An Investigation Into the Causes of Illness in the 1996 Dusi Canoe Marathon

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Declaration

This study represents original work and has not been submitted to any other university in any form.

Signed: 

Abstract

There has been mounting concern at reports of possible increases in the number of illnesses or infections and their severity following the 1996 Umsindusi Canoe Marathon. The race of 1991 had been considered the most polluted, but from initial complaints, 1996 could rival it.

The aim of this study was to determine the incidence of illness and the possible effect of water contamination on the health of participants during and after the 1996 Canoe Marathon.

The results for the investigation were obtained from a questionnaire that was sent to all participants. In this questionnaire competitors were asked about issues such as their Dusi experience, contact with water, incidences of sickness and whether they had taken prophylactic medication. Relationships between the various categories of question were then sought. Of particular interest was the relationship between water contact and post race illness.

Of the 652 (50%) competitors responding, 43.7% were found to have had some form of illness or infection during or after the race. No relationship was found between illness and the number of times a competitor fell out of the canoe during the race. Of those who did not fall out, 35% were ill, while 39% of those who fell out 9 or more times were ill. It was also found that 20% of the respondents required treatment by a doctor.

The Umsindusi and Umgeni Rivers were shown to have E.coli levels that exceeded both national and international norms for the safe recreational use of water. Thus it was not surprising when it was found that the sickness ratio for the recreational use of these waters was 437/1000 people which is 50 times higher than accepted norms.

The results of this investigation lead to the conclusion that no matter how often the participants fell out or lay in the water, or what their experience or level of skill was, just being in contact with the polluted water was enough to cause illness.

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CONTENTS

1. Introduction

This report sets out the results of a retrospective study into the effect of river pollution on the participants of the 1996 Umsindusi ("Dusi") canoe marathon.

It focuses on areas such as the effect of water contamination on the health of participants during and after the race and whether these results were influenced by factors such as the experience of the paddler and the medication taken. Recreational water quality criteria and guidelines are important to be able to determine the acceptable risk of illness. The results outlined in this report are important for future canoeists for their health and that of the community with whom they are associated. This area of research must remain active to evaluate the efficacy of new ways of combatting disease and controlling pollution which are being developed constantly. It is hoped that the results obtained from this project may be used in the planning of the medical tent for the 1997 race and those subsequent to it.

The objectives of this project were:

1. To investigate the Dusi canoe marathon, especially with regard to sickness.
2. To determine whether the post race illness was related to the number of times the participant was in contact with polluted water.

The project focussed on the sicknesses encountered, the location of contact with contaminated water, the levels of contamination, the experience of paddlers and the medication taken before the race.

The quality of water in the Umgeni and Umsindusi Rivers has deteriorated markedly from the early canoe marathons when first Ian Player and later Clive Lawrance, in 1951 and 1964 respectively, describe contestants drinking fresh water from the river. Nowadays, illness and infection are considered part of the race hazard and contestants only drink water inadvertently.

The report begins by mentioning the previous work conducted in this field. It then describes the method through which information was obtained, before continuing with the analysis of the results. Finally, conclusions are drawn and recommendations for further research are made.

2. Background and Literature Review

The beginnings of the modern day Dusi canoe marathon can be traced back to the following events:

1. On January 4th 1893 the Natal Witness reported Bill Foley and Polly Marianni's eventful "voyage" from Maritzburg and arrival in Durban seven days later. They canoed along the Umsindusi and Umgeni Rivers and had to carry their canoes along the banks for miles where the river was unnavigable (Lawrance, 1986).
2. Timber Wood and Sonny Mitchell are purported to have accomplished the journey in 1910 (Lawrance, 1986) in a hazardous trip down the Umsindusi in flood (Player, 1964).
3. Ian Player dreamt of canoeing from Pietermaritzburg to Durban whilst in the mountains of Italy during the Second World War, and it was this dream which eventually became a reality.

The first race started from Alexandra Park on 22nd December 1951with 8 contestants. Mayor Warmback's prophesy that the race would become as popular as the Oxford-Cambridge boat race was greeted derisively by the crowd. Today, nearly fifty years later the Umsindusi Canoe Marathon is a much publicised event, which enjoys television, radio and press coverage, large sponsorships and evokes keen public interest. Unfortunately there is ongoing concern with the pollution levels of the river water.

The early participants were intrepid men taking part in a supreme test of endurance covering 200km. Today's course is 118km. The tortuous sections have been cut out with (Lawrance, 1986) more or less straight portages changing the nature of the race. The participants have become dedicated skilled athletes using modern training methods to pit their courage and fitness against the unpredictable rapids, demanding portages and sometimes overbearing heat of the Valley of a Thousand Hills. Hardly anyone purposely drinks the river water.

A number of articles corroborate the evidence that illnesses follow the Dusi Canoe Marathon (SALUS, 1988; Water Sewage and Effluent, 1993; Appleton and Bailey, 1990; Charnas, 1995; Gear et al, 1986;

Grabow, 1993; Taylor et al, 1995). The more serious instances found during the literature survey form the basis behind the motivation for performing this project. The quality of the water in the Umgeni and Umsindusi Rivers has deteriorated markedly from the time that Ian Player describes drinking fresh water from them in 1950 (Player, 1964) to the present day when illness and infections are considered part of the race hazard.

Ian Player complained of crippling stomach cramps and violent attacks of dysentery on his return from his pioneering run on the Umsindusi in 1950 and again after his first race which started in 1951 (Player, 1964). During the race he described small pools of clear water. The contrast in water was highlighted during the 1953 race where he drank "dirty brown water" and water from a "tiny clear running stream" and saw mirror clear pools (Player, 1964).

Lawrance talked of the slow brown water of the Dusi but also of crystal clear water that Graeme Pope-Ellis and Richard Hackland were able to drink in 1964 (Lawrance, 1986).

These conflicting reports may relate to the absence of dams on the Umgeni and its catchment area, resulting in the river being washed out only after rains. The dams have altered the water flow and the amount of water that stagnates.

In 1979, faecal matter washed into the river by rain caused dysentery or "Dusi Guts" and cholera in the rivers threatened cancellation of the race. Contestants were also plagued by heat, sunburn, fatigue, cuts, sprains, torn muscles and broken bones. Higher pollution levels in the river water followed increasing population and decreasing levels of sanitation in the informal settlements on the river banks. The threat of cholera was still present in 1982 (Charnas, 1995).

Gear et al (1986) reported on canoeists admitted to the Rietfontein Hospital complaining of symptoms of bilharzia following the Dusi Canoe Marathon. The canoeists defiantly continued paddling in rivers known to be infested with bilharzial intermediate host snails following treatment with praziquantel which is usually very effective against all stages of the parasite in its human host.

Appleton and Bailey (1990) found faecal coliform levels in the river water to be unacceptably high during the 1988 and 1989 race and also assessed the prevalence of bilharzia in the canoeing community. The Umsindusi and Umgeni Rivers flow through areas endemic for waterborne diseases. Canoeists are aware of the possibility of contracting bilharzia and 70% and 27% respectively had taken antischistosomal drugs in those years. There is less likelihood of infection in the fast flowing water of the rapids. Water contact activities that most frequently lead to infections involve immersion of most of the body for extended time periods. Fewtrell et al (1992) reinforced the fact that canoeists can be made ill by sewage contamination. In their article they showed significantly higher incidences of gastrointestinal and upper respiratory symptoms in those canoeists using the site with a higher degree of microbial contamination than spectators or canoeists using the site free of sewage contamination. Their investigation used a similar technique to the one conducted presently, in that a structured questionnaire formed its basis.

The outcry following the 1991 Dusi canoe race, considered to have been the most polluted, led Grabow et al (1993) to examine the effects of pollution on those competing in 1992. This information was used to formulate guidelines to protect the health of those using the river for recreational purposes as well as those who use it for their daily needs (Grabow, 1993). The quality of the water was better at all sampling stations in 1992 compared with 1991 although some stations still exceeded the maximum recommended limit. By March 1993 the pollution, according to an article in Water Sewage and Effluent, was under control.

In their serosurvey of waterborne pathogens amongst canoeists in South Africa, Taylor et al (1995) demonstrated a significant association between canoeing and the antibody response to Schistosoma spp but not to hepatitis A and Norwalk viruses. Their purpose was to establish whether any infections contracted by the canoeists could be attributed to exposure to waters containing dispersed sewage. Faecal coliform counts following bacteriological analyses of the Umsindusi/Umgeni Rivers far exceeded the mandatory limits of 2000/100ml (Appleton, 1990) set by the European Economic Community (EEC). The authors found that there is a potential risk that paddlers may contract a number of waterborne infections in waters containing dispersed sewage. These may however not be recognised or associated with watersport activities, due to difficulties in their diagnosis or to their mild or subclinical presentation as some gastrointestinal pathogens have incubation periods extending to weeks.

Whereas they may not drink polluted water intentionally, canoeists probably swallow water when they capsize and when they come into contact with aerosols from splashing water. Paddlers have been shown to be at risk of contracting meningitis, respiratory infections, gastro-enteritis, hepatitis A and schistosomiasis with immersion in or swimming in polluted water (Taylor et al, 1995). They also suffer infections of wounds. Stress and heat exhaustion may also manifest with symptoms of diarrhoea.

Devastating flooding of the Edendale area a week prior to the race in 1996 raised the E.coli count in the Camps Drift area to well above the "safe" levels (Appleton, 1990). The concerns of the canoeists were allayed when these were deemed to have reached acceptable levels by race day. Further heavy rains on day one and during the second overnight stop altered the E.coli levels. Anecdotal reports after the 1996 race suggested that there were more and sometimes more serious infections than the previous flood year of 1991.

The presence of E.coli in the water is an indicator of contamination with faecal material and possibly excreted pathogens. Those stations on the Umsindusi and Umgeni Rivers which yield high E.coli levels are areas of intense water contact activity and possible points of schistosomiasis transmission (Appleton,1990).

Few developing countries can satisfy the indicator bacteria standards set by the European Economic Community for recreational body contact with water of:

100 E.coli/100ml water as a guideline value

2000 E.coli/100ml water as the mandatory limit.

The standards used for bacteriological analysis of the Umsindusi river by the Umgeni Water Board can be summarised by the following table (note no mandatory level is given):

Table 2.A: Standards used by Umgeni Water for classification of water quality

Microbiological water quality	E. coli / 100 ml	Recreational health risk
Good	< 1000	low
Moderate	1000 - 10 000	moderate
Poor	10 000 - 100 000	high
Very Poor	> 100 000	very high

The South African Department of Water Affairs and Forestry have set guidelines for recreational use of water:

E.coli per 100ml target guideline range - 0-126 contact recreation

0-1000 intermediate contact recreation

The definitions of the EEC "mandatory limit" and SADWAF "intermediate contact recreation" were not obtained.

Table 2.B: A comparison of different standards for water quality

E. coli / 100 ml	Umgeni Water Classification		S.A. Dept of Water Affairs and Forestry	EEC water classification
	Microbiological water quality	**Recreational health risk**	**Target guidelines**	**Limit for body contact**
< 100	good	low	acceptable	100 guideline value
< 126	good	low	126 guideline value - contact recreation	under mandatory limit
< 1000	good	low	1000 guideline - intermediate contact reacreation	under mandatory limit
1000 - 2000	moderate	moderate	over guideline limit	under mandatory limit
1000 - 10 000	moderate	moderate	over guideline limit	over mandatory limit
10 000 - 100 000	poor	high	over guideline limit	over mandatory limit
> 100 000	very poor	very high	over guideline limit	over mandatory limit

Pollution other than faecal contamination occurs in the Dusi and Umgeni Rivers. Industrial effluent into the Baynes Spruit which flows into the Dusi is also one of the factors which causes pollution. Alleged "spillages" from an oil discharge point established by Capitol Oil Mills in Chesterfield Road in Councils Road reserve, were reported to the Medical Officer of Health by the City Engineer for the first time in 1992. Pollution of the Baynes Spruit had also been caused by discharge of printing ink residues into the adjacent storm water drain. This effluent may be a possible cause of the seriously infected wounds. Cooking oil discharged into the river in the region of Sobantu village was reported at the confluence of Baynes Spruit and the Dusi by many contestants and made paddling conditions most unpleasant.

Storm water causes overloading of the sewers, and sewers in a state of disrepair in and around Pietermaritzburg leak into the storm water drains. An increasing population of informal settlers

building shallow latrines close to the water sources together with poor agricultural methods and run off from lands polluted by human and animal faeces all add to the level of pollution in the rivers.

It should be noted that a large number of paddlers regularly train on the stretch of water between Connaught /Athlone and Ellis Brown bridges with little untoward effect.

3. Method of Analysis

Due to the large number of participants involved in the Dusi marathon, a questionnaire type survey was deemed to be the most suitable method of analysis. The questionnaire was designed using a review by D.H. Stone (1993) as a basis. A copy is included in the appendix.

The major points being investigated were:

- the incidence of infection
- the nature of infection
- the influence of pre and post-race prophylactic medication
- the effect of canoeing experience
- the number of chances of inadvertently drinking the water (falling out in rapids)
- the sites at which this occurred
- previous episodes of illness and septic wounds perceived to have been associated with the race

In order to test the questionnaire's efficacy it was distributed in the physiology department at the University of Natal Medical School. After revisions were made, it was then sent to every competitor (n = 1302) with an explanatory note as to the aims of the survey and a stamped addressed envelope was enclosed. Competitors were encouraged via the media and their respective clubs to reply. Anonymity was guaranteed and participation was voluntary. Seconds and others associated with the canoeists were not questioned.

Statistical planning beforehand determined the smallest sample which would be viable for evaluation and a return of 20% or 265 was deemed adequate. A response of 652 from a possible 1140 who finished the race was achieved (57%). Demographic data using descriptive statistics were entered into a spreadsheet.

Umgeni Water was contacted and provided the E.coli counts of water samples taken along the route of the race as well as commenting on the microbiological water quality and the associated recreational health risk. These were compared with the South African standards as well as those of the European Economic Community.

The data from the questionnaire was analysed using Chi square or T-tests where appropriate. The results are shown in graphs and tables. A full description of all trends investigated is given in the results section

A table of the medicines taken and illnesses as well as how many took medicines has been drawn up. The results of this and other such investigations are shown in graphical form. Immunisations against hepatitis, cholera, typhoid and tetanus were also noted.

4. Discussion of results.

4.1 The Results of the questionnaire

The questions were structured to determine the incidence of infection and to allow correlation with water contact. By using the information gained from the questionnaire, various trends were illustrated. Limiting factors are the ignorance of some of the competitors of the location of the places at which they fell out, as well as inadequate responses. Some bias may be expected in the results since one must presume that some of the competitors were particularly interested in voicing their opinion. The preamble to the questionnaire asked those who were not affected during or after the race to complete and return their form, indicating their healthy passage through the race.

The total number of starters in the 1996 Dusi was 1302. Of these 1,140 finished. Questions 1 and 2 (refer to appendix for copy of questionnaire) ask the competitors to indicate their previous Dusi experience and to state their skill level. Of the 652 paddlers who replied there were a greater number with less experience, 149 novices (Fig. 1). This trend is shown on a percentage basis in figure 2, with the field being broken up into different categories.

Figure 3 shows the distribution of Natal graded paddlers as well as a mixed group of ungraded paddlers and those from other provinces. It is clear that there were more paddlers who fell into the "C" category than any other. A future questionnaire could ask which province the paddler came from as well as his/her grade.

