting (Baddeley, 1992).

Hutchinson *et al.* (1997) used the Wide Range Achievement Test (WRAT) to assess school achievement among Jamaica schoolchildren. They found that children with *Trichuris trichiuria* infections had lower achievement levels than uninfected children in spelling, reading and arithmetic. Children with *Ascaris lumbricoides* had lower scores only in spelling and reading. Kvalsvig *et al.* (1991) also found that in Nyuswara area near Durban, the primary school children who were infected with *Trichuris trichiuria* and *Ascaris lumbricoides* tend to have poorer cognitive functions and school achievement than uninfected children. Nokes *et al.* (1991) found that children who were judged by their teachers to be least academically able were not only likely to harbour infection but also more likely to harbour larger than average worm burden.

Sakti *et al.* (1999) did a study among 432 children from 42 primary schools in Java, Indonesia, and found that children infected with hookworm performed significantly worse in 6 of the 14 cognitive tests than children without infection. After controlling for school and age, socio-economic status and parental education, sex, stunting, body mass index, haemoglobin concentration and the presence of *Ascaris lumbricoides* and *Trichuris trichiuria* infections, infected children showed significantly lower scores in fluency test, digit span forward test, number choice test, picture search test, stroop colour word test and mazes test. However there were no significant difference for digit span backward test, corsi block test, stroop colour test, stroop interference test, free recall test, verbal analogies test, bead threading test and pegboard test. It was suggested that hookworm infection could have significant adverse effect on children's working memory, which may affect the child's reasoning ability and reading comprehension.

Simeon *et al.* (1994) examined the relationship between varying level of intensities of infection with *Trichuris trichiuria* and the performance of children on achievement tests, attendance and nutritional status in 616 school children in Jamaica. They found that in the three WRAT subtests, the measures declining with increasing severity of infection. But, after controlling for socioeconomic status, gender, age, the children's school and the presence of infection, the uninfected children had higher reading and arithmetic scores than children with uninfection intensity greater than 4000 epg of stool. However, there were no significant differences in spelling and school attendance.

One explanation for the lack of consistency between studies in the types of cognitive domains affected by or associated with helminthiasis is that different parasitic species have different physical or clinical effects, which in turn affect different cognitive functions. Thus, the specific effects on mental function are not clear and may depend not only on the duration and intensity of infection but also on the species of parasitic infection and whether or not the parasites are present as single or multiple species infections. Therefore, in this study we are not interested in specific cognitive domains but to understand the implications of the effects on children's performance on the test given.

2.3.4 Helminthiasis and anaemia

It is increasingly recognized that helminthiasis may have a harmful impact on haemoglobin, which can lead to iron defiency anaemia. Iron deficiency anaemia is always associated with impaired cognition, decreased learning ability and diminished capacity to carry out physical work. Hookworm is usually associated with anaemia when compared with *Trichuris trichiuria* and *Ascaris lumbricoides* (Layrisse *et al.*, 1976). Stephenson *et al.* (1990) conducted a study of the effect of treatment with single dose of albendazole on physical fitness of primary schoolboys compared with placebo group. They found that children with *Trichuris trichiuria, Ascaris lumbricoides* and hookwom infection after treatment for 7 weeks duration shown highly significant improvement in physical fitness. They found that the most likely mechanisms involve a decrease in symptomatology and improved food intake following decrease in helminthiasis, leading to increase in physical activity in albendazole group. These results illustrate that treatment for helmminthiasis in children may improve the ability to perform work, and support findings dating back 85 years that hookworm in particular may decreased physical fitness, work capacity and productivity of children and adults (Crompton & Stephenson, 1989).

2.5 Deworming

Deworming with anthelmintic is a well known highly effective, safe and low cost of short-term control measures of helminthiasis. The treatment with anthelmintic at intervals of one to several years should maintain the disease below the threshold which will results in reduced morbidity and improvement in nutritional status of hundreds of people, especially children. In 1991, in conference regarding 'concern for the growth, development and learning ability of school-aged children' held in Bellagio, it was proposed that cost estimates for such a program of mass chemotheraphy without individual diagnostic tests would be in the range of one dollar per treated child per year (Warren, 1993). Although there are a few broad-spectrum anthelmintic drugs available, they are not equally effective against *Trichuris trichiuria, Ascaris lumbricoides* and hookworm. There are 4 drugs, which are recommended by WHO for treatment that is albendazole (Zentel®) 400mg, levamisole 2.5mg/kg, mebendazole 500mg and pyrantel 10 mg/kg. A drug of choice that can be administered as a single dose is preferable either in mass control program or in management of individual patients. At a conference on hookworm control held in 1988, new research suggested that helminthiasis no longer needed to be dealt with one by one, since a single dose albendazole would simultaneously treat hookworm, ascariasis, trichuriasis and enterobiasis (Warren, 1991). Furthermore, albendazole is so innocuous to the human host that mass chemotheraphy can be employed without diagnostic testing. However, albendazole should not be given to children less than 1 year and pregnant woman during first trimester.

There are also few studies done in Malaysia. According to Ramalingam *et al.* (1983), albendazole is very effective against *Ascaris lumbricoides* at single dose 400 mg with cure rates 100% with each dosage, *Trichuris trichiuria* at single dose 600 mg cure rates is 60.9% and an egg reduction rate id 85.1% and hookworm at 400 mg is 94.5%. They conclude that albendazole is effective against *Ascaris lumbricoides* and hookworm and is moderately effective against *Trichuris trichiuria*. The recommended single dose against *Ascaris lumbricoides* and hookworm is 400mg and against *Trichuris trichiuria* is 600mg for 3 days.