Gradings are done by the Chairman of the Kwa Zulu Natal Canoeing Officials Association mainly on single canoe (kayak 1 or K1) events and the average time of the best three races is taken. If only two have been completed it becomes the average of two. If only one has been completed that is taken as the time. The grade is based on a percentage of the winner's time. So that:

- A grade is within 110% of the winner's time
- B grade is up to 125% of the winner's time
- C grade is up to 140% of the winner's time
- D grade is up to 165 % of the winner's time
- E grade/novice is more than 165% of the winner's time

Fig. 1: Distribution of previous Dusi experience (n=652)

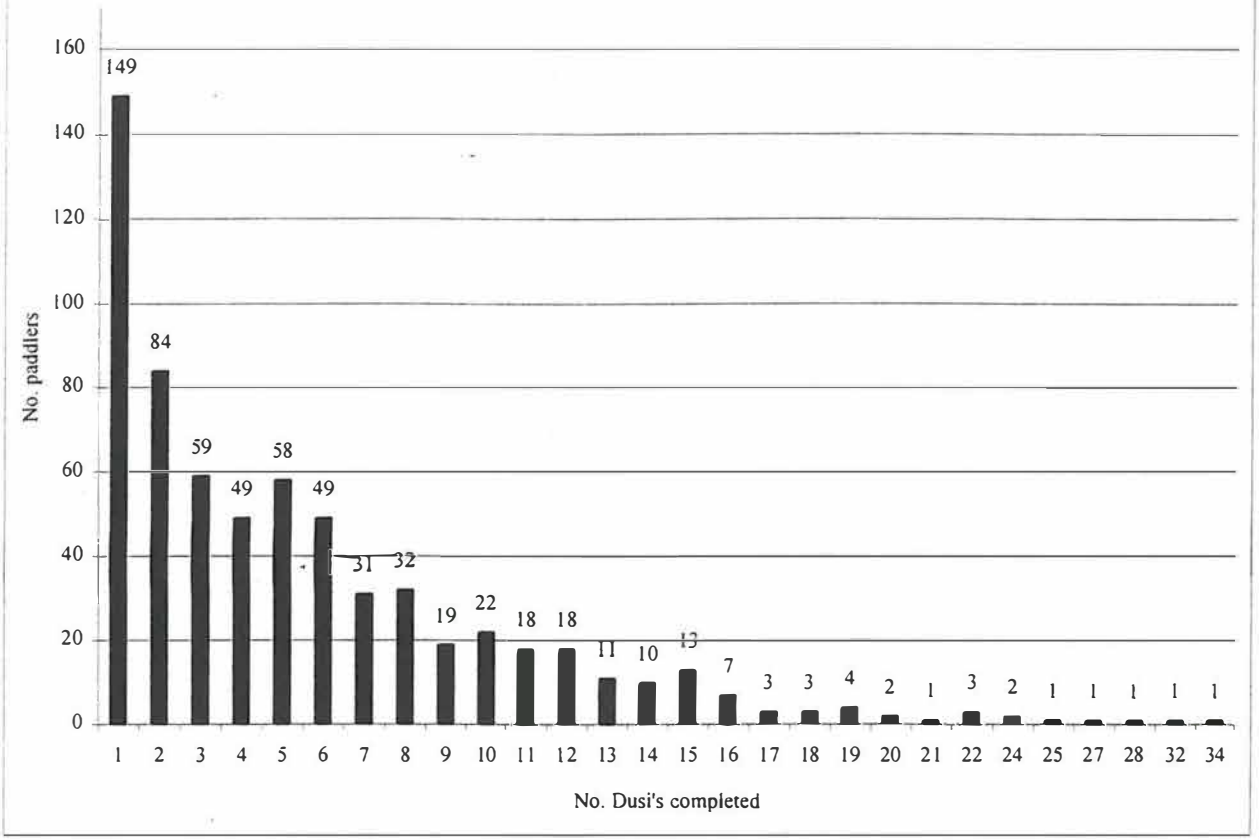


Fig. 2: Distribution of Dusi experience according to experience groupings (n=652)

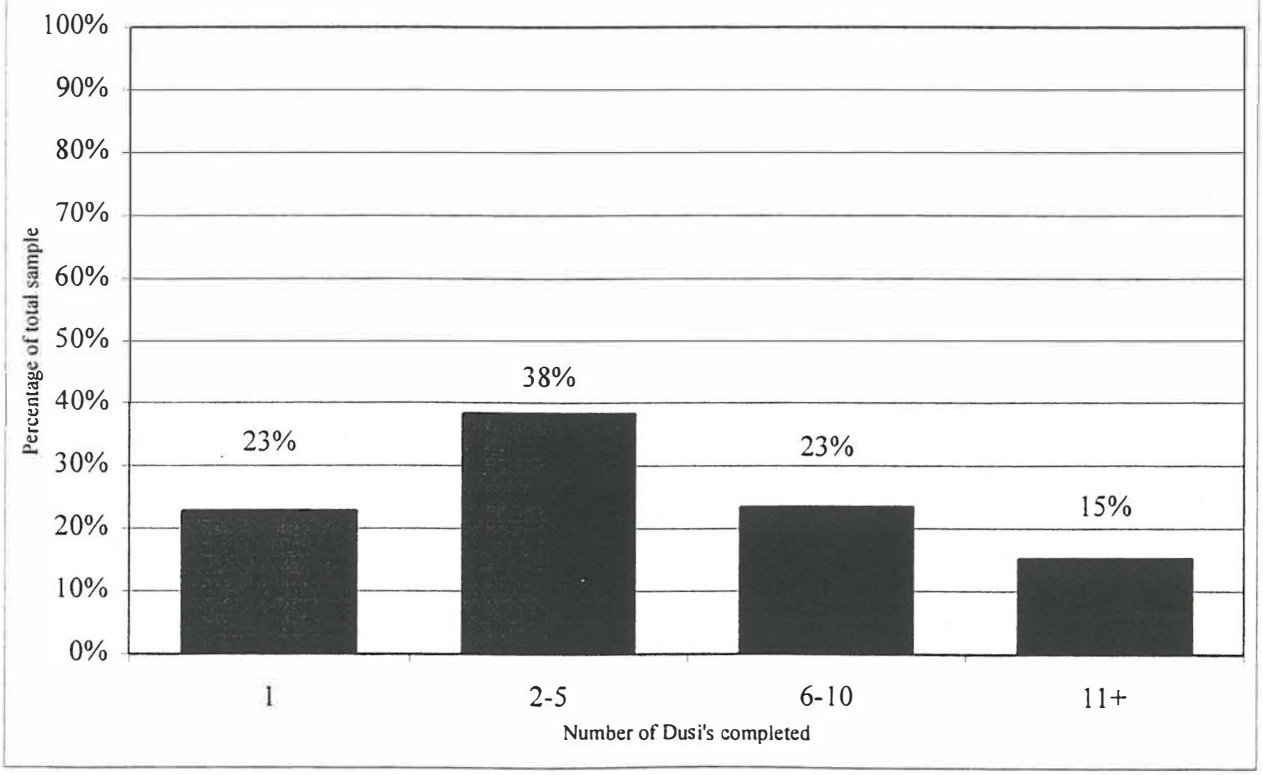


Fig. 3: Distribution of All Paddlers by grade (n=652)

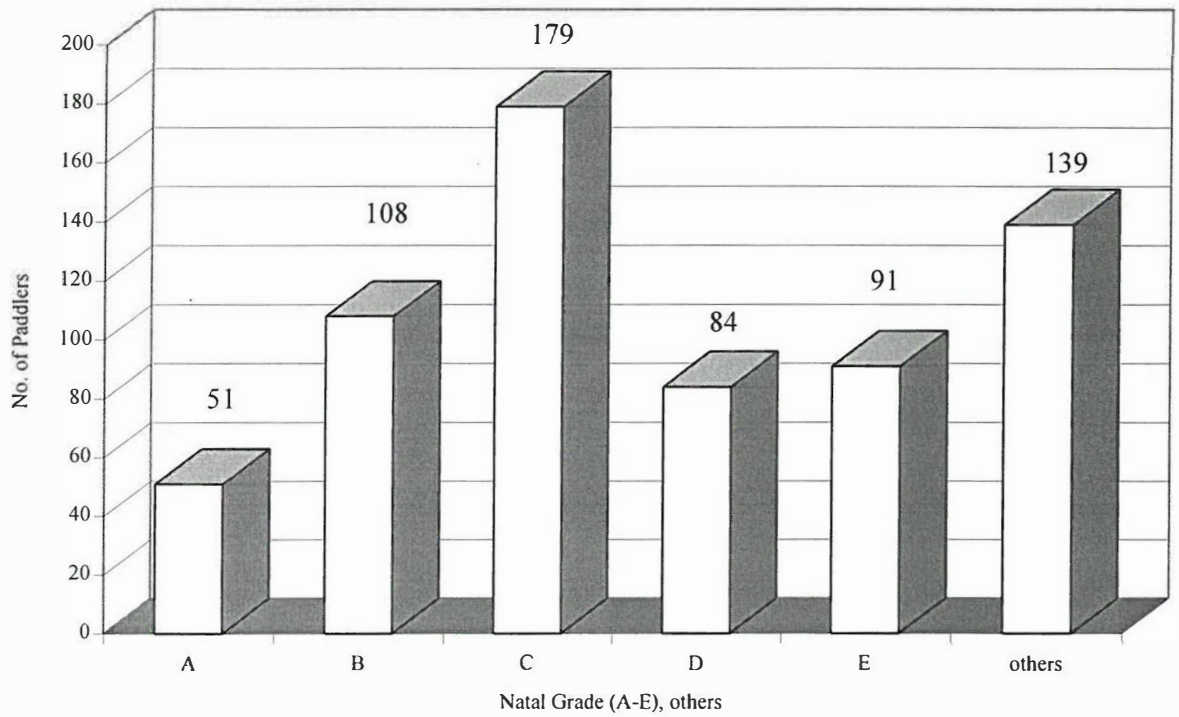
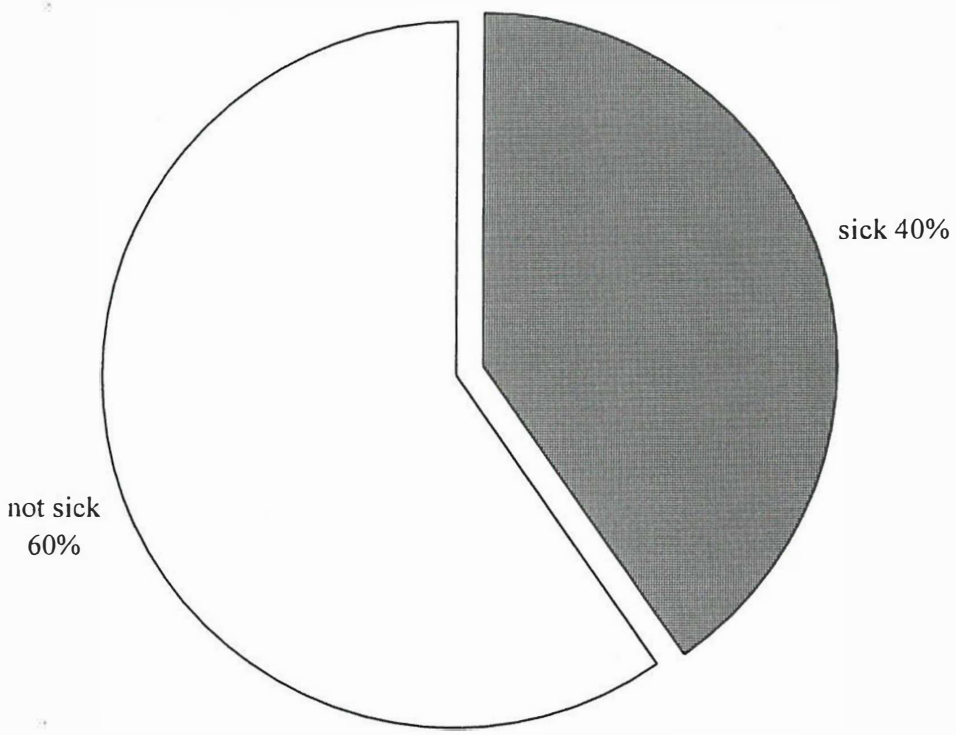


Fig. 4: Percentage of Competitors experiencing illness during or as a result of race (n = 651)



All first time paddlers are E grade in their first season unless they have done well during the season in which case they will be regraded.

Question 3 asks if the competitors experienced any illness during or as a result of the race. As can be seen in figure 4, 262 (40.2%) of the competitors answered positively. Detailed evaluation of question 5 reveals that, in fact, 285 respondents (43.7%) were ill during or after the race (this is a corrected value that takes into account the fact that respondents may have had more than one illness). There is thus an identifiable 3.68% error in responses to these questions. A further breakdown using question 4 shows that 60% of all competitors took medication of some sort (refer to figure 5). A later analysis showed that of the 262 who got sick, 85.9% took medication at some time.

Question 4 also asked the competitors to list the medicines used. Those most commonly used are shown in figure 6. Tables A1-3 in the appendix give a detailed breakdown of these results.

Figure 7 shows a breakdown of the 155 cases of immunisation, 55% did so against hepatitis in some form. A further breakdown of these cases is shown in tables 4.3.1.B and C.

Figure 5: Breakdown showing % paddlers using medication (n = 647)

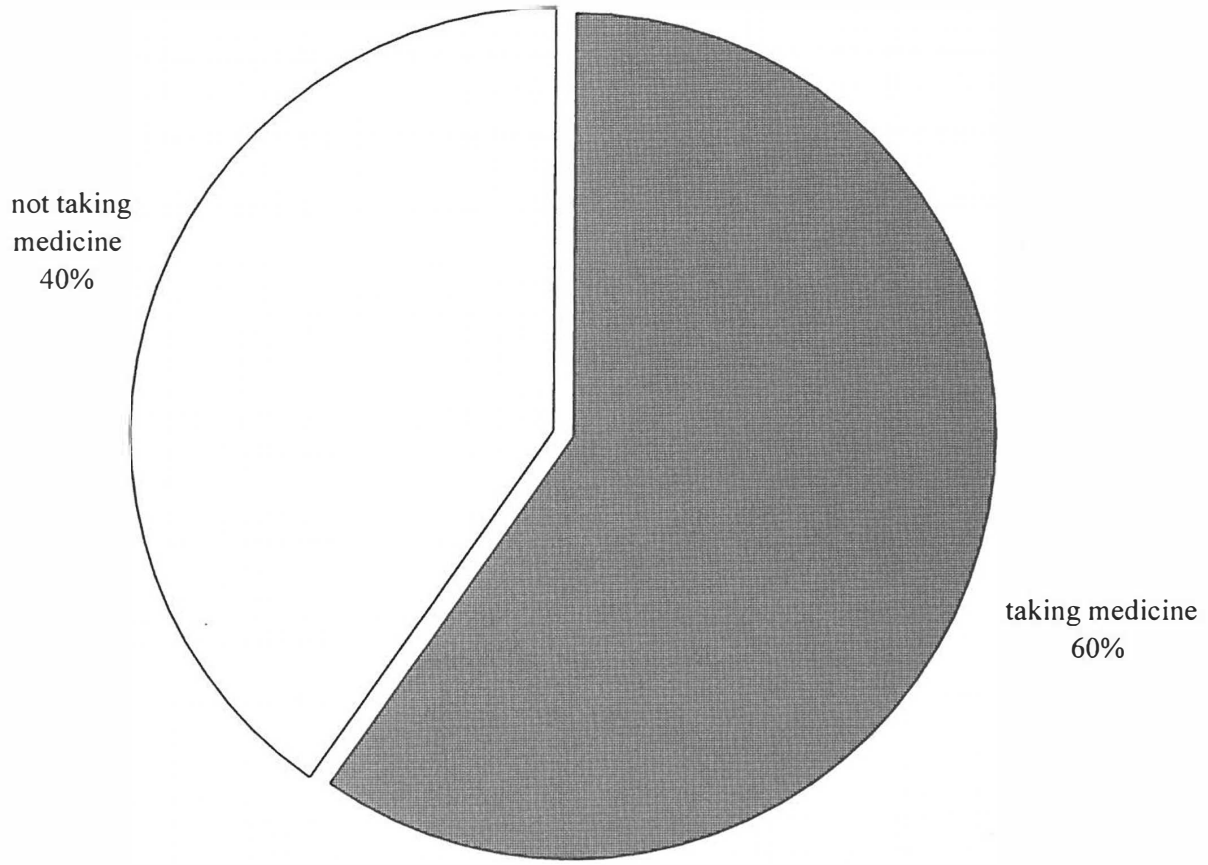


Fig. 6: Breakdown of Medicines Used during the Dusi (n=599)

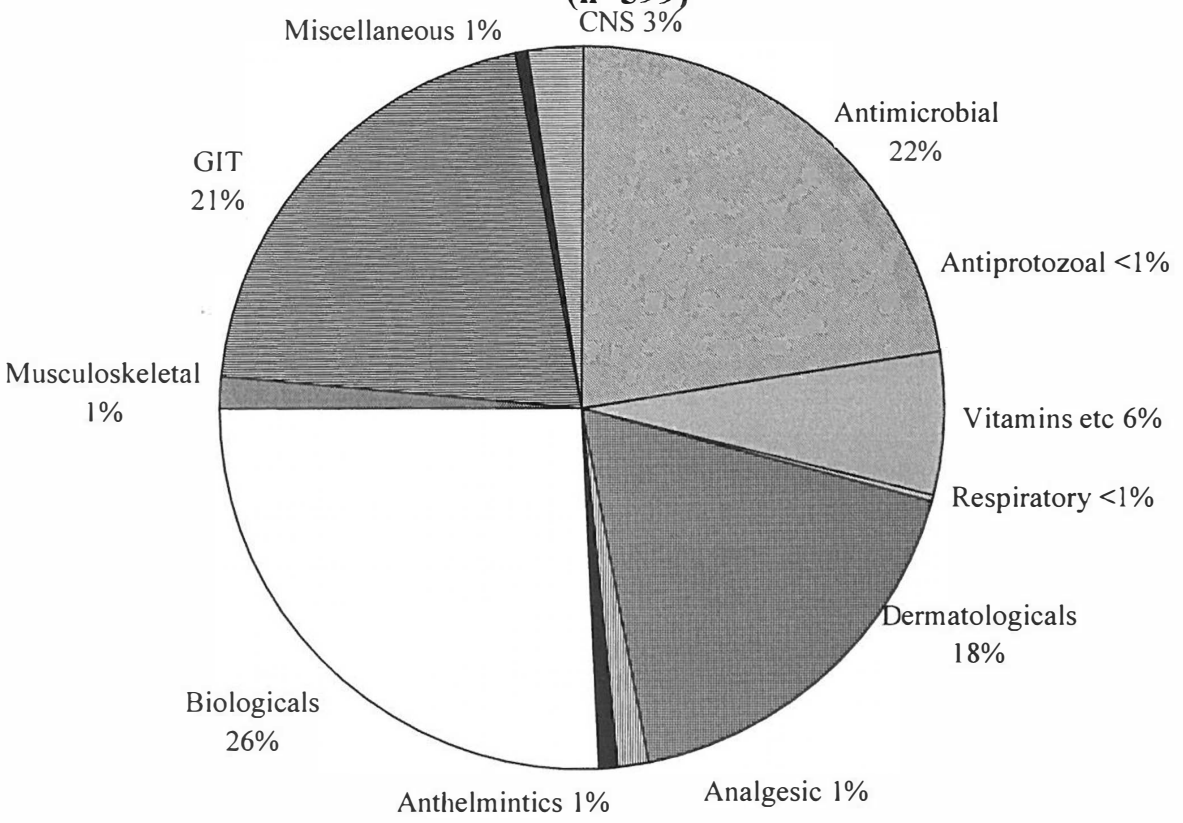
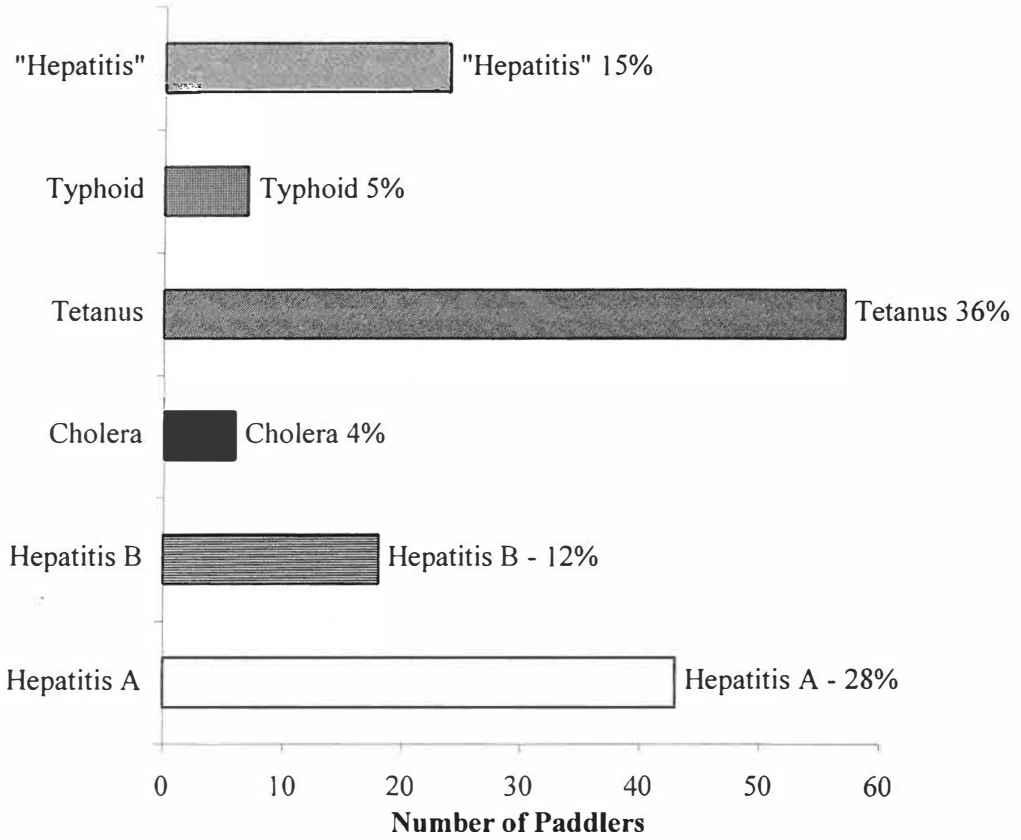


Fig. 7: Breakdown showing particular immunisations used by competitors (cases = 155)



In question 5 the objective was to determine the prevalence of particular illnesses and their timing. A summary of the results of this question is presented in the table below.

Table 4.1.A: A Comparison of different illnesses suffered during the race

	At any time		Day			After race		Treatment		
	Yes	No	1	2	3	Yes	No	None	Self	Dr
Diarrhoea	149	503	9	20	20	129	523	32	66	53
Nausea or vomiting	81	571	8	31	16	45	27	14	21	43
Infected wounds	123	539	17	17	22	100	554	8	65	59
Other illness	82	155	1	14	3	35	620		9	39
Total	435		35	82	61	309		54	161	194
Corrected total[1]	285		22	57	42	220				

As can be seen from the previous table (4.1.A), there were more occurrences of diarrhoea and infected wounds than either nausea or vomiting and other illnesses (which include dehydration, tick-bite fever, bilharzia and ear infections see table 4.6.A). From this table it is also possible to determine the number of people who were ill throughout the race, whether it be an overall figure or a figure on each particular day or after the race (This analysis is done using various conditional statements in a database scenario in order to prevent multiple entries being counted.) Although it must be noted that simply adding the totals of the columns will not give this figure - it will include cases where one paddler had more than one sickness. The results were analysed to account for this overlapping and the corrected totals as seen above were calculated. During the race 82 people reported 116 illnesses (1.4/person), with 220 people suffering 309 problems after the race (1.4/person). 285 people reported 404 illnesses (1.4/person) associated with the race. A breakdown of the grades and the distribution of illnesses appears in section 4.3.1.

One hundred and ninety four (194) conditions required treatment by a doctor (45%). This was made up of 36% of patients with diarrhoea, 53% of nausea and vomiting, 52% of infected wounds and

[1] The corrected totals account for the case where one paddler may have had more than one illness. This total excludes these cases.

48% of other infection. Almost every second problem required qualified medical attention. By extrapolation, as 44% had an illness or infection of some form, approximately one fifth of the participants in the race required treatment by a doctor as the result of participation.

If one refers to the days during the race on which the sicknesses were more prevalent there was a significantly greater chance of suffering from nausea and vomiting (Chi square $p < 0.001$) on Day 2. This may be explained by the fact that day 2 was extremely hot. Similarly there was a greater chance of experiencing any of the other medical problems, as described in Table 4.1.A, on Day 2 (Chi square $p < 0.001$). The subsequent data shows that post race problems were predominant. There are, however, some discrepancies, such as the fact that the sum of the instances of any particular illness on days 1,2 and 3 should be equal to or greater than the figure for "at any time" (they could be greater than, because a single competitor could have diarrhoea on day 1, 2 and 3). This is not the case for any of the above illnesses. All the entries (from the questionnaires) were checked. A possible explanation for the discrepancy is that the question was too complex to be answered quickly and without too much thought. (In some responses competitors expressed the sentiment that there were too many variables and that this question was not easily answered.)

Question 6 investigates the number of times paddlers fell out of their canoes, the location of these events and the number of times they lay in the water to cool off.

Table 4.1.B: Number of competitors falling out or lying in water on a specific day

	Number of times fallen out						lay in water	
	0	1	2	3	>3	total reply	yes	no
Day 1:	233	170	84	35	88	610	160	345
Day 2:	290	144	69	22	52	577	371	133
Day 3:	259	159	87	28	43	576	92	313

Without comparing the results of this question with one of the others (i.e. if the competitor was sick) it only shows how many competitors fell out or lay in the water on a given day. That 64% of respondents lay in the water on day 2, relates to the day being particularly hot, with paddlers trying to cool off after a strenuous haul across Inanda dam. A failure of the question was, that it did not ask whether the competitor avoided the most difficult part of the race by opting to use the Burma Road portage on the third day. Anecdotal reports by spectators indicate that a very small percentage paddled through to Durban. This suggests that the majority of fall outs reported on Day 3 occurred between Inanda Dam and the Burma Road take out (into unpolluted water), a relatively short distance of approximately 7km.

The results of question 7, which asks about illness and septic wounds in previous Dusi's, are summarised in the following table: This shows a select subgroup of paddlers with no previous sickness or sepsis.

Table 4.1.C: A comparison between 1996 and previous Dusi experience regarding illness and septic wounds

Criterion	Total having no previous condition	Number sick in 1996 (% of total is given in brackets)		
		Medication taken	No medication taken	Total
Never sick previously	**268**	86 (83.4%)	17 (16.6%)	**103** (38.0%)
Never any septic cuts previously	**298**	100 (84.0%)	19 (16.0%)	**119** (39.9%)
Never sick and never any septic cuts previously	**223**	72 (83.7%)	14 (16.3%)	**86** (38.5%)

From the table it is clear that of 268 paddlers who had no previous experience of sickness in the Dusi, 103 (38%) were sick in 1996. Of this group of 103, (83%) took medication while 17% did not. The results show that 39% of competitors who were never previously incapacitated during the Dusi, were affected during the 1996 race. This group had completed 1514 Dusis between them without being sick. One must also bear in mind that people do tend to forget what happened years ago, so that the reporting might not be totally accurate.

The following table shows the results of a comparison between competitors who obtained infected wounds during the 1996 Dusi and those who obtained such wounds in previous Dusi's. A corresponding comparison for illnesses is shown in table 4.1.E.

Table 4.1.D: A comparison showing occurrence of infected wounds in 1996 Dusi vs previous years

		Infected Wounds (1996)	
		Yes	No
Previous infected wounds	Yes	39 (36.8%)	67 (63.2%)
	No	84 (12.7%)	461 (87.3%)

There is a significantly greater chance of having wound infection if there has been a previous incident of wound infection ($p<0.001$, Chi Square)

Table 4.1.E: A comparison showing occurrence of illnesses in 1996 Dusi vs previous years

		Illnesses (1996)	
		Yes	No
Previous illnesses	Yes	91 (44.2%)	115 (55.8%)
	No	190 (42.8%)	254 (57.2%)

There was however no significant difference between previous illness and illness in the 1996 Dusi ($p=0.74$, Chi Square)

The above value shows that there is not a significant relationship between those competitors who were ill in both the 1996 Dusi and in previous years.

4.2 The influence of water quality on the instances of sickness

There are many pathogens in the water. E.coli is the only one routinely assessed on the course of the race by Umgeni Water, so that this is the only available information to monitor the water status.

During the 1996 Dusi marathon the Umgeni Water Board monitored the E.coli levels at various sampling points along the course. The results are shown in the table 4.2.A. Figure A in the appendix shows a map of the Dusi route together with:

- The number of competitors who fell out at each location
- Umgeni Water Board sampling points
- Locations 1 - 20
- E. coli levels / 100ml

Table 4.2.A: Results showing E.coli levels at sampling points along Dusi route (E.coli/100ml)

Sample points	Sample description	Day 1 - 25/1/96	Day 2 - 26/1/96	Day 3 - 27/1/96	1 week prior 17/1/96
61	Slangspruit - Mason's mill	10 000	109 000		690 000
62	Dusi - Edendale Rd	22 000	55 000		49 000
62.2	Camp's Drift - Upper weir	14 000	63 000		30 000
62.3	Camp's Drift - CD Rd	* 35 000	39 000		37 000
62.4	Camp's Drift - Lower weir	* 29 000	27 000		33 000
63	Dusi - Daniel Lindley bridge				
64	Dorpspruit - Ohrtman Rd				
64.1	Baynespruit	* 610 000			
65	Dusi - above refuse dump	* 160 000			
65.1	Blackborough Spruit				
66	Dusi above Darville STW				
66.1	Dusi upstream Baynes Spruit				7 200
66.2	Dusi - U/S Darville maturation river		46 000		3 100
66.3	Dusi D/S Darville maturation river				
67	Dusi - at Motorcross	* 300 000	91 000		3 900
67.1	Mpushini River	* 3 300			
68	Dusi above Mshwati confluence	* 3 500			
70	Eddy Hagan Drive	* 4 200	139 000		4 000
70	X - sample (duplicate)		88 000		
71	Dusi upstream Umgeni confluence		* 5 500		
	"Overnight"		580		
20	Umgeni/New Inanda weir		* 6 100		
23	Umgeni Kwa Magugwana		* 2 400		
26.1	Umgeni Inanda inflow	53 000	* 3 900		
	"Bridge 4"		* 1 900		
	"start" second day			* 1 200	
26.2	Umgeni weir below Inanda	104		* 60	
346.1	28 Umgeni Clermont pump			* 3 500	
28.5	Umgeni below Kwadabeka			* 8 200	
28.1	Umgeni above N2 bridge		8 900	* 14 400	
28.2	Umgeni Connaught surface		7 700	* 60 000	
28.3	Umgeni Athlone bridge surface		8 800	* 52 000	
28.4	Umgeni Ellis Brown surface		8 900	* 81 000	
8	Umgeni - Albert Falls outflow			10 800	

Note that an asterisk (*) denotes the samples taken on the race route on the race day. If a result is omitted, the test was not conducted.