Norhayati *et al.* (1997) have studied the efficacy of single dose 400mg albendazole to treat *Ascaris lumbricoides*, *Trichuris trichiuria* and hookworm infection among Orang Asli community. Fecal samples were examined on one month and 4 months after treatment. They found that the efficacy of single dose 400mg albendazole was higher in *Ascaris lumbricoides* infection compared to hookworm and *Trichuris trichiuria* infections. The cure rate and egg reduction was impressive in *Ascaris lumbricoides* and hookworm infections. For *Trichuris trichiuria* infections, the cure rate was low but the egg reduction rate was 49.1%. Many other studies reported similar findings (Jongsuksuntigul *et al.*, 1993, Albonico *et al.*, 1994 & Wahab, 1996).

2.6 Effect of deworming on cognitive performance

Many studies have examined the relationship between helminthiasis and cognitive performance. However, different researchers had designed differently the study. Some of them design a randomized controlled, double blind trial and there is also randomization according to infected and uninfected status. Duration of the study also varies from 1 month up to 6 months. Cognitive performance tests used in different study also different each other. There are some researchers using standard cognitive tests such using Wechsler Intelligence Scale for Children and some of them using school attendance rates or school examination results as a battery of cognitive performance tests.

Watkins *et al.* (1996) did a randomized trial, double blind study in children aged 7-12 years in Guatemala. Albendazole was used as intervention method whereby those in the treatment group will receive albendazole at 0 and 12 weeks of the study and those in the control group will receive placebo. The children's performance in tests of reading and vocabulary were measured at 0 and 24 weeks, the Peabody picture vocabulary test was given at 24 weeks and attendance was measured throughout the school year. After 6 months, treated children did not show significant improvement in the entire test compared to those in the control group.

Gardner *et al.* (1996) did a randomized controlled, double blind study among Jamaican children with light to moderate helminthiasis. Ninety-seven subjects with at least minimum 1, 200 *Trichuris trichiuria* eggs/g feces were randomly assigned to placebo or treatment group. Each paired of infected children was matched with an uninfected classmate. All of the subjects were given seven cognitive function tests that are French-learning, digit spans (forward and backward), Corsi block span, fluency, picture search and silly sentences. After 3 months, the children received another treatment and the cognitive function tests were repeated. They found that none of the cognitive function tests shown significant improvement with the treatment given.

In Jakarta, Hadidjaja *et al.* (1998) did a study on effect of intervention methods on nutritional status and cognitive functions among primary school children aged six and eight years old infected with *Ascaris lumbricoides*. They divide the children into three intervention groups that are mebendazole, health education, mebendazole and health education. Placebo and egg-negative children were grouped into control group. They were used standard cognitive performance, which are taken from Wechsler Intelligence Scale for Children and Raven's Colored Progressive Matrices. They found that the group treated with mebendazole showed significant improvement in the Colored Progressive Matrices and

Coding test. Children receiving mebendazole showed improvement in their learning ability, concentration, and eye-hand coordination after five months interval.

In 1997, Mahendra *et al.* published a study on effect of helminthiasis on school attendance by early primary schoolchildren in rural and urban schools in North-eastern Peninsular Malaysia. Infected children were given a single dose of 400mg albendazole and uninfected children were randomly selected. The children both in treatment and control group were recorded school attendance for 3 periods of 60 consecutive school days. First period was immediately before treatment, second period began 1 week after treatment and third period was immediately after period 2. They found that in rural school, the worm infected children as a whole lost more school days during the first post treatment period than uninfected children did. However, overall results they found that no evidence that infected children improved more in terms of attendance rates after treatment than uninfected children.

2.7 Rationale of this study

Helminthiasis is not a new issue among rural children and it is being forgotten as one of the common morbidity among children. Today, the prevalence among schoolchildren is still high especially those children from rural area. It is known that helminthiasis can affect growth, nutrition, anaemia and indirectely to reduce physical activity, cognitive performance and also reduce in appetite of the children.

We hope that this study will provide an estimate the latest data on the prevalence of helminthiasis of rural school children in Bachok, Kelantan. There was a study done by

Mahendra *et al.* (1996) in Tawang, Bachok among rural primary schoolchildren and we hope that we can compare their findings with ours.

In this study we are going to look for intensity of helminhiasis by using classes of classification such as light, moderate and heavy infection based on the WHO classification. Previous study have shown that most of the children are harbouring only mild and moderate infection and only about 10 % are suffering severe infections. Thus, we want to get current data on intensity of helminthiasis among rural schoolchildren in Kelantan.

Helminthiasis is usually related with poor personal hygiene, poor environment and sanitation, low socioeconomic family and overcrowding family. In this study, we are going to test the association among selected risk factors and helminthiasis among rural school children in Kelantan. Therefore, we hope with the data, the proper causal relationship can be established and a proper control measures should be thought in order to reduce the prevalence besides through effective chemotheraphy.

In this study, we are going to test an association between giving intervention with albendazole and changes in cognitive performance among the rural schoolchildren in Bachok, Kelantan. This is important as education is very crucial for children and we know that from previous data, the rural schoolchildren are commonly affected with helminthiasis. We also know that helminthiasis is associated with poorer academic performance. Studies have shown improvement in academic performance after receiving anthelminthics. In 1997, Mahendra *et al.* did a study on effect of deworming and school absenteeism from rural school in North-eastern Malaysia. They compared attendance rates of infected and