On the first day of the event, the E.coli levels measured are all classified as moderate to very high health risks. For example, the E.coli level at the start of the race, sampling point 62.3, (35,000) constituted a high recreational health risk, and that at the last portage take out point at Sewerage farm, 65, (160,000) a very high risk. The level at the sampling point 64.1 at Baynes Spruit was 610,000 E.coli/100ml water, the highest recorded during the three day event - a very serious health risk. There are several sewers at this point which affect the Dusi. The heavy rains made the level at 67 (i.e. Dusi at Motorcross) even worse and the microbial water quality very poor whereas on Day 2 the water quality was still poor but the E.coli level markedly down at the same point.

The levels on Day 2 fell within the moderate health risk. The route traverses relatively inaccessible terrain with a comparatively low population density. This may explain the lower levels seen on Day 2.

It is interesting to note that even though the above levels are extremely high, the bacteriological analyses for the Umsindusi River sampled a week before the race showed even higher E.coli levels than those measured on Day 1 at the start.This must have been cause for grave concern as to the advisability of holding the race.

On Day 3 the water from the bottom of Inanda Dam becomes surface water after the Dam, which probably accounts for the low 60 E.coli/100ml water. At Tops Needle immediately after the Dam 167 paddlers fell out, but into this fresh water. As the route proceeds an increasing level of pollution can be seen as tributaries and sewers run into the river. From the low level of 60 E.coli/100ml at Tops Needle the levels rise steadily (with a dip at Athlone Bridge) to above 80,000 E.coli/100ml at Blue Lagoon.

Heavy overnight rain and rain during the day pushed the levels on the third day up 8-9 fold. The prediction of the E.coli levels thus becomes very difficult due to the weather conditions and there is a major fluctuation on a daily basis. There is also a difference in E.coli levels at various depths of water as for example surface water and water deeper down. An attempt must then be made to replicate samples in order to make comparisons. Advice becomes difficult to give because the levels change more especially with heavy rain. The E.coli levels were higher than is internationally acceptable on the 1st, 2nd and 3rd Days, and on Days 1 and 3 higher than South African standards. Day 2 still exceeded the EEC acceptable limits.

The daily fluctuations can clearly be seen e.g. at sample points 28.3, the Umgeni at Athlone Bridge levels increase from Day 2 (8,800) to Day 3 (52,000) and at 67 they decrease from 300,000 on Day 1 to 91,000 on Day 2.

At sample point 26.1, on Day 2, the E.coli levels fell within the moderate recreational health risk with microbiological water quality of moderate standards. The day before the recreational health risk would have been high and the water quality poor. This makes the giving of advice and the prediction of E.coli levels extremely difficult although years of monitoring these same levels may make it possible.

The change in levels with heavy overnight rain is illustrated by sampling points 28.1, 28.2, 28.3 and 28.4 where the levels increase markedly from Day 2 to Day 3 but fluctuate on Day 3 along the course of the Umgeni probably due to various sewers joining the river.

A week prior to the race the levels at the start were higher than on the day of the race reiterating the point that prediction of the levels is difficult particularly with changing weather conditions especially heavy rains. The E.coli levels are either raised due to overflow of the sewers or lowered when the rivers are washed out.

The relationship between the particular level of E. coli, the number participants falling ill at this location and the number who came into contact with the water is performed in section 4.5.

4.3 The influence of experience or grade on contact with water and sickness

4.3.1 The Influence of grade

The subsequent investigation is based only on the Natal graded paddlers, (n=518), since they formed by far the majority of those returning their questionnaires. Grading criteria are outlined in Section 4.1. The criteria that were compared against the canoeists grade were variables such as: the number of times a paddler lay in the water on a particular day and the number of times a paddler fell out of his/her canoe on a particular day. Also shown are trends to see if a relationship exists between the grade of paddler and the number of competitors experiencing various medical problems.

Figure 8 shows the trends for the grade of paddler with the percentage of that grade that lay in the water during day 1, 2 and 3. It is found that the higher (A is the highest) graded paddlers tended to lie in the water less than the lower grades. This can be attributed to the fact that they are more competitive and would only lie in the water once the stage has been finished. This fact, can be clearly seen on day 2 when a large proportion of all the paddlers lay in the water. The day was particularly hot and the stage finished after a long paddle across the dam. The paddlers then cooled off by swimming in the dam.

This trend is even more marked in figure 9 which shows the percentage of paddlers of each grade that fell out on a particular day. Here not only would one expect the higher graded paddlers to have a lower overall percentage who fell out but also that the percentage of paddlers who fell out over 3 times should also be considerably lower than the D and E grade paddlers. The higher grade paddlers (A) fell out significantly less than the lower grade paddlers on Day1, Day 2 and Day 3 (Chi-square, $p = 0.001$).

Fig. 8: Trend Comparing grade of paddler with % of grade that lay in water

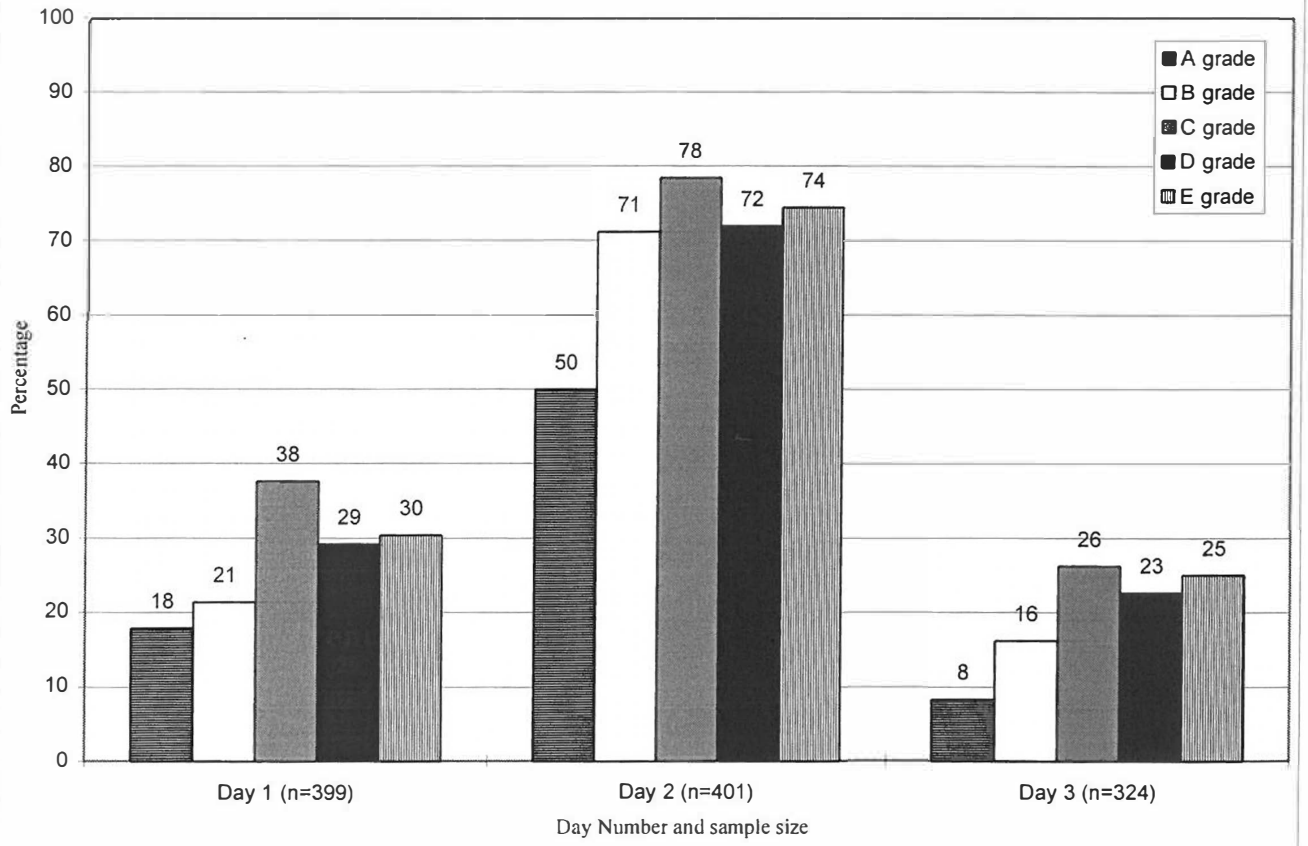
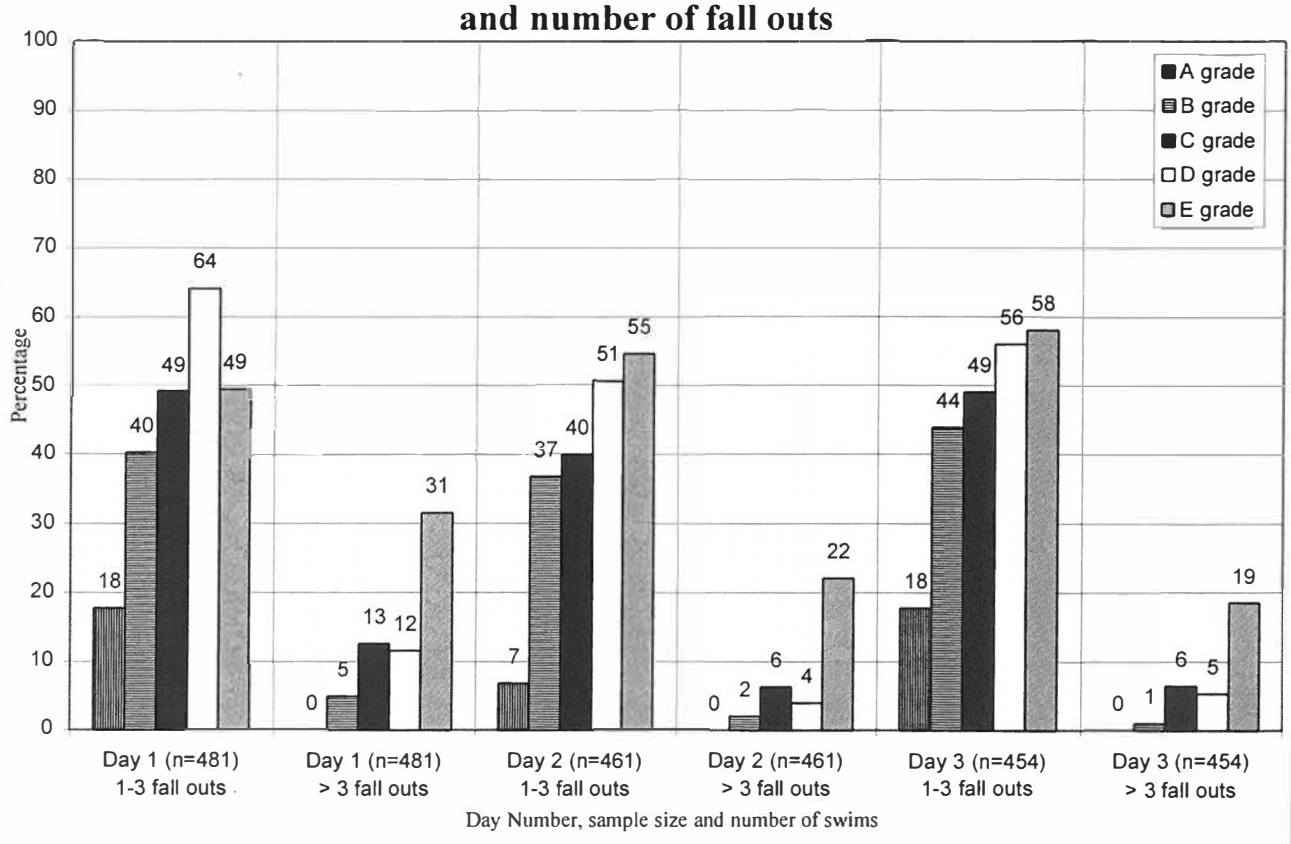


Fig. 9: Trend of grade compared with % of grade that fell out and number of fall outs



In figure 10 and 11 a relationship between various illnesses and the grade of paddler is investigated. The results do not show a consistent trend. There is a surprising result that the higher graded paddlers tended to have a higher percentage who suffered diarrhoea and medical illnesses during the race. A possible explanation for this is that they were highly trained and might have been sufferring from a depressed immune system and this together with the deleterious effects of heat and exhaustion would have made them more susceptible. The higher grade paddlers, by virtue of their skill, are however, competing for a shorter time and should have fewer problems.

A statistical analysis showed that there was a significant difference between the A through E grade paddlers for the above trends (Chi-square for linear trend 3.956, p = 0.0467.) Mixed grade was excluded from the statistics. Of the A grade paddlers as seen in the table below significantly fewer fell out but 45% fell ill, whereas the E grade paddlers who had a lot of water contact only had 33% sick. The amount of water contact thus does not seem to be a factor in determining sickness.

Table 4.3.1.A: Competitors who fell out and were sick

Grade	Did not fall out	Fell out	% Fell out	Sick	Not sick	% Sick
A (n =51)	36	15	29.4	23	28	45.1
B (n = 108)	31	77	71.3	49	59	45.4
C (n = 178)	33	145	80.1	78	100	43.8
D (n = 83)	10	73	87.9	30	53	36.1
E (n = 90)	5	85	94.4	30	60	33.3
Mixed (n= 142)	28	114	80.3	52	90	36.6

In a further investigation into the immunisation undertaken by participants it was shown that almost the same number of people got sick as not. This can be interpreted as either that the immunisations were not effective or that the participants were immunised against the wrong diseases. Table 4.3.1. B and C compare these results. These tables show a sample of the paddlers who felt it necessary to take either immunoglobulins or be vaccinated against tetanus, hepatitis A and/or B, cholera and typhoid over and above any treatment for diarrhoea, nausea or infected wounds.

Fig. 10: Comparison of grade vs % grade suffering "other illnesses"

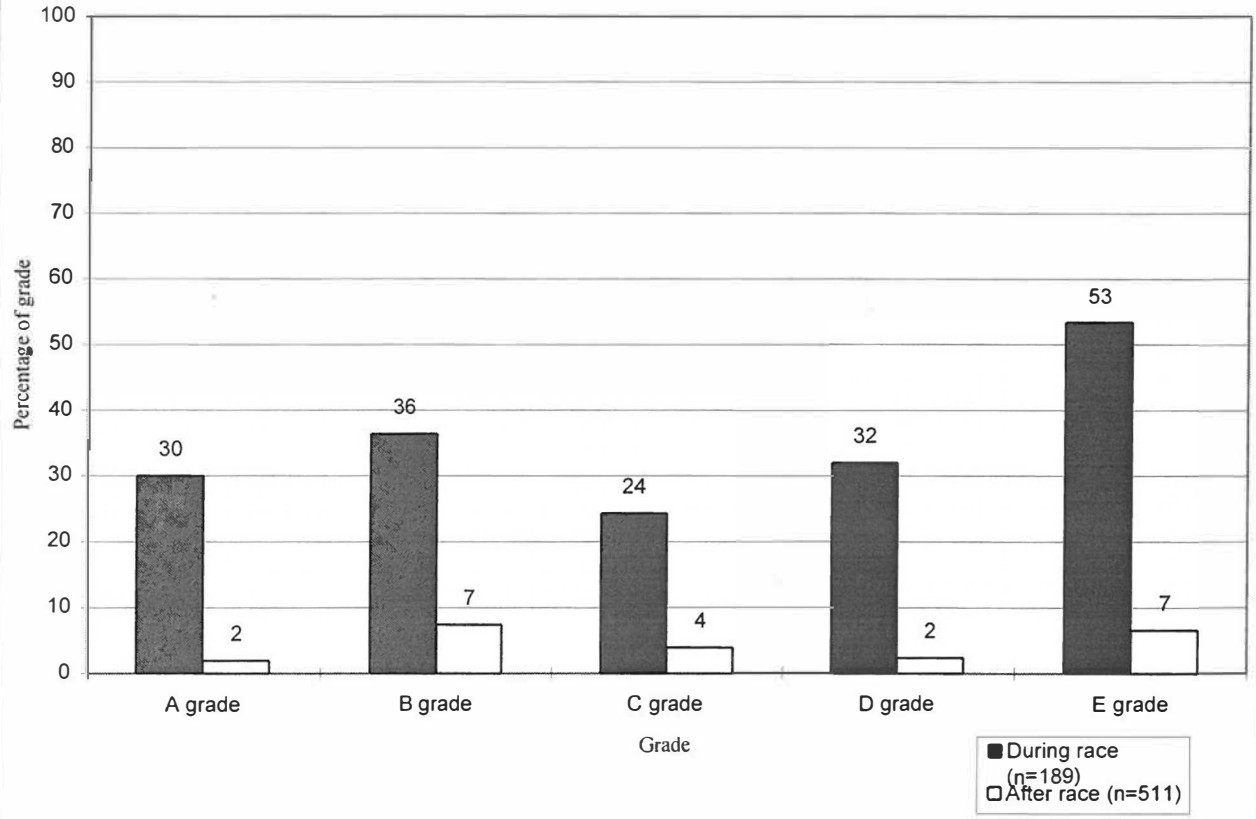


Fig. 11: Diarrhoea and Infected wounds suffered after the race

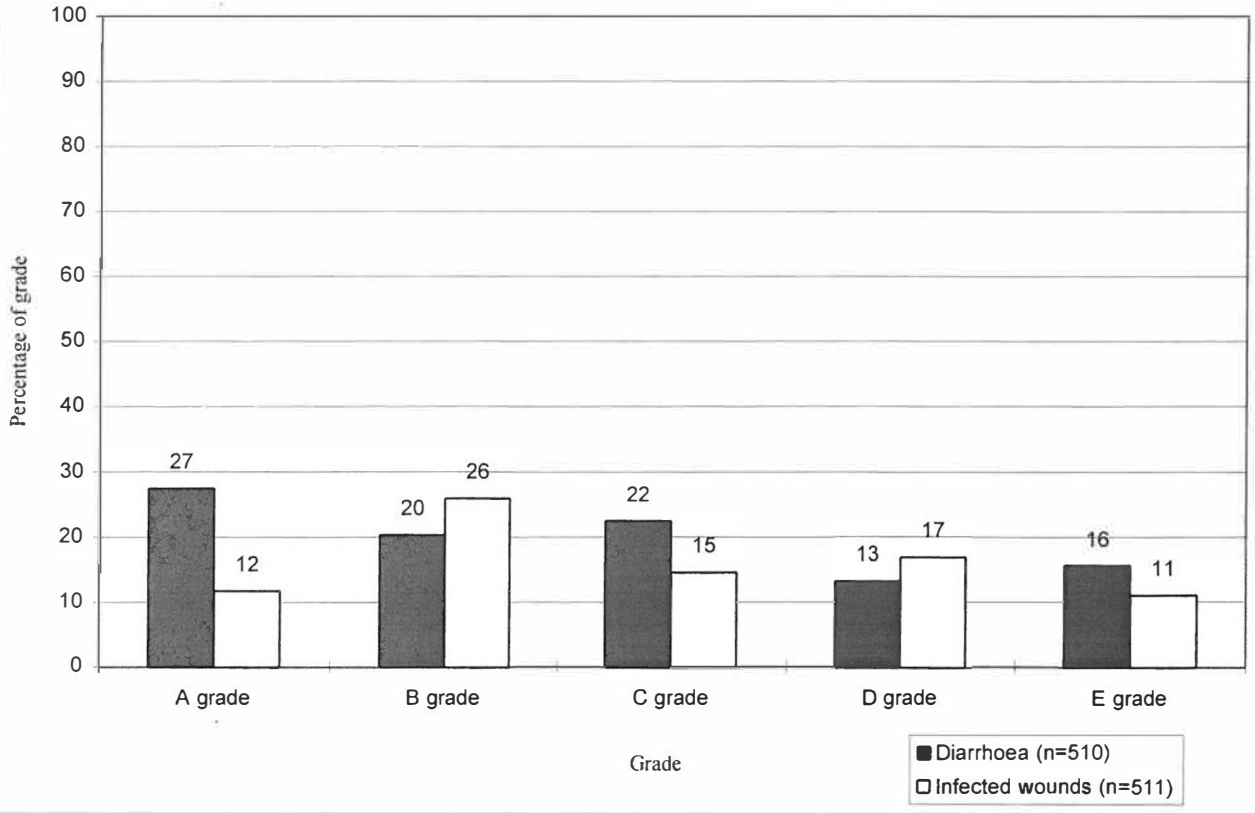


Table 4.3.1. B Competitors who were immunised and were sick

Grade	Total people immunised	1 vaccine	2 vaccine	3 vaccine	completed races
A (n =51)	4	4	0	0	17
B (n = 108)	8	5	3	0	44
C (n = 178)	18	10	7	1	73
D (n = 83)	5	3	2	0	20
E (n = 90)	5	0	4	1	6
Mixed (n= 142)	12	7	2	1	26
Total	**52**	**29**	**18**	**3**	**186**

Table 4.3.1.C: Competitors who were immunised and were not sick

Grade	Total people immunised	1 vaccine	2 vaccine	3 vaccine	completed races
A (n =51)	5	2	1	2	22
B (n = 108)	7	4	2	1	49
C (n = 178)	14	9	5	0	70
D (n = 83)	6	3	2	1	21
E (n = 90)	10	7	2	1	13
Mixed (n= 142)	13	7	4	1	51
Total	**55**	**31**	**16**	**6**	**226**

Further statistical analyses were conducted comparing grade with diarrhoea, nausea, infected wounds and other illnesses. In all of these cases the p value was greater that 0.1 thereby showing no significance in these associations.

The following table shows a breakdown of the distribution of cases of illness according to grade.

Table 4.3.1.D: Distribution of illnesses according to grade

Grade	1 Illness	2 Illnesses	3 Illnesses	4 Illnesses	Multiple Illnesses - % of grade (absolute no. in bracket)	Totals
A (n =51)	14	9	0	1	19.6 (10)	**24**
B (n = 108)	31	13	6	2	19.4 (21)	**52**
C (n = 178)	66	18	2	0	11.2 (20)	**86**
D (n = 83)	23	6	2	0	9.6 (8)	**31**
E (n = 90)	17	18	3	0	23.3 (21)	**38**
Mixed (n= 142)	38	12	4	0	11.3 (16)	**54**
Total	**189**	**76**	**17**	**3**	**(96)**	**285**

It was found that the numbers of illnesses from 2-4 were too small to do a correlation coefficient; therefore, 2, 3 and 4 illnesses were combined and then compared against the

grades. The comparison performed revealed that there was no significant relationship between the grade and number of illnesses. (Chi square for linear trend = 0.575, p = 0.448).

4.3.2 The influence of experience

This investigation ranks the experience of the competitors based on the number of Dusi's completed into the following groups: 1, 2, 3, 4, 5-10 and more than 11 completed Dusi's. One might expect that the more experienced competitors would be more aware of the dangers of contracting illness from water contact. Because of this they would be expected to take more care not to lie or swim in the water. This would suggest that the more inexperienced paddlers should be more likely to become sick. However, a statistical analysis on these two criteria was performed and it was found that there was no statistical significance in such a comparison (p = 0.287).

Figure 12 shows the relationship between the experience of the paddler and the number of times that he/she lay in the water on day 1, 2 or 3. Figure 13 shows the number of times the paddler fell out as a percentage based on experience. The structure of the questionnaire prevented a correlation of this data as the data was entered in categories rather than exact discreet values. A Chi square analysis of these trends shows that experienced paddlers (5 or more completed Dusi's) fell out significantly fewer times than novices (first Dusi), on each of the days of the race, $p < 0.001$. A possible explanation could be that they were more aware of conditions of the river and possible danger areas and were more skilled. By day 3 the difference between the number of times the experienced paddlers fell out versus the inexperienced has decreased. This is probably a reflection of the fact that more experienced paddlers attempted to paddle through the more difficult sections at Tops Needle and around the Burma portage while the less experienced paddlers were more conservative and portaged rather than risk breaking their boats and failing to finish.

A T test was used to compare those who did and did not fall out with respect to the average years of experience. Results showing these average number of years of experience for zero or one or more fall outs as well as the respective standard deviations (S.D.) are shown in the table below:

Table 4.3.2.A. A comparison of the number of fall outs with the average no. of years experience

Day number	no fall outs - ave. no. years experience (S.D.)	one or more fall outs - no. years experience (S.D.)	Chi Square P value
1	6.32 (3.56)	4.16 (3.35)	< 0.001
2	6.07 (3.60)	3.85 (3.18)	< 0.001
3	5.86 (3.60)	4.29 (3.37)	< 0.001
Combined 3 days	7.32 (3.39)	4.31 (3.41)	< 0.001

From the above table it is clear that those who did not fall out during a particular day or during the entire race, had significantly more experience than those who did fall out.

Figure 14 shows a trend that relates the paddlers experience with other variables such as miscellaneous illnesses (i.e. bilharzia, tick-bite fever, dehydration etc) suffered and medication used. The only noticeable trend found in these figures is that the less experienced paddlers tended to take more medication. A possible explanation is that the novices took medication as a precaution, as they had been warned of the dangers of the race.

Fig. 12: Comparison of experience of paddler with % of paddlers who lay in water

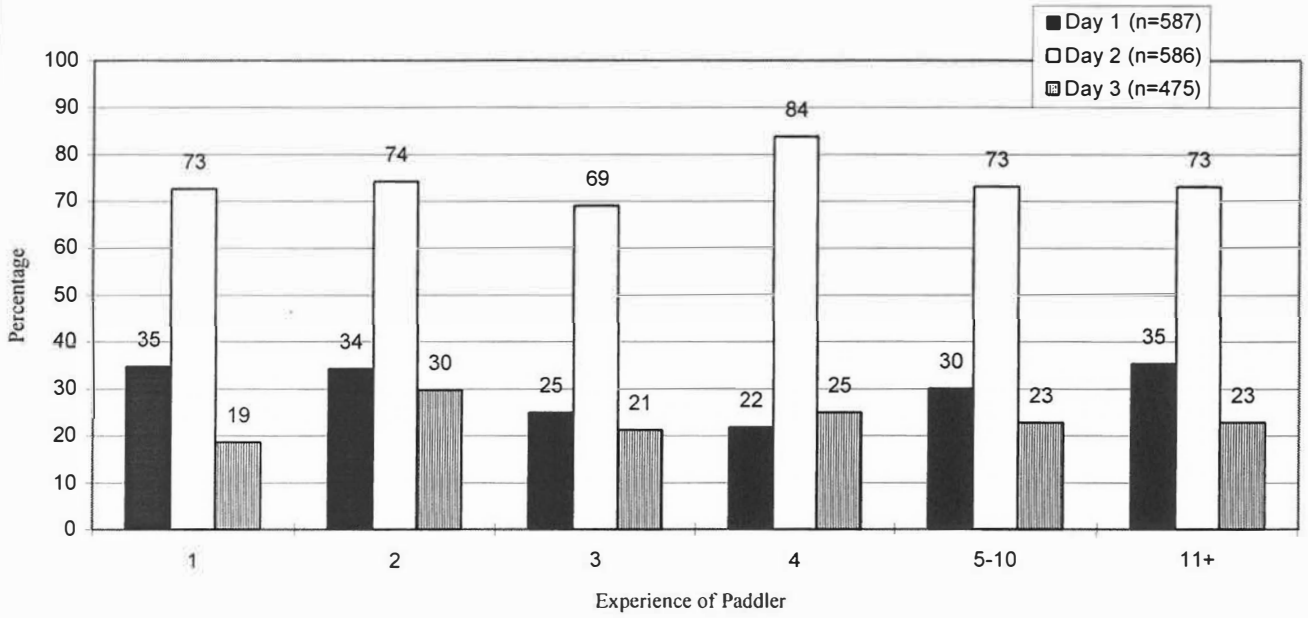


Fig. 13:Trend of experience compared with % of paddlers that fell out and number of fall outs

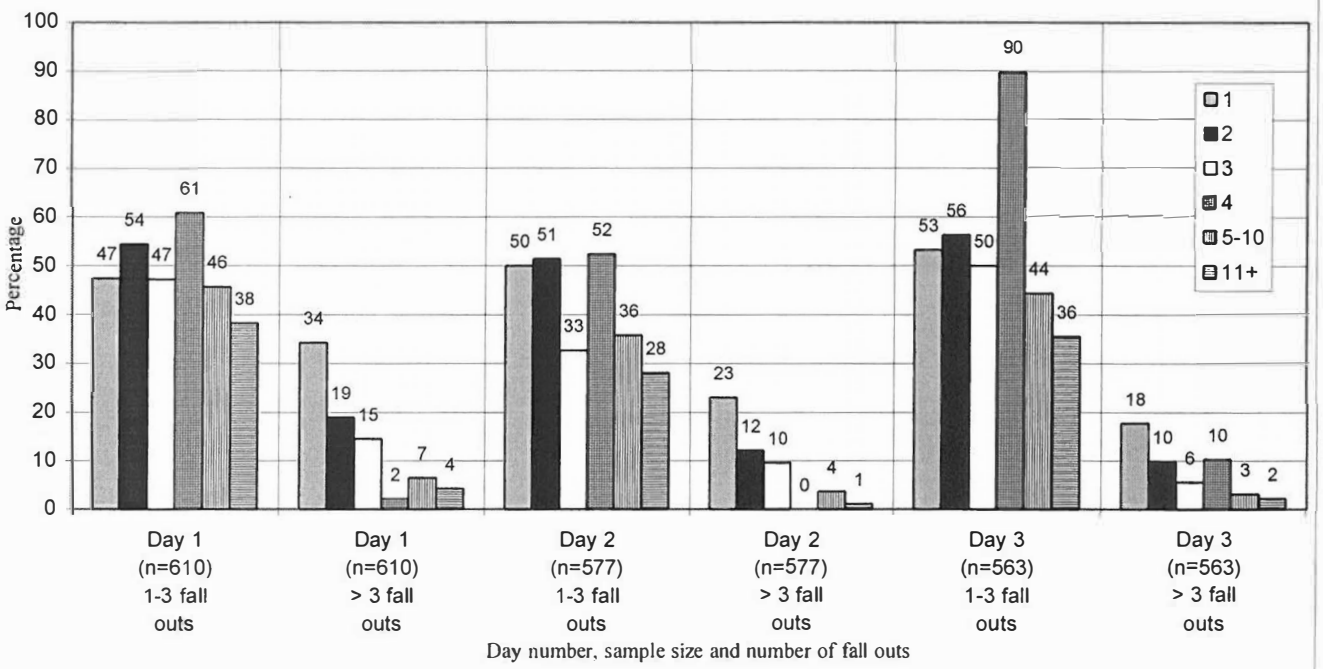
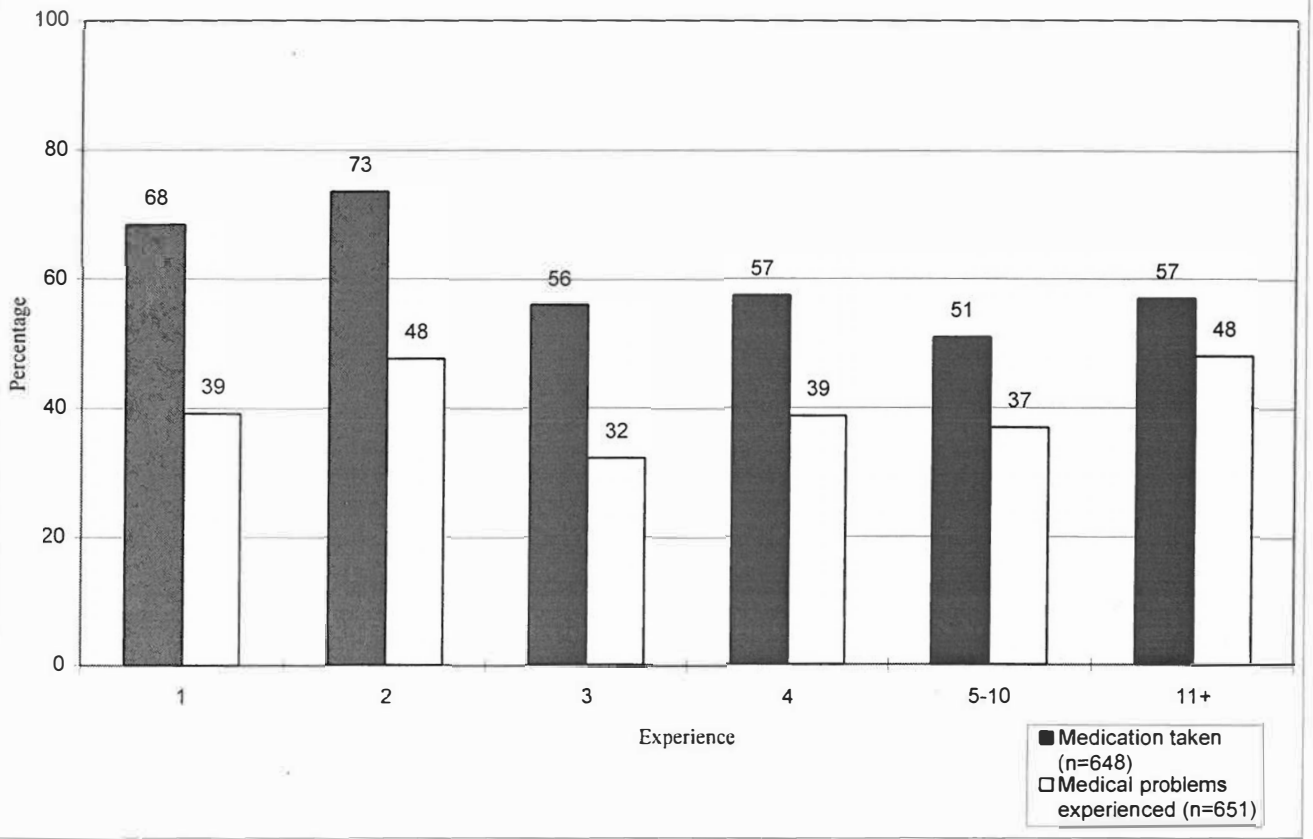


Fig. 14: Experience of paddler vs % of paddlers who took medication and % of paddlers experiencing medical problems



The three tables below show the percentage of each particular experience category and the type of illness suffered. The results for each particular day can be compared with the daily average for all categories and from this it can be seen whether a particular category was more susceptible to that illness.

Table 4.3.2.B: A comparison of experience versus the instances of diarrhoea suffered during and after the Dusi

Previous experience in marathon	% of category with diarrhoea on day 1	% of category with diarrhoea on day 2	% of category with diarrhoea on day 3	% of category with diarrhoea after race
1 (n=149)	2.1	1.4	3.5	26.17
2 (n=84)	1.2	1.2	4.8	22.6
3 (n=59)	0	3.4	3.4	11.9
4 (n=49)	0	2.0	2.0	16.3
5-10 (n=211)	1.4	1.9	1.9	17.5
11+ (n=100)	1.0	2.0	3.0	18
Average	**0.95**	**1.98**	**3.1**	**18.75**

In the above table the only remarkable trend is that the incidence of diarrhoea increases as the race goes on. This can be explained by the fact that those who contracted the illness on day 1 continue to suffer from it on the following days. There is thus a cumulative effect. Another possible explanation is that there is an incubation period and the diarrhoea manifests later.This is borne out by the fact that there were a much higher percentage of paddlers in all categories who had diarrhoea after the race. A Chi-square test was used to compare the different categories and no statistical difference was found between novices and experienced paddlers who had completed 5 or more races.

Table 4.3.2.C: A comparison of experience versus the instances of nausea suffered during and after the Dusi

Previous experience in marathon	% of category with nausea on day 1	% of category with nausea on day 2	% of category with nausea on day 3	% of category with nausea after race
1 (n=149)	0.7	2.8	2.1	11.41
2 (n=84)	1.2	8.3	3.6	7.1
3 (n=59)	0	3.4	1.7	5.1
4 (n=49)	0	6.1	6.1	8.2
5-10 (n=211)	1.42	4.3	1.0	5.7
11+ (n=100)	3.0	5.0	3.0	3
Average	**1.05**	**4.98**	**2.92**	**6.75**

The higher incidence of nausea on the second day would be expected when one considers that over half the field spend about 5 hours per day, some as much as 7 hours engaged in strenuous

exercise. The paddlers would then suffer all the detrimental effects of heat and exhaustion besides coping with contaminated water. The above table also shows that the most experienced canoeists suffered the least nausea and vomiting after the race.

Table 4.3.2.D: A comparison of experience versus the instances of infected wounds suffered during and after the Dusi

Previous experience in marathon	% of category with infected wounds on day 1	% of category with infected wounds day 2	% of category with infected wounds on day 3	% of category with infected wounds after race
1 (n=149)	2.1	1.4	2.1	10.07
2 (n=84)	5.9	5.9	4.8	17.9
3 (n=59)	1.7	1.7	1.7	13.6
4 (n=49)	2.0	0	2.0	18.4
5-10 (n=211)	2.4	2.8	2.4	14.7
11+ (n=100)	2.0	3.0	4.0	21
Average	**2.68**	**2.47**	**2.83**	**15.95**

The post-race infections far exceed those during the race which is explained by the fact that wounds which were not properly cleaned initially would go septic later. Competitors reported that the same happened when thorns were not removed. Those suffering most from post-race infection were the 11+ or most experienced paddlers (known as Dusi "rats" by the canoeists) - a surprising trend. This was, however, not statistically significant when a Chi square test was applied.

4.4 The influence of medication on the instances of sickness

The number of participants who took medicines during the race as well as the medicines taken has already been investigated in section 4.1 (see figures 5,6 and 7). However, this section deals with the question of the efficacy of the medication.

The results shown earlier, state that 40% of all competitors answering the questionnaire suffered from some kind of illness. (This figure is based on answers to question 3. If the result is based on question 5 using the corrected total of 285 the percentage increases to 43.7%.) Of the 40% who responded positively to Question 3, 85% took medication of some sort. These percentages may be misleading as they do not tell one how many people who took, for instance immodium suffered from diarrhoea. However, this statistic in itself does suggest that the competitors were not taking the correct medicines or that the preventative medicines taken were not effective. One competitor felt that she had had so many vaccinations that her immune system could not cope and she was very ill.

Figure 15 shows a breakdown of the number of paddlers who took a certain medicine and the percentage of these that fell ill. Once again its shortcoming is that it does not show whether the medication taken was appropriate. This analysis was not done since a great majority of the paddlers did not specify exactly what sickness they suffered from. The figure suggests that either the preventative medicines taken were not very effective or that competitors took the medicines because they were sick.

Table 4.4.A: Preventative medicines used

	Sick - Yes	Sick - No
Preventative med. - Yes	50 (17.5%)	57 (15.6%)
Preventative med. - No	235 (82.5%)	309 (84.4%)
Total	**285**	**366**

The taking of preventative medicine was not a significant factor in determining sickness ($p = 0.5$).

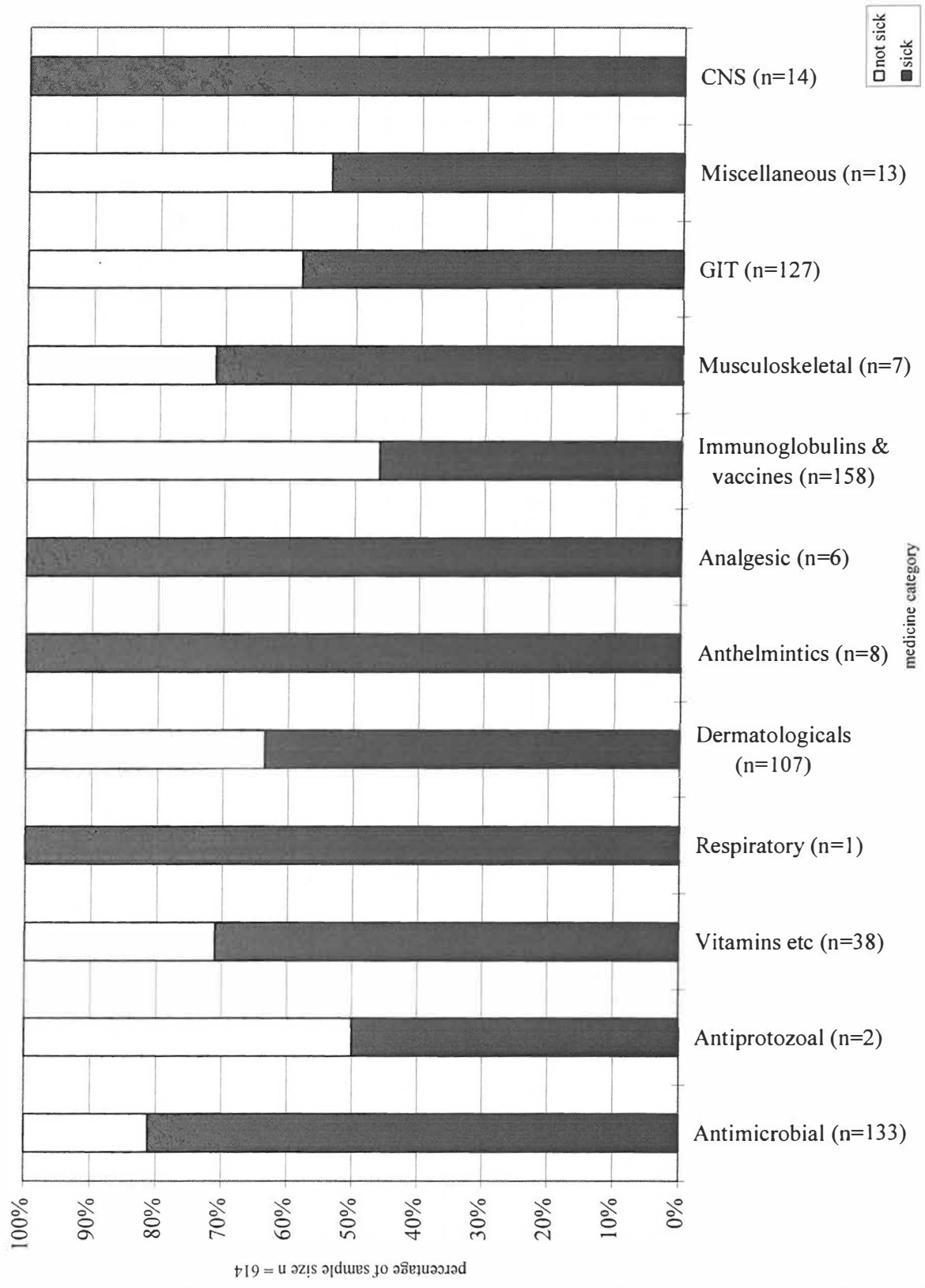
Table 4.4.B: Total medicines used

	Sick - Yes	Sick - No
Taking medicines - Yes	235 (61.5%)	147 (38.5%)
Taking medicines - No	50 (18.6%)	219 (81.4%)
Total	**285**	**366**

Chi square = 118.2 $p=0.001$

As can be seen from the above table a significant number of competitors took medicines

Fig. 15: Trends of Medicines taken during marathon



4.5 The influence of water contact with the instances of sickness

This section is critical to the hypothesis of this project, which states that the incidence of sickness in the 1996 Dusi is directly related to the water quality. Here trends between the frequency of the competitors contact with water, the location of this contact together with the corresponding E.coli levels as well as the competitors' health are sought.

The first set of results that will be considered is the breakdown of how many competitors fell out/ swam or lay in the water and whether they were ill. If one looks at the table below comparing the incidence of illness with the percentage of paddlers who lay in the water, there does not seem to be a link between sickness and lying in the water. Significantly more of those who did not lie in the water were sick, than those who lay in the water ($p=0.005$). Of those who lay in the water 38.6% were sick (refer to figure A in appendix showing number of competitors falling out at each location).Note that "sick " includes the heat-related illnesses.

Table 4.5.A: A comparison between the incidence of sickness and lying in the water

	Did not lie in water (no.)	Lay in water (no.)
sick	55 (53.9%)	159 (38.6%)
not sick	47 (46.1%)	253 (61.4%)
Total	**102**	**412**

Figures 16, 17 and 18 show the results of a comparison between the incidence of illness on a particular day with the number of times competitors fell out. Considering all three days there is no apparent trend between the number of paddlers who were sick and the number of times they fell out.

Fig. 16: Trend comparing incidence of illness with no. of fall outs - Day 1 (n = 609)

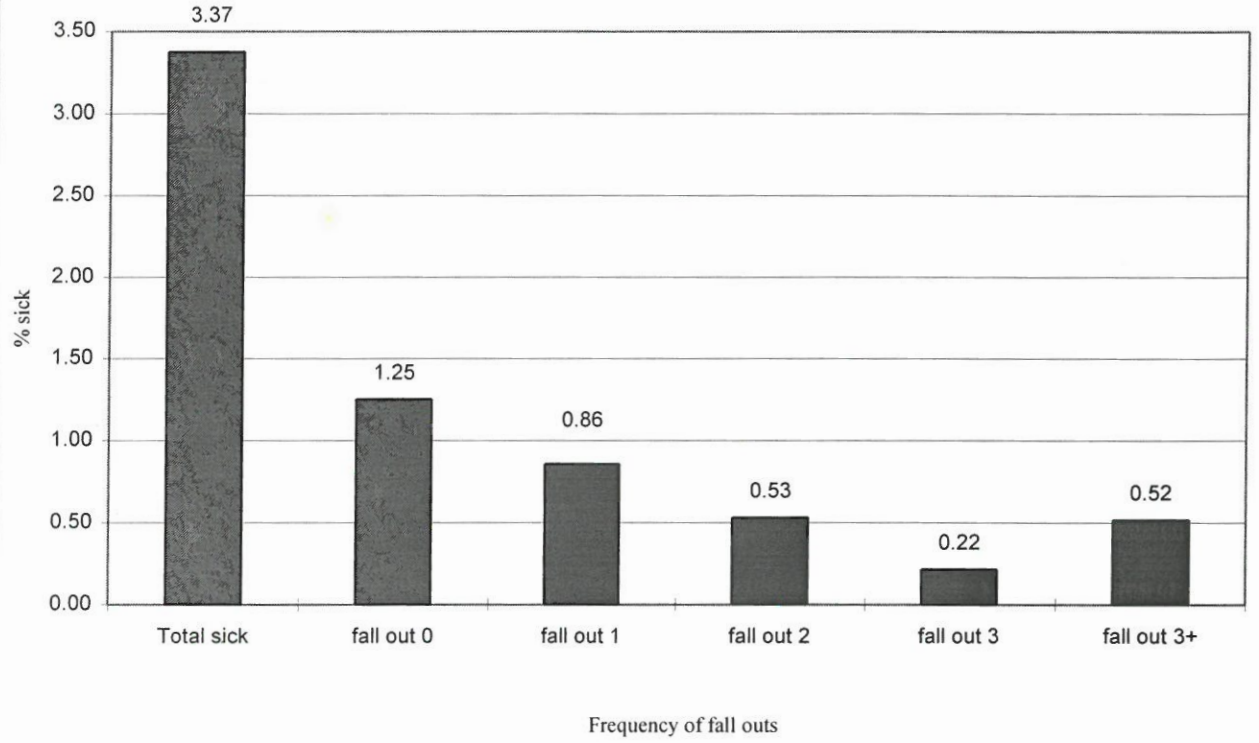


Fig. 17: Trend comparing incidence of illness and no. of fall outs - Day 2 (n = 576)

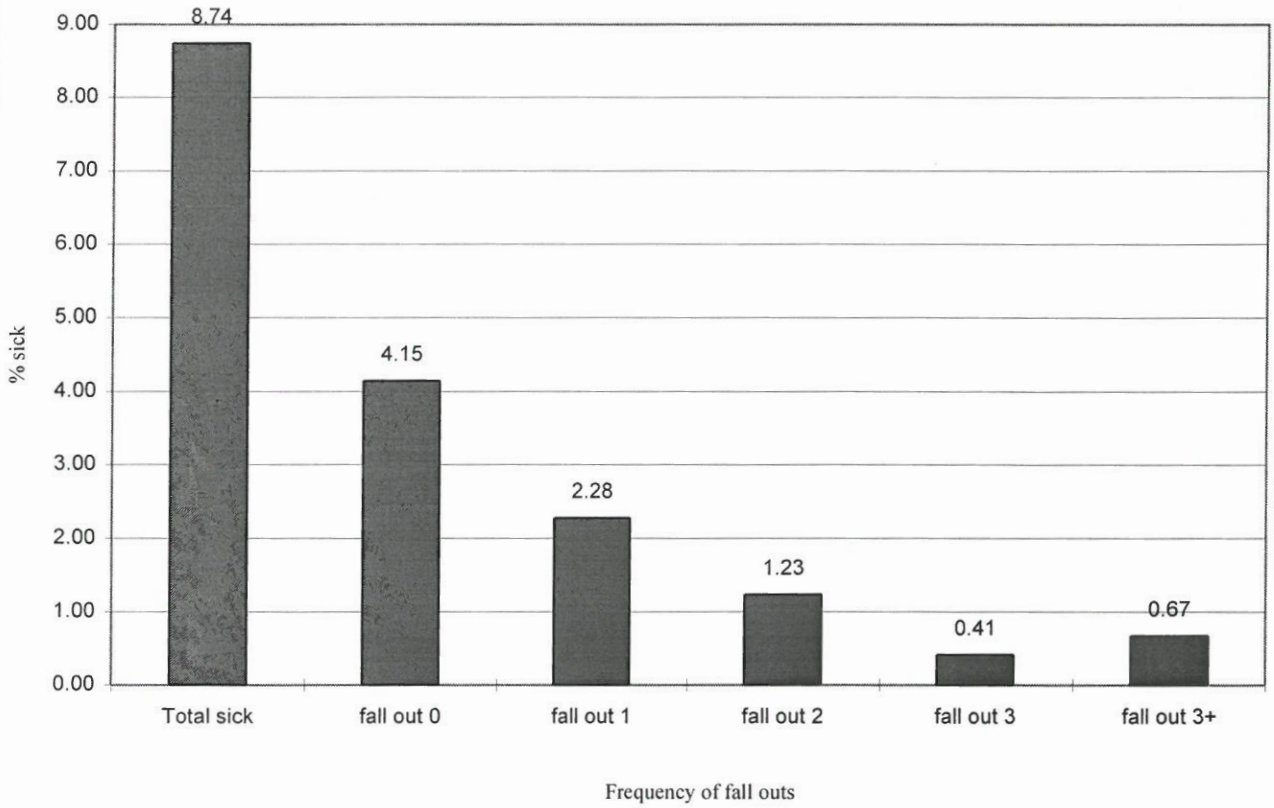
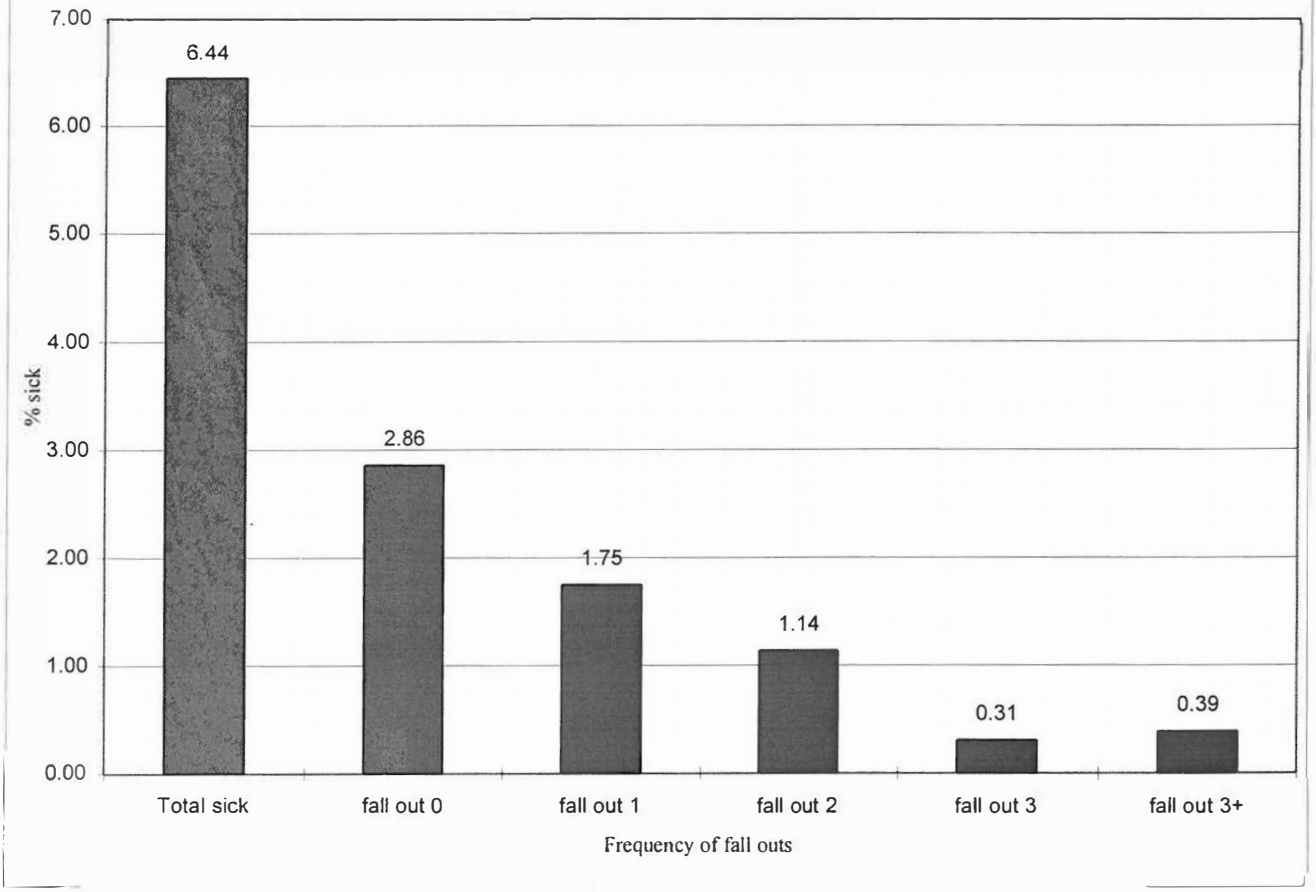


Fig. 18: Trend comparing incidence of illness with no. of fall outs - Day 3



The following table shows that, regarding sickness, it did not matter on which day or combination of days a competitor fell out. It is remarkable that in all cases investigated an almost constant percentage (40%) of paddlers got sick. Although this figure of 40% is the same as that found for the overall incidence of sickness as described in section 4.1, this is mere coincidence as it is derived using completely separate searching criteria. Note that this table differs from that above in that the incidence of sickness does not only relate to the particular day.

Table 4.5.B: A breakdown of when paddlers fell out and if they were sick or not

	Fell out only on day/s						
	1	2	3	1 & 2	1 & 3	2 & 3	1 & 2 & 3
Total no. of paddlers	72	38	73	72	73	19	148
no. sick	30	18	30	32	28	7	63
% sick	41.67	47.3	41.1	44.4	38.4	36.8	42.6

Table 4.5.C: A breakdown showing the incidence of sickness among those paddlers who fell out

Criterion	Total no. meeting criterion	No. of paddlers sick	% of paddlers sick
Didn't fall out	143	51	35.7
Didn't lie in water	102	55	53.9
Didn't fall out or lie in water	34	20	58.8
Fell out only once	119	48	40.3
Fell out 2-8 times	387	166	42.8
Fell out 9 times or more	31	12	38.7

The table shows the relationship of water contact to illness. It is important to note that there is no statistical difference in the number of paddlers reporting illness and the number of times that they fell out during the race ($p = 0.190$). Of interest is the high percentage of paddlers who did not fall out or lie in the water who fell ill (58.8%), probably the higher grade and/or more experienced paddlers. This is significantly higher, $p < 0.01$, (Chi square) than those paddlers who fell out 9 or more times. There was no difference between the number of paddlers who fell out (495) and who became ill (208) and the number of paddlers who did not fall out (143), and subsequently fell ill (51), ($p=0.17$). Furthermore there was no difference between those who did not fall out, and those who fell out 9 or more times ($p=0.75$).

Table 4.5.D: A comparison between the incidence of sickness and falling out

	Did not fall out (no.)	Fell out (no.)
sick	51 (35.7%)	211 (41.5%)
not sick	92 (64.3%)	298 (58.5%)
Total	**143**	**509**

The above table (4.5.D) summarises previous results showing that there was no significant difference in subsequent illness between those who fell out and those who did not fall out (p=0.21). It is interesting to note that even if paddlers did not fall out about one third were also sick, probably from the higher grades as seen before.

In the following table the sickness ratio (i.e. the ratio between the instances of sickness and the number of times paddlers fell out) is calculated according to the guidelines formulated in the United States and Canada for recreation in environmental waters (Grabow, 1993). These recommend an acceptable risk limit of 8 illnesses per 1000 swimmers. However, care should be taken when conducting such a comparison since complications may arise where there are infections without clinical symptoms. Other cases such as infections with long incubation periods which make it difficult to detect infections or identify the source of infection should also be accounted for.

The figures are skewed low because 4 is the maximum number of fall outs recorded on any day.

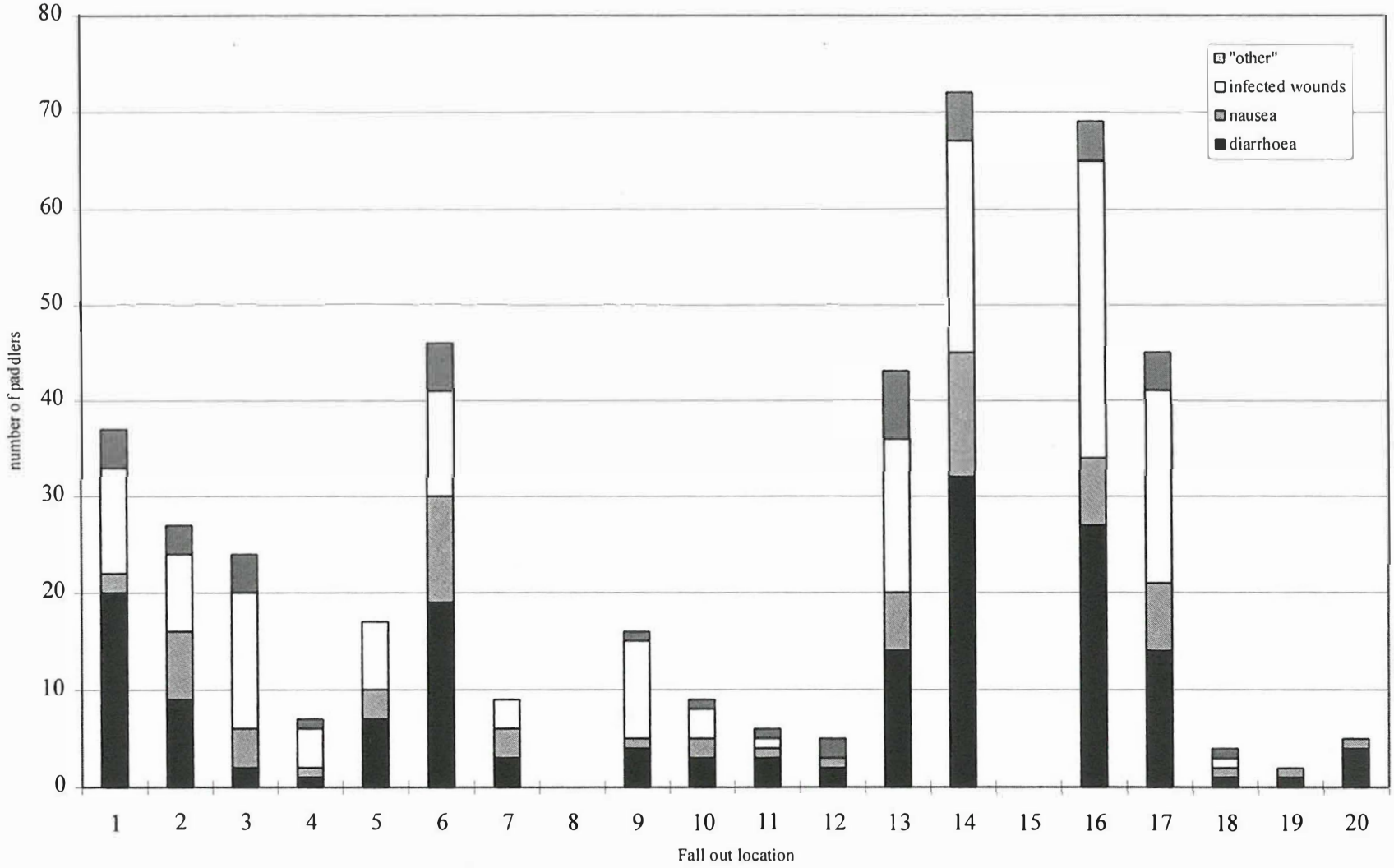
Table 4.5.E: The Calculation of Sickness Ratios for the 1996 Dusi Canoe Marathon

Sickness	Number of paddlers who fell out	Number of times paddlers fell out	Reported cases of sickness overall	Never fell out and sick	sickness ratio per 1000 people	sickness ratio per 1000 fall outs
Diarrhoea	495	1940	149	19	262.6	67.0
Nausea	495	1940	81	13	137.4	35.1
Infected Wounds	495	1940	123	19	210.1	63.4
Other illnesses	495	1940	82	16	133.3	34
	sample size					
Any Problem	652	1940	285	-	437	-

From the results, it is clear that in all cases even when the type of illness is categorised the sickness ratio is higher than the prescribed limit and can hardly be considered acceptable.

The final comparison in this section was one showing the overall number of competitors who fell out of their craft at a single location, whether the competitor was sick or not and what illness they suffered. A breakdown of when the competitor was ill (i.e. what day during the race) was also noted. Figure 19 shows the overall trend of this analysis. Note that multiple fall outs were possible at each single location.

Fig. 19: A comparison of paddlers who fell out only at a single location and their sicknesses (note: multiple fall outs at one location possible)



4.6 A Breakdown of "Other Ilnesses"

This is a special category that was used for competitors who suffered any illness that was not specified anywhere on the questionnaire (eg. dehydration). A table summarising the replies to this category follows below:

Table 4.6.A: A breakdown of other illnesses

Type of Illness	Number of cases reported
total number replying	96
dehydration	29
tick-bite fever	13
bilharzia	11
influenza - Dr treatment	7
cellulitis	4
ear infection	4
stitches to cuts	2
eye infections	2

Other conditions reported were (1 of each): typhoid, encephalitis, mumps, boils, whitlow, herpes, glandular fever, hypertension, hepatitis A, malaria, bronchitis and a viral infection. The remaining 12 of the 96 who reported "other illness" did not specify what their illness was. The most serious infected wound led to surgical removal of necrotic tissue and medical expenses of R27,000 - a severe indictment against the quality of the river water. Many more than the 29 reporting dehydration here were treated in the medical tent and the four with cellulitis could be included in infected wounds.

The above list of diseases suffered during the Dusi is of great importance as it allows race organisers to plan ahead for future medical tents, eg. the river was so high this year that more competitors took to portages and were bothered by thorns. An example of such future planning is the supply of needles required to remove thorns as their shortage during the 1996 race was noted by the nursing staff.

5. Conclusions

Based on the results of this investigation the following conclusions can be drawn:

652 competitors (50%) responded to a post-race questionnaire following a race held under flood conditions. Forty-three percent of those taking part in the 1996 Dusi Canoe Marathon who replied to the questionnaire got sick and 85.9% of those took medication.Twenty percent of respondents required treatment by a doctor during or after the race.

It did not matter how often the participants fell out or lay in the water, or what their experience or level of skill was, just being in contact with the polluted water was enough to cause illness. There was no correlation between the experience of the paddler and the number of times he/she fell out or lay in the water on Day 1,2 or 3. The higher graded paddlers tended to fall out less and lie in the water less often than the lower grades. They also tended to have a higher percentage who suffered diarrhoea and had medical problems. A possible conclusion is that this was due to the fact that they were highly trained and their immune systems depressed making them more susceptible to the deleterious effects of heat,exhaustion and infection.

The E.coli levels at all but one sampling point along the course were above the mandatory limit set by the EEC. Levels above 10,000 E.coli/100ml water are considered a serious health risk if the water is consumed. In 1996 water from locations 1, 2, 3, 19 and 20 thus contained excessively high levels.

The sickness ratio of 67, 35, 63.4 and 34 per 1000 fall outs in the race for diarrhoea, nausea, infected wounds and other illness respectively, compares unfavourably with the guidelines formulated in the U.S.A and Canada for recreation in environmental waters which recommends an acceptable risk limit of 8 illnesses/1000 swimmers. Although the Dusi Canoe Marathon is a race in an emerging country this is still unacceptably high. These ratios provide a guideline to the incidence of infection following participation in the Dusi Canoe Marathon in flood year conditions. The overall sickness incidence of 437/1000 competitors should be cause for concern.

Based on the daily fluctuations in E.coli counts it is unlikely that predictions of E.coli counts can be made when there is rain immediately before and during the race.

6. Recommendations for further work

As a result of the findings and conclusions of this project, the following recommendations for further work can be made:

1. Paddlers must be educated as to the optimum method of overcoming the effects of pollution by not drinking water, cleaning wounds immediately and using the most effective prophylactic medication.

2. Competitors must be made aware of the signs and symptoms of bilharzia and hepatitis. This would make them more alert to the possible severity of their condition and the complications following untreated and chronic infestations.

3. Umgeni Water and the medical officer of health should liase with the race organisers and those associated with the medical tent to discuss possible water contamination and the potential health risks.

4. Authorities need to be more vigilant to the extraneous pollution such as the "spillages" of cooking oil that occurred during the 1996 race. In such cases appropriate action should be taken against the culprits.

5. Seconds and others associated with the canoeists were not questioned and they should be included in further research. This would give an indication of the incidence of illness among people who accompanied the canoeists for the duration of the marathon and had minimal exposure to river water but comparable exposure to other sources of infection.

6. A controlled experiment could be set up in which a cocktail of prophylactic medication could be assessed.

7. Constructive criticism made by some competitors could be used to refine the questionnaire for future use.

8. Further research on the higher grade paddlers could be carried out to determine why they tended to have a higher percentage who suffered from diarrhoea and medical illnesses during the race.

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Appendix

Table A1: A breakdown of the different medicines taken during the Dusi

Category	Antimicrobial	CNS	Musculoskeletal	Respiratory	Analgesic	Anthelmintic
Medicine	antibiotic	anti-emetic	anti-inflammatory	decongestant	-	-
No. taking	134	15	7	1	6	8
% taking	20.6	2.3	1.1	0.1	1.0	1.2

% are based on number of people replying to questionnaire i.e. 652

Table A2: A breakdown of the different medicines taken during the Dusi

Category	Dermatologicals	Vitamins, tonics, minerals & electrolytes	G.I.T.	Miscellaneous	Antiprotozoal
Medicine	antibacterial / antiseptic	-	antidiarrhoeal, antispasmodic	-	-
No. taking	107	38	124	3	1
% taking	16.4	5.8	19.0	0.5	0.1

Table A3: A breakdown of the different immunisations taken during the Dusi

Category	Biologicals					
Vaccines	hepatitis A	hepatitis B	cholera	tetanus	typhoid	"hepatitis"
No. taking	43	18	6	57	7	24
% taking	6.6	2.7	1.0	8.7	1.1	3.7

Table A4: A comparison of illnesses suffered with location of fall outs - paddlers not sick

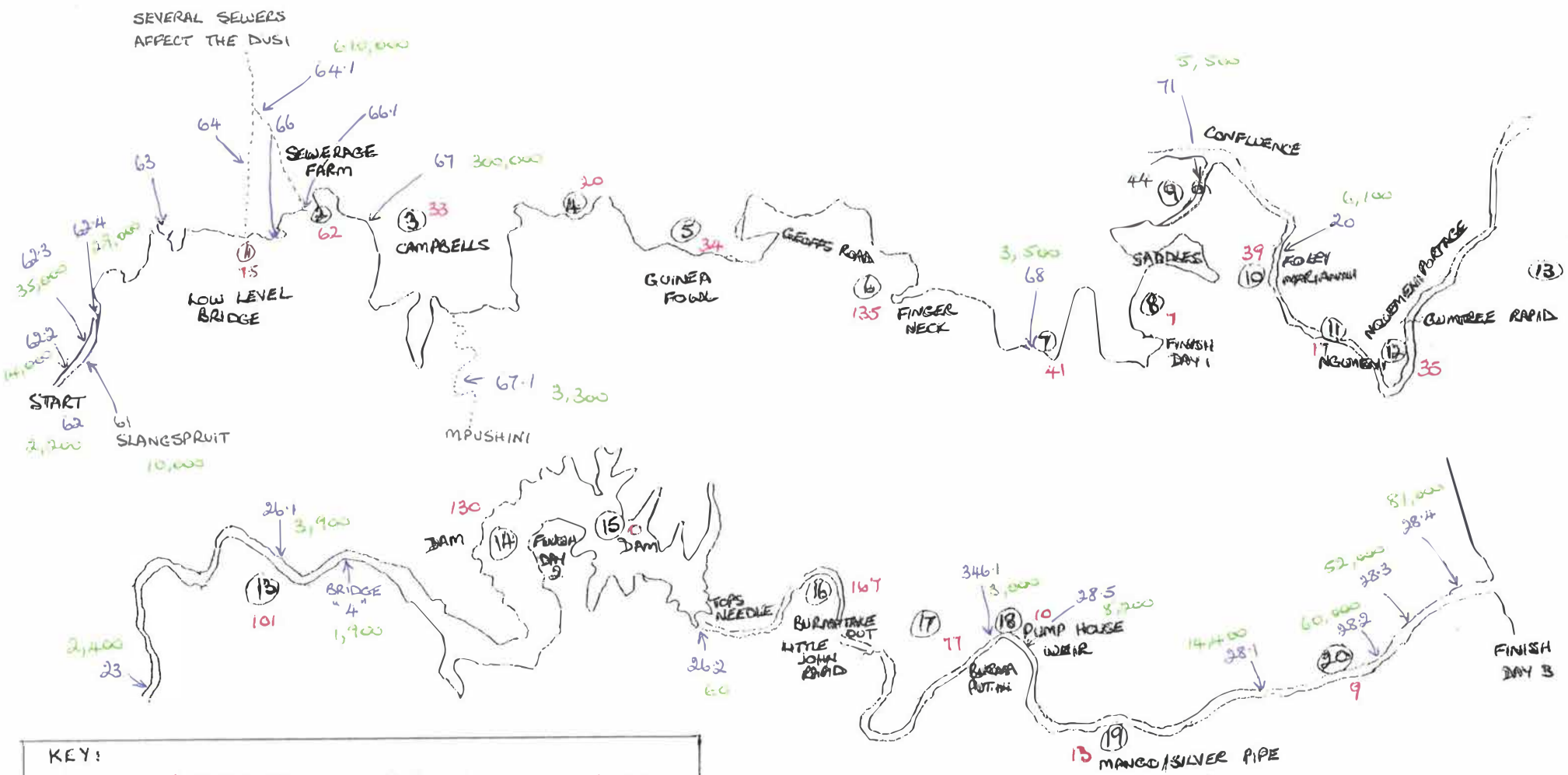
Not Sick		
Location number	**Location name**	**Number of fall outs**
1	Start - Low level	40
2	Sewerage farm	34
3	Campbell's portage	12
4	Campbell's - Guinea fowl	12
5	Guinea fowl	14
6	Jeff's road - Finger neck	77
7	Finger neck - Finish	26
8	Start - Saddle	2
9	Saddle portage - Confluence	27
10	Confluence - Marianni Foley	25
11	Marianni Foley - Ngumeni	6
12	Ngumeni Portage	20
13	Gumtree - Dam	58
14	Dam-Finish	67
15	Dam (Start)	0
16	Tops Needle - Burma take out	96
17	Little John - Burma put in	34
18	Burma put in - Pump house weir	5
19	Pump house weir - Mango/Silver pipe	8
20	Silver pipe - Finish	3

Table A5: A comparison of illnesses suffered with location of fall outs - paddlers sick

Sick		
Location number	**Location name**	**Number of fall outs**
1	Start - Low level	35
2	Sewerage farm	28
3	Campbell's portage	21
4	Campbell's - Guinea fowl	8
5	Guinea fowl	20
6	Jeff's road - Finger neck	59
7	Finger neck - Finish	14
8	Start - Saddle	5
9	Saddle portage - Confluence	17
10	Confluence - Marianni Foley	14
11	Marianni Foley - Ngumeni	11
12	Ngumeni Portage	15
13	Gumtree - Dam	43
14	Dam-Finish	62
15	Dam (Start)	0
16	Tops Needle - Burma take out	70
17	Little John - Burma put in	43
18	Burma put in - Pump house weir	5
19	Pump house weir - Mango/Silver pipe	5
20	Silver pipe - Finish	10

Figure A

1996 Dusi Route showing number of competitors who fell out at each location, sampling points, locations and E. coli /100ml



KEY:

Number of competitors who fell out at each location

Umgeni Water Board sampling points.

Locations ① - ⑳.

E. coli levels / 100 ml

EXERCISE LABORATORY
UNIVERSITY OF NATAL MEDICAL SCHOOL

Dear Fellow Dusi Paddler,

As you are aware, there was much concern about the degree of pollution of the Dusi following the devastating and tragic flooding in and around Maritzburg in the weeks preceding the race. The good water levels on the first and third days, made the race a memorable one, but not for all of us. There is at least one competitor, who after several operations, is still suffering the effects of an infection contracted during the race.

I am trying to establish whether this is an isolated freak occurrence or whether this truly was a bad year for wound infections and "Dusi guts". There is very little data on this problem from previous years. One of the reasons for this is that other surveys have been largely ignored and filed in the waste paper bin. We as paddlers need to know what the chances are of our becoming ill when racing in polluted water. To do this, we need to establish a database of what happens in polluted years and compare it with less polluted years. This can only be achieved if we get a large enough response to this survey. A reply indicating that you encountered no problems is just as important as one telling us about your days spent racing to the toilet.

One of my post graduate students has offered to take this on as a research project. Please help her and future Dusi paddlers by spending five minutes completing this survey.

Yours sincerely,

Professor Maurice Mars

Please fill in this form by ticking the appropriate box.

1. How many Dusi's have you completed? ☐

2. What is you Natal Grade? ☐

3. Did you have any medical problems with infected wounds or any illness during or after this year's Dusi?

   ☐ YES If Yes, please complete the rest of the questionnaire

   ☐ NO If No, please leave out the question 5

4. Did you take any medicines before, during or after the Dusi in an attempt to prevent illness during the Dusi, e.g. anti-diarrhoeal medication, anti-septic ointment on an abrasion or cut?

   ☐ YES If Yes, please list the medicines taken or used.

   ☐ NO

5. Which of the following problems did you experience? Please tick the appropriate boxes.

	At any time			Day			After Race			Treatment		
Diarrhoea	Yes	No		1	2	3	Yes	No		None	Self	Doctor
Nausea or Vomiting	Yes	No		1	2	3	Yes	No		None	Self	Doctor
Infected wounds	Yes	No		1	2	3	Yes	No		None	Self	Doctor
Other illness-specify	Yes	No		1	2	3	Yes	No		None	Self	Doctor

If you required treatment, what treatment did you receive? _____

_____

_____

_____

6. In order to work out the places where paddlers are most at risk of infection in years of bad pollution, we need to know where you were unfortunate enough to swim and the number of swims that you had. (If you answer "more than 3" it is not necessary to list the places.) We also need to know if you lay in the water to cool off either during the race or at the end of a day. If you sustained any cuts or abrasions which subsequently went septic, where on the race did they occur?

Day 1

Swims [None] [1] [2] [3] [More than 3]

Lay in the water [Yes] [No]

Swam at or sustained cuts at: _____

_____

_____

Day 2

Swims [None] [1] [2] [3] [More than 3]

Lay in the water [Yes] [No]

Swam or sustained cuts at: _____

_____

_____

Day 3

Swims [None] [1] [2] [3] [More than 3]

Lay in the water [Yes] [No]

Swam or sustained cuts at: - _____

_____

_____

7. On previous Dusi's, have you suffered any -

illness [Yes] [No] Years _____

septic wounds [Yes] [No] Years: _____

Thank you very much for completing and posting back this survey.